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

Kuvik, A.N.

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The Global Competition for Talent:
Life Science and Biotech Careers,
International Mobility, and Competitiveness

AIMEE KUVIK

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The Global Competition for Talent: Life Science and Biotech Careers, International Mobility, and Competitiveness

ACADEMISCH PROEFSCHRIFT

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aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
    Prof. dr. D.C. van den Boom

ten overstaan van een door het College voor Promoties ingestelde
commissie, in het openbaar te verdedigen in de Agnietenkapel
op donderdag 28 mei 2015, te 12:00 uur

doors

Aimee Nicole Kuvik

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Faculteit der Maatschappij- en Gedragswetenschappen
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I first became aware of what a PhD entailed as a Sociology Bachelor’s student, and am indebted to one of my first Sociology instructors and academic advisor, Dr. Michael Katovich at Texas Christian University, for inviting me to present at an academic conference and broadening my mind to new ways of looking at the world and theories.

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I am also forever thankful to all the individuals around the world, who took time to answer the CiLS survey, and those who participated in interviews. I thank you for your time, and hope that the contents of these pages express your career dreams and frustrations, in a way that can lead to better understanding.

The late Dr. Uwe Becker and the ‘Smallcons’ Amsterdam political science research team (aka the girls) – Franca van Hooren, Natascha van der Zwan, and Corina Hendriks – who I worked
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To my dear friends who I met early on during my Master’s degree in Amsterdam – Brit Lynnebakke, Claire Meeussen, and Karin Schaake – you formed the cornerstone of both academic encouragement and also personally as life turned in unexpected ways from the start of my Amsterdam life chapter of life until now. I am thankful for all the understanding, the laughter, and adventures I have shared with each of you!

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Branyo, you are the love of my life, my greatest support, the balance of my weaknesses, the one who can always makes me laugh and smile. I once heard the general advice to wait until a PhD is finished before getting married, due to the PhD stress involved. Although I thought it made sense at the time, I am so thankful I did not follow this advice. With you, the seemingly difficult becomes much easier. It was you who took me from being proud of being independent to being interdependent. I love you completely and cannot imagine my life without you.

I would not have been able to make it to where I am now without faith, and am thankful for God for the challenges overcome and for uncountable blessings. Thanks to all those who said prayers for me when they knew I needed it.

Thinking back at the names listed of those that helped me during this project, individuals from more than 15 different countries, worked closely with me and influenced. Additionally, people from 69 countries took the time to share their thoughts and experiences through the CiLS survey. People may debate what global skilled, scientific, or student mobility will or should bring, but it is evident that changes are happening! My greatest wish is that at least one person will be inspired by this research and advance the research topic further than I ever could alone.
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# TABLE OF ABBREVIATIONS

Abbreviations related to this research study:

- **CiLS** Careers in Life Sciences survey and study
- **YEBN** Young European Biotech Network

Geographic abbreviations:

- **BRIC** Brazil, Russia, India, and China
- **CEE** Central and Eastern European
- **EEA** European Economic Area
- **EFTA** European Free Trade Agreement
- **EU** European Union
- **OECD** Organisation for Economic Co-operation and Development

Abbreviations related to policy:

- **ERA** European Research Area
- **GATS** General Agreement on Trade in Services
- **HRST** Human resources in science and technology
- **IT** Information technology
- **MINT** Mathematics, information sciences, natural sciences, and technology
- **R&D** Research and development
- **S&E** Science and engineering
- **SET** Science, engineering and technology
- **STEM** Science, technology, engineering and mathematics
THE GLOBAL COMPETITION FOR TALENT: KEY CONCERNS

An article from the Migration Policy Institute (2008) summarized the top ten international immigration issues of that year, and a notable contradiction immediately appears. Number one on the list was the ‘buyer’s remorse,’ or the regrets of countries that have been open for labor migration, while number two on the list involved the ‘race for talent’ and ways to best attract skilled migrants. When talk of economic crisis circles the globe, it is easy to imagine a tendency for more closure of national labor markets, but likely increasing individual interest for seeking better opportunities than what is found locally. It is also plausible that the international demand in certain occupations, and particularly for those which are seen as to trigger innovation and hence job growth over the longer term, could in fact increase even more, despite the recession in other sectors, as governments name these as the engines for sustainable economic growth in the coming decades. These top two global issues and tensions for migration policy are also reflected in the current situation in Europe. On one hand, immigration is a contentious issue in many countries and is very highly politicized; on the other hand support for technological development and the knowledge economy is nearly universally accepted and hence ‘attracting talent’ is often viewed as essential.

Economic changes are often linked to globalization pressures, defined as increasing mobility of capital, goods, and labor. At times there is a need to ‘compete’ to attract and maintain these valuable resources. As traditional manufacturing jobs have largely been relocated from Western Europe or the US to countries with cheaper production costs, and as the destinations with ‘cheaper’ costs also push further outward as emerging economies develop, interest has been focused on how economies can maintain high employment and prevent economic stagnation. As a result, there is increasing interest on creating and targeting industries with the highest productivity gains and added value, and hence more focus on developing knowledge-based industries to thwart the risk of long-term economic decline. Employment patterns continue to change alongside internationalization of companies and the new global division of labor. The growth of the knowledge economy, as seen in industries such as IT, software, and skilled service jobs has offered new economic opportunities, particularly since the 1990s. Yet, global competition has also increasingly involved outsourcing to firms in countries with lower labor costs, including jobs associated with the knowledge-based economy, such as research and development (R&D). With these new pressures, governments have been concerned about ensuring future job growth and economic prosperity; or in other words, international competitiveness and the underlying factors that help a place to maintain its competitive edge.

Since the late 1990s, immigration, and particularly skilled migration, has also become more associated with the growth and development of the knowledge economy, to fill high-skilled labor shortages and as a way to generally gain the ‘best’ employees, largely drawing from analyses done on the IT sector in the US. ‘Skilled migration’ does not have a single definition, but rather is typically defined either by education levels, usually a Bachelor’s degree or higher, or by
occupations seen to contribute to the country or by skills that are in short supply within a national economy. Large amounts of interest have been generated by the particular example of the successful Silicon Valley, California’s leading IT cluster, and its use of foreign skilled labor and entrepreneurs, particularly building on the research of Saxenian (2005; 2008). The increase in the US’s visa quota allowed extremely high levels of immigrant involvement. For instance, in 1999, 32% of the science and engineering workforce (Saxenian, 1999, p. viii) and 25% of the entrepreneurs in the Silicon Valley were foreign-born (p. 20). The 1990s can therefore be seen as the beginning of an important change, even a paradigm shift, as skilled migration increasingly became associated with economic competitiveness and led to the emergence of subsequent discussions of a ‘race’ or ‘global competition for talent’ (for example Kupisch & Pang, 2006; OECD, 2008; Shachar, 2006; Skeldon, 2009; Zalatel, 2006). However, such phrases seem to presume that skilled immigration has been accepted as necessary for competitiveness by national economies and that mobility of individuals proceeds unrestricted, driven by the personal motivation of highly skilled individuals who choose, on a global scale, where to relocate. While elements of this image are true, the mechanisms that limit and restrict possibilities for global migration are completely ignored. Globalization presents a dilemma for governments in how to best balance participation in international economic systems while protecting their national citizens’ interests. These tensions between global economic processes and supporting the well-being of citizens also mean that there is a great room for variation in approaches adopted by governments to support their labor markets and citizens. This variation is illuminated in political-economic literature related the varieties of capitalism (see e.g. Esping-Andersen, 1990; Hall & Soskice, 2001; Schmidt, 2002), which partially discuss the existing models of welfare states and various models of welfare capitalism. This idea has also further led to discussions of how countries can be competitive despite high levels of regulation and costly systems of social protection. These tensions have also further been illuminated by debates surrounding how to deal with the current economic crisis of the early 2000s, with support for protectionist measures on the rise in many countries\textsuperscript{1}. The importance of the question is further reflected the rising support for ‘right-wing,’ politics with anti-immigrant platforms as central to their campaigns, as has happened visibly in 2009 and 2010 in countries long applauded for their ‘tolerance’, such as the Netherlands and Sweden.

The global economic and financial crisis starting around 2008 further highlights the challenges of finding a balance between concerns about preserving jobs for nationals and concerns about being globally competitive, but perhaps not in the ways expected. Various research reports (see e.g. Cerna, 2010; Dobson, Latham, & Salt, 2009; Ghosh, 2011; International Organization for Migration, DG for Employment, & Social Affairs and Equal Opportunities of the European Commission, 2010; Koser, 2009; OECD, 2009a) have examined the effects of the economic crisis on international labor mobility. The general finding has been that skills shortages persist even during economic recession.

\textsuperscript{1} http://news.bbc.co.uk/2/hi/business/7866930.stm, Accessed 4 March 2015
Past theories as well as patterns, of globalization have focused primarily on the aspects of the increasing mobility of capital and goods, and the human mobility aspect has been seen as facing greater limitations in being truly globally mobile (Rodrik, 2001). This study will argue that skilled human mobility and specifically that for occupations linked to innovation, such as for science and technology, has also undergone a rapid and continuing internationalization. This change has theoretical implications and requires a greater merging of theories in diverse disciplines. First, skilled migration theory is too narrowly based on past patterns of labor mobility, and on assumptions of US dominance in attracting skilled migrants, with too few applications analyzing recent changes in skilled mobility in diverse contexts. Second, the change is substantial enough to question the adequacy of skilled migration theory in explaining new trends in skilled mobility. In the economic literature, ‘human capital’ research often narrowly focuses on educational levels as creating economic gain, while the competitiveness literature assesses diverse structural aspects, but often breezes over the personal characteristics of the workforce and their professional experience and qualifications. The main premise of the study is that the ‘global competition for talent’ has come into play in media, policy, and migration research, but more as a catchword rather than as an intricately defined concept or theory that pays attention to both the more ‘global’ changes as well as the particularities of career and place contexts. This study’s aim is to begin closing this gap by discussing the theoretical frameworks and changes surrounding international skilled labor mobility, developing a more integrated framework for assessing the now only speculative global competition for talent, and looking at variations through a case study, focusing on life scientists and the biotechnology sector in various countries.

What does examining the life science and biotechnology sector in particular add to the discussion of skilled migration? First of all, these sectors are likely to be areas of long-term interest, both for skilled migration policy and also for more general economic and science policies. Much of the initial research related to the knowledge economy workforce has focused on the IT sector, as this sector launched much of the interest related to skilled migration for the knowledge economy. However, beginning in 2007, the pharmaceuticals and biotechnology sector became the sector with the highest corporate R&D spends globally, surpassing the technology hardware and equipment sector (European Commission, 2007c). The overall industrial R&D spends in Europe showed year-to-year growth in 2009, despite the recession starting in 2008 (European Commission, 2009a, p. 1). Although the magnitude of the growth has decreased, there was still a 6.9% nominal growth among the European companies included in the study, compared to 9.0% in 2007 and 10% in 2006.

The life sciences and biotechnology sectors are therefore important both in the global as well as the European Union’s (EU) knowledge economy specifically, and have been selected as the field investigated in this study. The OECD defines biotechnology as “the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services.” Biotechnology involves a range of goals, including for healthcare (the most developed field), agriculture, alternative fuels and environmental solutions such as handling of wastes and pollution, sustainable food production, and improved, more efficient and ‘cleaner’ industrial processes,
clearly a range of issues of global concern and relevant to both developing and developed countries.

Yet predicting future demand for any occupation or skill set is difficult. On one hand, along with the growth of R&D and new sectors such as biotech, questions arise as to whether the supply and skills of the workforce will be available to meet the growing demand. A 2004 report titled Europe Needs More Scientists (European Commission, 2004, p. 78) states,

> Without the availability of additional, highly qualified research personnel, the aim to double private research investments will merely lead to a tighter labor market and to the ‘poaching’ of personnel from universities and other public research centres or from other European countries, including new member countries or from countries outside the EU that are SET (Science, engineering & technology) rich. Looking at the current labor costs for R&D personnel, realization of the Barcelona objective (part of the Lisbon Agenda which states that R&D should comprise 3% of member state’s GDP) implies a need for an additional supply of researchers between now and 2010 of around 700,000 (Key Figures 2003-2004) full-time equivalents.

On the other hand, due to the high level of funding for R&D and then regulatory approvals needed for new products, the biotechnology sector has also been identified with sudden, massive layoffs and even closures of companies, given the importance of small and medium-sized firms. Identifying the current and potentially changing patterns of mobility and structural, economic and other factors that support or hinder these changes, are therefore crucial to understanding the rise of the knowledge economy as well as an individual country’s structural strengths and weaknesses. It also points to the importance of issues related to utilization of the national labor force versus international mobility and discussions of potential brain drain or brain gain. Little research has addressed whether and how these workforce demands are being met in light of this competition and rapid knowledge economy growth, and more international and European comparison with attention to varying contexts is warranted.

**RESEARCH QUESTIONS**

The research questions for this study are listed in Table 1, and their analysis is divided into two parts. More details on the specific methods adopted are described in Chapter 3.

**TABLE 1 RESEARCH QUESTIONS**

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talent as observed in the life sciences/biotechnology in particular?

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<td>Explore work history and individual goals related to mobility - How important/prominent is international mobility in life science careers?</td>
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<td>Which factors are considered and influence life scientists’ intentions to move or moves abroad? Which countries are attractive to life scientists and why?</td>
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<td>Which duration of stay is most desired for moves for life science jobs in the US and in Europe?</td>
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<td>What effect do life scientists expect international mobility to have, in terms of staying abroad or returning to their home country to work?</td>
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<td>How have skilled migration policies and other policies facilitating international mobility of students and scientists developed in Europe?</td>
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<td>What are the main features of these policies within the European Union?</td>
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<td>What are the features of the labor market within which life scientists work?</td>
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<td>Which cities and countries are seen as the most competitive for biotechnology globally?</td>
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RELEVANCE OF RESEARCH ON THE GLOBAL COMPETITION FOR TALENT: RECENT GLOBAL CHANGES

The topic of this study, the global competition for talent, is important for several reasons. Skilled migration trends will likely change based on larger global changes in economic performance and the workforce characteristics, two aspects which cannot be seen as acting in isolation. Three of these global changes are assumed in this thesis to apply across a large number of economies, and are discussed in more detail for the broader European (EU) context:

1. **Global economic restructuring:** There is a projected shift in global economic performance and there are concerns that countries currently seen as having a competitive edge in technology and research-intensive fields may lose their edge. The industries that drive national productivity, and hence innovation (OECD, 2010) as well as competitiveness, have undergone substantial changes since the 1970s. It is predicted that in light of the rise of developing countries’ strength in not only manufacturing, but also in terms of science and technology, advanced economies will need to anchor their expertise in these areas. For example, a report by the European Commission (2009b, p. 10) states:
Research will develop outside the countries traditionally considered as leaders. If the recent trends continue, in 2025, the United States and Europe will have lost their scientific and technological supremacy for the benefit of Asia (China and India will have caught up with or even overtaken the Triad) even if they will still appear among the principal world powers as regards R&D. However, their relative weight in terms of R&D investments could strongly fall to the profit, in particular, of emerging Asia. India and China could thus account for approximately 20% of the world’s R&D, i.e. more than the double of their current share.

The Lisbon Agenda is a response to trying to maintain competitiveness, primarily building on concerns from ‘de-industrialization,’ loss of manufacturing sectors and other ‘traditional’ industries, and ‘de-localization,’ such as through outsourcing.

With more attention on globalization and the related structural economic changes, the concept of competitiveness has come to the forefront of both economic and migration policies. In order to maintain prosperity, it is felt that new economic sectors should be developed. Technology intensive, knowledge-based sectors are seen as a cornerstone of competitiveness for advanced economies and are often of interest for developing countries as well. Within the EU, the Lisbon Strategy was launched in 2000 and set as one of the top priorities for Europe to become the “world’s most competitive knowledge-based economy” by 2010. In order to maintain prosperity, new economic sectors should be developed and R&D spends increased to 3% of GDP across all EU member states. However, there are also numerous challenges. The specific areas of growth and employment can be hard to predict as the technology and demand involved changes quickly, the political-economic environment varies across place, and competition to build knowledge-based industries is international. The size and strength of these sectors is also growing in developing countries such as India and China.

2. Rapid changes in forms, patterns and scale of international mobility. There have been large-scale increases in international mobility of both university-level students and professionals, coupled with a high increase in the number of university educated individuals within many developing countries as well. These changes, along with cheaper and easier international travel and communication, have brought about possibilities for a more ‘global’ workforce. Although broad changes are being seen in international mobility patterns world-wide, the dynamics have also faced additional reasons for rapid change in Europe, namely due to the expansion of the number of countries belonging to the EU. Between 2004 and 2007, ten Central and Eastern European countries joined the EU and entails the right of ‘free mobility,’ including the mobility of individuals to live and work, across all countries in the EU – 27 EU members in total (see Glorius, Grabowska-Lusinska, & Kuvik, 2013). These political and institutional changes can have large ramifications on mobility patterns to and from countries in the EU, as there is greater disparity in incomes and job opportunities between not only individual regions, but when comparing countries within the EU on a whole.

3. Greater demand for skilled migration: The ageing of the working population in Europe has led to concerns of not having a young enough workforce to meet the future demand. Alongside a general decline in the size of the working population, there are also concerns about having
shortages of certain skills in the science and engineering workforce. Skilled professionals from abroad are seen as offering a possible solution, and while not all European countries have responded equally to date, it is assumed that the demand for qualified professionals will continue. However, it is important to also note skilled migration is only one potential route to address these issues.

Despite these trends, immigration policy often remains an area where the tensions of globalization in terms of successfully participating and operating in global economic systems while simultaneously protecting well-being and welfare of nationals and others, including immigrant populations already residing in a country is apparent. On one hand, it is becoming more accepted to see skilled migration as making a positive contribution to the welfare system while also helping to balance the demographic changes associated with the graying of the population and potential workforce shortages. On the other hand, critics of skilled migration argue that training and utilization of the national workforce should be the priority instead of immigration and that skills shortages indicate structural problems, such as those in the education system. Past policies for immigration are often seen as problematic and countries must decide which rights the immigrants should have and whether or when to extend full citizenship. Deciding on which conditions apply and to whom raises moral questions; for instance, when rich investors are favored over other individuals who may be needed economically. Immigration has also been limited due to concerns are also related to national security, especially after the events of 9/11. Furthermore, although policy mechanisms, such as work permits and visas, may be less contentious for high-skilled jobs, the particular laws and mechanisms (for example in quotas by nationality or sector of employment, labor market tests, income requirements, or the degree of power afforded to corporations for offering work or residence permits) vary. In light of the economic crisis starting in late 2007, some countries currently open to skilled migration, the UK and Australia, had announced cuts in quotas for skilled migrants due to economic recession and pressure from the public and trade unions already in the first half of 2008. Similar measures are likely elsewhere when economic woes deepen, as has been observed in past recessions (for discussion of the impact of the crisis on migration policies, see Cerna, 2010; International Organization for Migration et al., 2010; OECD, 2009a).

CONTRIBUTION TO THE LITERATURE

The global competition for talent is a fairly recent concept in the academic literature and policy (Abella, 2006; Cervantes & Goldstein, 2008; Doomernik, Koslowski, & Thränhardt, 2009; Florida, 2005; Kapur & McHale, 2005; Kuptsch & Pang, 2006; OECD, 2008; Papademetriou & Sumption, 2013; Shachar, 2006; Skeldon, 2009; The Partnership for a New American Economy & The Partnership for New York City, 2012). While the phrase is often used, the various elements that have an impact on its development are not fully understood. In addition, very few studies have been able to frame how these new dynamics, that is new forms of mobility and new destinations, actually have an impact on the workforce.

In summary this research projects adds new, topical information to better understand what is meant by the global competition for talent on several levels.
• First, it is situated within current debates surrounding economic competitiveness and pressures from globalization. Furthermore, in light of discussion about the “global competition for workers” the attention to career aspirations and countries’ differences is instructive to better understand the global competition for talent.

• Second, the study will add important empirical analysis by focusing on the life science/biotechnology sector, which is currently being targeted both through policies of the EU and in national economic policies. This topic is therefore of interest to business and governments alike.

• Third, much of the immigration research in Europe has focused on past migrations (guest workers/post-colonial). This study proposes an innovative way to study new dynamics (beyond brain drain versus brain gain) and mechanisms for skilled migration within the modern context of Europeanization and globalization.

• Fourth, states are currently torn between debates on how to best attract high-skilled migrants, while limiting the number of other economic (often, but not exclusively low-skilled) migrants. This contrast within states between simultaneously aiming to attract certain migrants and exclude others, leads to a number of policy dilemmas, societal tension and debates, and the effects of this debate on attracting and retaining skilled workers, require further research attention. It is therefore important to understand new mobility dynamics within the knowledge economy to better guide these decisions.

The global competition for talent is an idea that pulls on both the hopes and fears of developing and developed countries alike. Advanced, OECD economies purport words like ‘competitiveness,’ often comparing and benchmarking themselves with other advanced economies, in an assumed, measurable ‘competition’ to be the best. At the same time, outsourcing, relocation of facilities to lower cost countries and the growing economic power of emerging economies comes into focus, playing on fears that new, real competition may come from previously unseen rivals. Emerging economies face other issues – those related to facilitating the restructuring of previously uncompetitive economies, of large internal economic and developmental disparities, potential instability, and fears of ‘brain drain,’ as the most educated and driven seek jobs elsewhere. These emerging economies are found across the globe, such as in the large and rapidly expanding countries like India, China, and Brazil, as well as within the borders of the European Union, due to EU-expansion in 2004 to include several Central and Eastern European countries. And, in terms of self-assessment in the ‘global competition for talent’ the country often considered the leader, the US, and their researchers say that the country is at risk of failing to adapt to new global dynamics and therefore is losing its edge (see Florida, 2005; State, Rodriguez, Helbing, & Zagheni, 2014; The Partnership for a New American Economy, 2012).

**STRUCTURE OF THE STUDY**

Given these dynamics, better understanding the ‘global’ aspect almost paradoxically entails a deeper understanding of specific countries’ (or even regions, cities, towns) situations and industry particularities. It entails looking at opportunities and constraints related to the intersections of changing local and global economic dynamics. Despite any commonalities in
terms of global concerns, multiple policy routes are available and diverse outcomes are likely. ‘Europe’ is not a single entity, but rather is made up of countries with extremely diverse histories, economies, laws, and various social and cultural traditions.

This study utilizes diverse disciplines, including sociology, geography, political-economy, and migration studies to discuss the concept and changes related to the growing ‘global competition for talent’. Skilled migration, as a field of study within migration studies, is still expanding, given that the scale of skilled movements in the past was more limited to specific occupations (particularly health care, managers in multinational corporations, artists and athletes, and later IT workers and creative industries), and there were only a few main destinations interested in broadly attracting skilled migrants (largely the US and other Anglo-Saxon countries). Skilled migration as a pressing topic of both European and global importance has only emerged in the past decade or two. This study argues that the emergence of the catch-phrase “the global competition for talent” reflects that skilled migration has entered a new stage with much more diversity in terms of both the individuals migrating and their intended destinations.

The chapters are divided into two main parts, which are organized as follows:

Part I focuses on what structures the global competition for talent on the whole, that is in terms of both theory and policy and from a perspective applicable to multiple countries. This part argues that implicit in the paradigm of a ‘global competition for talent’ are theoretical debates on the foundations for (national) economic competitiveness arising from processes of globalization. Yet differences also arise in light of the relative positioning of states in terms of their economic structures, openness to labor migration in general as well as the characteristics of the national labor force, and while considering both global and local dynamics. Chapter 1 focuses on the concept or theories of international competitiveness and the importance of productivity, and then assesses the role of the workforce, while Chapter 2 discusses the concept of the “global competition for talent” linking it with the theoretical literature related to skilled migration. Chapter 3 provides an overview of the research questions and the research methodology adopted. This overview of the study goals is then followed by an analytic framework for assessing the global competition for talent, consisting of productivity, people, place and policy. Chapter 4 examines skilled migration and mobility policies and patterns, focusing on Europe but in light of the global context. This chapter argues that in the European policy context, homogenizing EU-level policies facilitate scientific mobility, and these policies have often occurred outside the domain of ‘immigration’ policy.

Part II looks at the global competition for talent in practice. The focus of this section is on competitiveness, mobility, and opportunities in biotechnology, pointing to variations among various countries by utilizing life scientists’ viewpoints. This section of the study utilizes desk research and original data collection, including results from a 30-minute international survey among 594 life scientists conducted from November 2008 to early 2009. The data in Part II represents the views of life scientists across many corners of the globe to illuminate a wide range of situations regarding the global competition for talent, including both economically advanced and developing economies.
The chapters in Part II will use the CiLS data to look specifically at life scientists’ career path preferences (Chapter 5), patterns of international scientific mobility and its importance for life science careers (Chapter 6), the desired destinations for moving for work in the life sciences and biotechnology and the reasons used for selecting a destination to move to for scientific work (Chapter 7), and finally a look at biotechnology competitiveness and its potential influence on international mobility in life science careers by comparing data mainly on the country-level as well as looking at the desired duration of stay, and expectations on whether international mobility will lead scientists to stay abroad or later return to their home country (Chapter 8).
PART I: WHAT STRUCTURES THE GLOBAL COMPETITION FOR TALENT?
CHAPTER 1: THE CHANGED NATURE OF ECONOMIC COMPETITIVENESS AND GLOBAL COMPETITION – THE INCREASING ROLES OF KNOWLEDGE AND MOBILITY

INTRODUCTION

In one of his monumental papers, Drucker (1986, p. 768) discusses the changing nature of international competition, stating,

The talk today is of the ‘changing world economy.’ I wish to argue that the world economy is not ‘changing’; it has already changed – in its foundations and its structure—and in all probability the change is irreversible.

Drucker, in the 1980s, was referring to specific changes related to international production and the increasing global mobility of capital replacing trade as pillars of the economy. The increasing globalization of capital was coupled with dramatic changes in industry whereby increasing production was no longer equated with increases in employment to the extent it had in the past due to new technologies for production and the proportionally lower cost of materials in technically-oriented products as compared to the research that goes into producing them. These changes lead to the emergence of the knowledge economy and changes in the factors that contribute to competitiveness.

‘Competitiveness’ is an elusive term (Barkley, 2008; Krugman, 1994). Although it serves as a buzzword for measuring economic strength, including in global context, truly being competitive covers an enormous range of measures and can be assessed for individual firms and institutions, cities and regions and countries as a whole. As such, it is a concept that is relevant to a wide stream of academic literature, including management, economics and political-economy.

This chapter build on these ideas to better understand the theoretical foundations supporting the ‘global competition for talent,’ which are linked to understanding the theoretical underpinnings of international competitiveness as it applies particularly to workforce and employment issues, the importance of the knowledge worker, and the rising interest in the concept of ‘talent’. This chapter first discusses the concept of competitiveness, primarily focusing on the work of Porter (see e.g. 1990; 1998; 2003) and some critiques of the concept of competitiveness. It then discusses the association between competitiveness and knowledge worker, building mainly from the work of Drucker (1986; 1999). It then argues that an assumed link has been made, particularly following the IT boom in the 1990s, between immigration and competitiveness. Building from this association, the ‘talent’ perspective has emerged, as this perspective integrates discussion of how immigration can contribute to competitiveness. This perspective has been popularized in part by the influential work of Florida (2002; 2005) and has also been taken up in the human resources literature. This premise is essential for understanding both the reasons the ‘global competition for talent’ is emerging as a top topic of future concern and for advancing further study of this phenomenon. Theoretical perspectives related to skilled migration are addressed in the next chapter.
THE DIFFICULTIES IN DEFINING COMPETITIVENESS

Importance of productivity to competitiveness

The work of Porter (see e.g. 1990; 1998; 2003) has been important in advancing the concept of competitiveness, which he argues is often used in various contexts, lacks one coherent definition, and has changed across time. Porter explains that competitiveness had been long understood as being driven by “factor comparative advantage,” commonly defined by share of exports to assess the strength of various countries and industries, by taking into account global trade. In brief this perspective argues that countries will have a cost advantage in specific products or industries, and will therefore specialize in these products for export. With this perspective, there is a strong focus on lowering costs of production, either in materials or in the cost of labor, to increase the relative advantage for the product traded. Changing economic structures, with growing importance of knowledge-based sectors, have rendered such economic models insufficient. One of the key problems is that factor comparative advantage only looks at trade; it does not account for international mobility of labor or capital (Porter 1990, p. 12) or assesses the contribution of technology.

Porter (2003, pp. 2-3) therefore states that competitiveness is actually defined by productivity, not exports, and assessing competitiveness requires investigations of the “underlying sources of prosperity”. In his definition, factors, especially technology, innovation, relationships between firms, infrastructure, and labor force characteristics are essential. Porter also advances the idea of clusters, whereby various institutions (large and small firms, universities, etc.) cooperate to create stronger interdependencies and social as well as industry ties within a certain region, (p. 5-6) thereby further rooting the industry in that particular location (region) and creating advantages for countries that cannot compete on lower costs. Furthermore, Porter (1990) argues that individual industries must remain the filtering lens through which macro-level competitiveness can be viewed and assessed. Porter argues that while looking at measures for the aggregate economy can reveal “the importance of the quality of a nation’s human resources and the need for improving technology,” it cannot explain:

[…] why and how meaningful and commercially valuable skills and technology are created. This can only be fully understood at the level of particular industries. The human resources most decisive in modern international competition, for example, possess high levels of specialized skills in particular fields. These are not the result of the general educational system along but of a process closely connected to competition in particular industries (p.9).

As discussed in more detail in the chapter on skilled migration, in the 1990s, ‘new growth theory’ (building from Lucas, 1988; Romer, 1990) also emerged to further detail economic changes in competitiveness seen from the growing importance of technology and the importance of knowledge in creating profits. New growth theory further states the importance of R&D, innovation, quality of human capital for productivity and hence international competitiveness. This theory also linked ‘creativity,’ a largely subjective and individual attribute that has become viewed as essential for economic competitiveness, to knowledge economy growth.
These theoretical underpinnings then supported other work that looked at the contribution of measures such as human capital and creativity to the economic growth of regions and nations (Budd & Hirmis, 2004; Trippl & Maier, 2007). While much work has been done in the past decades to improve data collection and measure innovation (see OECD, 2010), measuring knowledge has been more difficult. Many of the measures of ‘knowledge’ rest in that related to technological advancement or ‘innovation’, such as through measuring R&D spend or patent statistics. While these measures allow for comparison between countries or cities, for example, they do not reach the core to understand skills and characteristics needed in the workforce that influence productivity. Despite recognition that the availability of creative employees and knowledge are crucial for competitiveness, understandings of how workforce availability have an impact on competitive advantages, nationally or regionally, and productivity are still emerging topics of research. Economic theory, which is quantitatively driven, has also had difficulties grasping changes linked to skilled migration as related to larger economic competitiveness.

Brown, Green and Lauder (2001) researched strategies for skills development in various countries. Their more recent work (Ashton, Lauder, & Brown, 2009; Lauder, Brown, & Ashton, 2008) also argues that there has been a substantial shift from more national skills-based concerns to more global ones, based largely on actions taken by large, international corporations, who increasingly decide which knowledge will remain in the company, versus when to partner, including advanced research, and have coined the term ‘skill webs’ to explain the international connectivity of skills. These authors (Ashton, Brown and Lauder, 2009: 332-333) argue:

As they (companies) move from a national to a global orientation, TNCs (transnational corporations) cease their dependence on national institutions for their skill supply and start to exert greater skill over it, in order to take advantage of opportunities offered by global markets. This becomes possible only when they have loosened their bonds with their home institutions and national culture. For the companies we interviewed, decisions about what to produce, where to produce, how to produce, and what forms of organization to use, are no longer taken within the confines of national boundaries. The supply of skilled labor is no longer a given, determined by the national institutions and government polices but is now just another area of choice for managers […]

In other words, skills are essential for economic success, but companies are able to move various parts of the business to any location where the skills needed are most accessible. This changes the nature of competitiveness, as not only are knowledge and skills crucial, but companies are likely to move locations when they are not found.

While the work named above all address aspects of changing economic competitiveness in relation to global changes, other research has focused more on individual contributions and micro-economic competitiveness. Notably, human capital theory (Becker, 1962; 1983) discusses ‘the economics of education’ including both the wage benefits for the individual as well as in macro-economic terms. According to the OECD (1998, p. 9), human capital is “the knowledge, skills and competencies and other attributes embodied in individuals that are relevant to economic activity.” The research on human capital and migration is extensive (see e.g. Beine, Docquier, & Rapoport, 2008; Bourdieu, 1986; Carrington & Detragiache, 1998; Poot, Waldorf,
& van Wissen, 2009; Williams & Baláž, 2005) and cannot be discussed in full here. However, two points relevant to the argument made in this study on immigration and competitiveness are focused on here. First, while human capital is now also associated with ‘knowledge’ and of interest in light of the knowledge economy, human capital has typically been defined by education levels, the foundation of the work by Becker (see e.g. 1962; 1983). While human capital theory has been important in understanding the implications of individual knowledge and skills on economic competitiveness, it is less useful to understanding changes related to the global competition for talent for several reasons. Looking at education alone does not allow proper assessment of skills availability in the total workforce as compared with demand. In other words, the problem may not be finding someone with a certain degree, but with certain skills as well as personality that fits with the organization. Second, migration to meet skills gaps has also been seen as an important, although again difficult to measure, factor (Doudeijns & Dumont, 2003; Sumption, 2011; World Bank, 2007).

Given these difficulties, although ‘human capital’ is seen as a crucial driver of innovation and competitiveness, it is also often absent from international country competitiveness indexes.

Knowledge workers as contributors to competitiveness

Similar arguments about the changing nature of the economy have been made in the management literature about the importance of the individual for productivity. Notably, Drucker (1986) stated that there had been a “substitution of knowledge and capital for manual labor” (p. 777). The identification of the rising importance of ‘knowledge’ and productivity built from recognition of the declining role of blue-collar work in manufacturing in advanced economies (Drucker, 1986, pp. 777-778). In the late 1990s, Drucker further assessed the changes, building on his expertise in business and management, and popularized the term the knowledge worker to explain the shifts:

The most important, and indeed the truly unique, contribution of management in the 20th century was the fifty-fold increase in the productivity of the manual worker in manufacturing. The most important contribution management needs to make in the 21st century is similarly to increase the productivity of knowledge work and knowledge workers. The most valuable assets of a 20th-century company was its production equipment. The most valuable asset of a 21st-century institution (whether business or nonbusiness) will be its knowledge workers and their productivity. (Drucker, 1999, p. 79)

Drucker emphasized that knowledge is an important concept for understanding both modern-day productivity as well as innovation:

We know now that the source of wealth is something specifically human: knowledge. If we apply knowledge to tasks we already know how to do, we call it 'productivity'. If we apply knowledge to tasks that are new and different we call it 'innovation'. Only knowledge allows us to achieve these two goals. (Drucker, 1992, p. 23)

Drucker discussed that knowledge workers’ productivity is not necessarily based just on the amount produced while working, it is essentially about the quality of work produced. This work
entails specialized knowledge or creativity that is less easily measured, and the output is also based on the level of motivation of the individual. This idea makes it essential that employers build an environment in the workplace that can foster this type of work.

Assessing competitiveness to understand its role in the global competition for talent

In comparing the various viewpoints above, one key debate about competitiveness relates to the level, micro (by company) versus macro-economic (by country), on which it can be assessed. Krugman (1994, p. 31) claims that competitiveness is only appropriate on the company level, as countries ‘do not go out of business’. Furthermore, Krugman argues that if competitiveness does exist, it must be defined by, and hence is the same, as productivity. However, this is refuted by Martin and Tyler (2003, cited in Budd & Hirmis, 2004, p. 1021) who argue that regions are in direct competition for resources, namely: 1. investment; 2. “for technology through region’s ability to attract knowledge and innovation activity;” and 3. “for labour by being able to attract skilled employees, entrepreneurs and creative workers.” In other words, one aspect of understanding the foundations of prosperity, relates to identifying limitations of the key resources required, and in the knowledge economy today, many of these key resources have changed. Therefore the ability of regions to ‘attract’ these resources has gradually become seen as a part of the definition of regional competitiveness. For instance, one definition of regional competitiveness (Huovari, Kangasharju, & Alanen, 2001, p. 1) states that it can be seen “as the ability of regions to foster, attract, and support economic activity so that its citizens enjoy relatively good economic welfare.” Or, according to Cerny: “the main task or function of the contemporary state is the promotion of economic activities, whether at home or abroad, which make firms and sectors located within the territory of the state competitive in international markets” (quoted in Lavenex, 2007, p. 33). The literature that studies these relationships is currently very large, and often falls within the geography discipline and particularly, geography of knowledge or innovation, and has been a large topic of research since the early 2000s (see e.g. Boschma, 2004; 2005; Bunnell & Coe, 2001; Malecki, 2004).

THE MERGING OF WORK ON COMPETIVENESS AND THE WORKFORCE

The ‘talent’ perspective

Florida’s (2002) work, which focuses on the competitiveness of cities in comparative perspective through identifying (quantifying) and defining the needs of ‘creative class’, is another breakthrough piece in trying to better define and assess the workforce aspect of competitiveness. Florida defines competitiveness of places as resting on three aspects: technology, talent, and tolerance (the 3Ts). Florida (2002, p. 249) summarizes the value of his perspective as adding more than the theories that argue that social capital and/or human capital drive regional growth:

But I believe my creative capital theory does an even better job. Recall its basic argument: that regional economic growth is powered by creative people, who prefer places that are diverse, tolerant and open to new ideas. Diversity increases the odds that a place will attract different types of creative people with different skill sets and ideas. Places with diverse mixes of creative people are more likely to generate new combinations. Furthermore, diversity and concentration work together to speed the flow
of knowledge. Greater and more diverse concentrations of creative capital in turn lead to higher rates of innovation, high-technology business formation, job generation and economic growth.

Florida’s analysis also places explicit emphasis on the importance of individual preferences in determining a location’s competitiveness—people can choose where to live and can move away from an environment that does not foster their creativity, is intolerant, or does not offer the type of lifestyle they seek.

His book on the creative class was followed by a work aiming to apply his ideas to the global competition for talent, *The Flight of the Creative Class* (Florida, 2005). He applies the 3T framework to countries as a whole. The main argument of his book is that the United States has lost its advantage in attracting talent. He argues the US needs broader strategies that build both economic opportunity as well as people’s “basic security – physical, social, political, and economic” (p.268-269).

Florida’s work has several shortcomings. First, although Florida has a basic premise that the creative class is rooted in technology, talent, and tolerance, he has changing definitions of how to measure them. For instance, the volume of *The Rise of the Creative Class* that I have contains an appendix (p.353-379) in the back listing out all the new measures that have been added since the first edition, only 2 years earlier. For example, his original calculations of tolerance were only based on an index on the presence of gays, and he since added an index of foreign born, creative individuals who he calls “bohemians” and an index of racial composition. The statistics used for international destinations as a proxy for his assessment of tolerance on the national level in *The Flight of the Creative Class* are completely different, which makes sense given that his earlier index of tolerance was based on aspects particular to the US. He instead uses the results of Inglehart’s World Values Survey, which instead measures whether a country has traditional or secular values. While this may address similar issues, it is clear the calculations going into his ratings are very different.

Second and I believe more importantly, Florida’s work neither accounts for the nuances of economic structures across cities nor for policy differences. His emphasis on the creative class assumes that these individuals play a similar economic role across all cities, and that individuals share common values for an attractive environment, irrespective of their field of specialization or work. This is problematic, as a city may have high opportunities in one field, such as IT, and few in another, such as biotech. Second, he does not address policy differences, particularly those for assessing the national level. For example, he argues that negative scores on one of his indexes, the mosaic index, show cities internationally that “are either attracting a very narrow band of immigrants or not attracting many immigrants period” (2005, p. 173). Yet, this assessment does not look at whether or not there are policies in place that even allow immigrants to come in the first place.

While the work of Florida is often identified more by his concept of the creative class or creative capital, I believe his focus on ‘talent’ is equally, if not more, important, and the popularity of his work may have given additional fuel to the idea of a global competition for talent. From
Florida’s perspective, immigration is essential to competitiveness, not only for bringing in talent, but also because diversity helps a city to thrive. Despite its shortcomings, his work is very important for the study of the global competition for talent in that it led to more acceptance or recognition that immigration can contribute to competitiveness.

The importance of ‘talent’ has also been identified by businesses and there has been an explosion of interest in the new field of “international” or “global talent management” in the past few years (for a review of the literature, see Tarique & Schuler, 2009). There is a general impression that the younger workforce values more creativity, flexibility, and are less set on finding permanent positions. At the same time, companies have already expanded internationally, and aim to expand further. In this context, diversity and respect for diversity is highly valued among employees to better understand the needs of a broader population and to work with more types of people. The phrase the ‘global competition for talent’ is being echoed not only in terms of skilled migration policies, but also as companies support their workforce to meet these demands. Like competitiveness, talent can be assessed as related to its value to both the company and the national level.

Furthermore, in order to best handle this next wave of globalization, large-scale international mobility of people, companies and organizations, across sectors, countries and businesses are already placing increasing value on international experiences as criteria for hiring. Deloitte consulting explains that many businesses are moving away from a view of offering ‘international assignments,’ which is more characteristic of the expatriate model of the 1980s and onwards, to one of trying to best manage ‘global mobility’ (Deloitte., 2010), whereby moves are not only, for instance, from the US to developing economies, but also from developing economies into the previous ‘core” as well as in between developing countries. They also explain that the change to ‘global mobility’ reflects that individuals increasingly want international experience as part of their career paths. In other words, rather than companies ‘sending’ people abroad they can offer opportunities for mobility for interested individuals. At the same time, there has been recognition that global mobility is increasingly initiated by individuals, rather than the company, with a stream of human resources literature on self-initiated expatriation starting in the 2000s (see e.g. Al Ariss, 2010; Andresen, Al Ariss, & Walther, 2012; Doherty, 2013; Doherty, Richardson, Thorn, Al Ariss, & Crowley-Henry, 2013; Myers & Pringle, 2005; Vaiman & Haslberger, 2013). One of the crucial questions for companies and organizations then becomes how to best balance the goals of the individual with that of the company or organization.

The rising interest in talent management can be broadly linked to a few main trends:

1. Companies are increasingly saying their location choice is based on the availability of qualified people.
2. Increasing global mobility, where it is no longer just skilled individuals from developed countries moving, but rather any combination, such as between developing countries, from developing to developed countries and so forth.
3. Increasing importance of emerging markets for the corporations’ growth strategies, which entail a workforce that can understand and work with diverse people and markets.
4. A “talent paradox” (Deloitte, 2013; Schwartz, Barry, & Liakopoulos, 2013), whereby even during the recent recession with a supposed surplus of workers, businesses find certain positions as being hard to fill. Often these involve finding people with both the business or technical expertise required who also have strong management skills.

Defining competitiveness in this study

With various debates surrounding the meaning and applications of competitiveness, it is necessary to better define how competitiveness will be applied in the research I have conducted on the global competition for talent. Competitiveness, will be used broadly in the analysis as “status as a leader.” In my view, competitiveness is an outcome that can be defined both in terms of productivity as well as in terms of reputation. Both of these aspects are influenced by access to resources, of which both technology and human capital are essential. Policy is important in shaping the degree that these resources are available. Competitiveness is also influenced by what Porter (has called the ‘business environment.’) The business environment can be identified not only through various statistics, but also through attitudes of its workforce.

The discussion above adds several important elements for understanding the idea of the global competition for talent. First of all, the availability of quality labor is an important, but often overlooked factor influencing competitiveness. Next, one of the difficulties in discussing ‘competitiveness’ relates to the blurring of associations between ‘competitiveness’ with ‘competition;’ however the two concepts are not synonyms. Competition must exist in order for the concept of competitiveness to be of use. Measures of protectionism aim to limit competition for various products, but they have historically been found to be stifling rather than increasing competitiveness. The same may apply to various measures to various policies that create a closed, insular labor market. As the focus of this research is not on how competitiveness is built, but rather on the workforce dimensions of it, the main focus is on defining aspects of competitiveness affecting the global competition for talent. This means much of the focus in this study is on international mobility or migration.

CONCLUSION

With both changing demands of the knowledge economy and from globalization processes, advancing understanding of the global competition for talent, the focus of this research, is essential. Few studies have looked at issues of labor force availability for the knowledge economy in a way that integrates both the position of nationals as well patterns of skilled migration, including both supply and demand side factors. The concept of the ‘global competition for talent’ holds promise for creating a more integrated framework for assessing the changes and comparing the institutions and strategies supporting or hindering its growth in various countries and within specific sectors of the knowledge economy. This shifting interest to immigration as global is new, as immigration studies to date have mostly taken the view of the nation-state as the main context and ties between two specific countries, rather than of dynamic globalized systems. Although the situations of nation-states will continue to frame much of the skilled migration discussion, there will be a need to also compare the attractiveness across countries, which can also be viewed as competitiveness on an international scale, as well as to
understand how and why new international skilled mobility patterns are appearing. As discussed by Porter, understanding these trends involve not only more research on the workforce, but also in view of the dynamics of particular industries. It also involves understanding the local contexts which support or hinder their development, or variations in the broader opportunity structure. It is important to acknowledge that economic changes will also be reflected in institutions, both as institutions lead the changes, whether done strategically or unintentionally, as well as shifts when policies change and organizations adapt.

In the history of globalization, the earliest measures were related to goods, evident for several centuries already, then more recently marked by massive changes in international movements of capital particularly since the 1980s. The dramatically increasing mobility of people, labor, on a truly global scale seems to be the next major shift. While it had been argued that globalization has been primarily enacted through increased internationalization of capital and goods, rather than labor, a new period is arising where the mobility of labor too is seen as impacting competitiveness by comparing positions of countries in the global context. While the scale of these movements may reflect a minority of the working force, they are nonetheless seen as essential for certain, particularly innovation driven, sectors and occupations. The questions they bring about will likely be further reflected, perhaps even echoed in future debates on the next wave of globalization – the dynamics of the global competition for talent and government’s responses to it. To borrow from and adapt Drucker’s (1986) insights – perhaps the importance of international mobility of skilled workers is not changing – it has already changed.
CHAPTER 2: SKILLED MIGRATION AND THE GLOBAL COMPETITION FOR TALENT – RECENT DEVELOPMENTS AND THEORETICAL CONSIDERATIONS

This quote was part of the findings on global migration from the Gallup organization, which conducts some of the largest-scale polls globally:

> What the whole world wants is a good job. That is one of the single biggest discoveries Gallup has ever made. It is as simple and as straightforward an explanation of the data as we can give. If you and I were walking down the street in Khartoum, Tehran, Berlin, Lima, Los Angeles, Baghdad, Kolkata, or Istanbul, we would discover that on most days the single most dominant thought carried around in the heads of most people you and I see is, “I want a good job.” It is the new current state of mind, and it establishes our relationship with our city, our country, and the whole world around us […]” (p.3)

The shift in importance to “a good job” leads to a significant change in the evolution of civilization. There are endless indicators, but the most evident change is in global migration patterns (Clifton, 2007, pp. 3, 4).

Yet, the quote above was written even before the global economic crisis put being able to offer ‘good’ jobs as the top political priority across the world and still states the importance of global migration. Supporting economic growth and availability of jobs has long been one of the primary tasks of politicians, and the lack of jobs plus better opportunities elsewhere have long been seen as the primary push and pull factors for immigration.

This chapter will discuss research for understanding skilled migration. The chapter begins by discussing the most prominent definitions of skilled migration. It then will give an overview of recent developments for skilled migration, discussing the increasing flows and background of the changing policy concerns in the past few decades. Following this overview, a few of the main theories, mainly drawing on more general theories for labor migration, will be discussed as they apply to understanding skilled migration. The next section will discuss new paradigms that are emerging to explain skilled migration, particularly the phrase the global competition for talent and views of effects of skilled migration as a contributor to human capital and international development.

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2 This chapter appears in a similar form in Kuvik, A. (2012). Skilled Migration in Europe and Beyond: Recent Developments & Theoretical Considerations. In M. Martiniello & J. Rath (Eds.), An Introduction to International Migration Studies: European Perspectives (pp. 211-236). Amsterdam: IMISCOE Textbook Series.
Like all immigration categories, there is not one strict definition of a ‘highly skilled’ migrant internationally, but rather it depends on the local economic, social, and demographic contexts and the local concerns and the policies in place. In the migration literature, skilled migrants are often defined as individuals with a tertiary degree or higher. Additionally, skilled migration may be defined on the basis of the policy in place and hence the type of visas and permits issued. However, policy-based definitions do not look at the sector of employment or give any indications of employment among other skilled individuals. For instance, ‘deskilling’ may occur, for instance as seen when highly qualified refugees work below their qualifications or as recently observed in one of the prominent mobility patterns whereby university graduates from the new EU member states in Central and Eastern Europe work temporarily in low-skilled jobs, particularly in the UK, which means there can be a mismatch between academic discussions of the ‘skilled’ and the official statistics. Another way to look at skilled migrants is in terms of occupation. This can be done broadly in terms of ‘professionals’ or, as is recently becoming prominent, in terms of ‘talent’ (for example Kuptsch & Pang, 2006; Shachar, 2006; Zalatel, 2006). Solimano (2008) further says that within these main classifications, a few specific occupations of interest emerge: “technical talent, scientists and academics, professionals in the health sector—medical doctors and nurses, entrepreneurs and managers, professionals in international organizations; and cultural talent” (p. 22). Additionally, it should be noted that foreign-born entrepreneurs and students are also often included in discussions of skilled migrants.

Definitions of ‘skilled’ migration change across time and place. In other words, “skilled” is a relative term, dependent on the demographics and qualifications of the greater society, and skills that are currently in demand. Currently, there seems to be a shift away from defining ‘skilled’ migrants in terms of educational qualifications and instead a move towards focusing on occupation (managers, healthcare workers, scientists and other workers for the knowledge economy); many national immigration policies to support skilled migration in Europe tend to focus on labor market demands. In general, statistics for various job classifications have not been harmonized. For instance, although the mobility of health care workers has long been a topic of global concern, the Dumont & Zurn (2007, p. 164) reports,

Discussions on the international mobility of health professionals are severely hampered by data limitations, including ambiguity in data sources and definitions of health worker migrants, or excessive reliance on indirect quotations. These limitations are particularly acute when one seeks to make international comparisons. To a certain extent, this has contributed to confuse the debate on international mobility of health workers.

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3 See EMN (2007) page 27 for an overview of these policy categories for skilled migration in Europe
In order to conceptualize skilled migration broadly and theoretically, in a potentially lasting framework, there is a need to extend beyond the technicalities and nuances of categorical definitions to see broader patterns and implications. Where data is collected, it often does not indicate which sectors an individual is employed in. However, efforts have been made to improve data on this topic, for instance through the OECD’s Database on Immigrants and Expatriates, the first comparative database on this topic which has been operational since 2005 (see Dumont & Lemaitre, 2005). Data on international student mobility has been standardized jointly by UNESCO, OECD, and Eurostat, new interest is emerging for more specific topics, such as careers of doctorate holders (Auriol, 2010; Auriol, Felix, & Fernandez-Polcuch, 2007).

Flows of skilled migration in Europe as compared to classic immigration countries

While a detailed statistical overview of the various classifications of skilled migration in various countries is outside the scope of this chapter, it is nonetheless important to understand generally how skilled migration has progressed in Europe and how it compares in magnitude to other migration flows.

Skilled migration has only recently become a topic of interest to policymakers and academics in Europe. Although skilled migration is not new, it has demonstrated substantial increases in recent years as seen both in statistics (see Tables 2 and 3) and in the increasing variety of countries and types of policies supporting skilled migration. In reviewing the literature, a few notable trends can be seen in the development of skilled migration policies, processes, and paradigms. Much of the research that does exist on skilled migration can be said to be based on the extremes – on one side focusing on studies from the ‘immigration countries’ (US, Canada, Australia, and New Zealand), which have longer histories of receiving immigrants in general as well as have had earlier adoption of specific skilled migration policies and programs and on the other side on countries seen to be suffering from an acute ‘brain drain’ or on countries that are benefiting from a ‘brain circulation’ (FierceBiotech.com, 2009; Kapur & McHale, 2005), with China and India drawing a substantial amount of attention. While these cases are clearly important in understanding the most prevalent forms and the strongest effects of skilled migration, they also only give a partial picture of the ‘global’ element in the competition for talent and the situation in many European states, with more cautious approaches to immigration, is less studied and understood.

In tracing the development of skilled migration and policies historically, a few main turning points can be discerned that link current thinking on skilled migration. The first of these is the movement of scientists to the United States, following the World Wars and the development of military technologies (also said to be an important influence on the US’s current strength in the IT sector) during the Cold War. Notably, this development spawned the initial discussion of ‘brain drain,’ which remains an important element in discussions on skilled migration. A second important development is linked with the internationalization of business, including increasing foreign direct investment, particularly in the 1980s. The migration of business professionals in the 1970s appears to have been quite low (Salt, 1983-1984). However, as companies began setting up affiliated branches in other geographic regions, it became more prominent for managers to move abroad as part of the career ladder. Skilled migration gained force in the
1980s and seems to have been largely tied with either intra-corporate movements or free trade agreements (for example the North American Free Trade Agreement or the European Economic Community). Therefore, the flows were predominantly between advanced economies. Global business operations underwent several shifts in the mid-1980s to early 1990s that have impacted policies, including the growth of business services in the economy and multinational corporations’ further expansion and subcontracting of work in other countries. In 1986, the GATS discussion began under the auspices of the WTO to advance trade in services, which further facilitated global legislation to allow short-term business stays and potentially this also helped broaden skilled migration from being primarily for managers to incorporating less senior professionals, more job types, and all sizes of firms, although few studies seem to record this aspect (for discussion of impact of GATS on global governance of skilled migration see Lavenex, 2007). In the early 1990s, a marked shift in policies occurred in the (so-called) immigration countries to further facilitate the movement of skilled professionals and recognition of a growing trade in high-skilled services internationally. One of the most important developments was the US’s expansion of the quota of the H1B (temporary) visa for specialty occupations, largely IT and other knowledge-based jobs, from 65,000 to 115,000 between fiscal years 1999 and 2000 (Kapur & McHale, 2005, p. 55). The demand for the IT workers was also a very time-specific response to fears of adverse Y2K computing problems (Kamat, Mir, & Mathew, 2004, pp. 15-16). In 2000, the quota was subsequently raised again, to 195,000 per year for fiscal years 2001, 2002, and 2003, notably within a law bearing the name “American Competitiveness in the Twenty First Century Act of 2000.” While the name of this act is often not cited, it seems to be an important indicator of the changing rhetoric related to skilled migration and its association with competitiveness. The quota increases were the direct result of lobbying by the IT industry (Freeman & Hill, 2006; Rodrik, 2001). Additionally, the rising quota not only placed more emphasis on the political agenda in the United States, but that by the mid-1990s, other countries such as Australia, New Zealand, and the United Kingdom also were attracting more skilled immigrants, although with much lower absolute levels, on a temporary basis, as demonstrated in Table 3.

The mid-1990s was an important period largely because of the IT boom, associated productivity growth and the resulting policy focus on the knowledge economy. This period can be seen as the beginning of an important change, even a paradigm shift, as skilled migration increasingly became associated with economic competitiveness and the emergence of subsequent discussions of a ‘global competition for talent’ in the academic literature (for example Kuptsch & Pang, 2006; Shachar, 2006; Zalatel, 2006), media (See Bauder, 2008 for discussion of skilled immigration in media in Germany), and policy documents. Large amounts of interest have been generated by the particular example of the successful Silicon Valley, California’s leading IT cluster, particularly building on the research of Saxenian (2005; 2008). However, this learning likely cannot be directly transferred due to policy differences and particularities of the area/industry, which allowed for extremely high levels of immigrant involvement -- 32% of the science and engineering workforce (Saxenian, 1999, p. viii) and 25% of the entrepreneurs in by 1999 (p. 20). Furthermore, as Freeman and Hill (2006, p. 7) argue that the changes in the US were not made with the global situation in mind:
National politics, rather than global economic pressures, drive the twists and turns of U.S. immigration policies, with key roles being played by high tech employers, professional associations, pro and anti-immigrant organizations, and even associations of immigration lawyers. There appears to be little space in their accounts for the kind of global legal/institutional influences signaled by WTO reforms or by the importance of global multinationals.

The burst of the IT bubble and the claims of a labor surplus in many areas did not seem to limit the associations between immigration and competitiveness, at least not internationally. Rather, it seems to have led to a new period where immigration became seen as a contributor to the broader ‘knowledge economy’ in general and therefore for a set of occupations that are both ever-changing in the skills required and for specific ‘new’ sectors which governments across the advanced world were offering policy support. Doudeijns & Dumont (2003, p. 31) made an interesting classification in the early 2000s of policy approaches taken towards labor migration in many of the OECD countries. Their compilation supports that much of the desired labor migration was for skilled occupations. Programs varied from points-driven to attract individuals with desirable characteristics, to those based on specific occupations or shortages, and finally those driven by international trade agreements. Many of the programs adopted were for temporary migration to fill expected labor shortages, and ranged from being regulated by the employer to the national government to international agreements.

**TABLE 2 ADMISSION OF SKILLED IMMIGRANTS IN SELECTED COUNTRIES, 1991, 1999, 2001**

<table>
<thead>
<tr>
<th>Country</th>
<th>Number (thousands)</th>
<th>Share of all immigrants (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia^b</td>
<td>41</td>
<td>35</td>
</tr>
<tr>
<td>Canada^c</td>
<td>41</td>
<td>81</td>
</tr>
<tr>
<td>New Zealand^d</td>
<td>na</td>
<td>13</td>
</tr>
<tr>
<td>United States</td>
<td>12</td>
<td>57</td>
</tr>
<tr>
<td>Sweden</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>4</td>
<td>32</td>
</tr>
</tbody>
</table>


^a Data for United States referring to 2002

^b Skilled category including family members with certain tested professional qualifications and linguistic aptitudes

^c Skilled workers category including assisted relatives who are not points tested

^d Employment-based preference category including family members of skilled workers
TABLE 3 TEMPORARY WORKERS ADMITTED UNDER SKILL-BASED CATEGORIES
SELECTED COUNTRIES, 1992-2000

<table>
<thead>
<tr>
<th>Country</th>
<th>Thousands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>41</td>
</tr>
<tr>
<td>Canada</td>
<td>70</td>
</tr>
<tr>
<td>New Zealand</td>
<td>27</td>
</tr>
<tr>
<td>United States*</td>
<td>143</td>
</tr>
<tr>
<td>France</td>
<td>5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>54</td>
</tr>
</tbody>
</table>

Source: Kuptsch & Fong 2006 p. 15
* Number of admissions under H1-B visas, not number of persons

Academic literature: Skilled migration in Europe

The skilled migration literature for business demand (discussion of skilled migration for services such as health care or education are not included here) in Europe therefore follows similar trends. There was little attention to the topic before the mid-1990s, with a few exceptions focused on managers and international corporations (Findlay, 1990; Salt, 1983-1984). By the late 1990s and early 2000s, the topic of skilled migration in Europe was gaining attention, mainly keeping with a focus on international corporations, expatriates, and managers (e.g. Beaverstock, 1990; Beaverstock, 1991; Beaverstock & Smith, 1996; Koser & Salt, 1997; Mahroum, 1999; 2001) as few explicit policies for attracting skilled migrants were in place yet in European countries, outside of internal corporate recruitment mechanisms. The UK leads Europe in terms of adopting the first large-scale skilled migration program in 2003 and hence has the most literature available on skilled migration and its impact. Other research looks at comparisons, particularly between the US and Europe for attracting skilled migrants (Cervantes & Goldstein, 2008).

4 Discussion of skilled migration for services such as health care or education are not included here; for a broad overview on healthcare, see Dumont & Zurn (2007)

5 The UK policy towards skilled migration is relatively recent, although there have been previous skilled flows such as for doctors and also given the diversity of the UK population (such as post-colonial Indian migration). Up until 2003, when the UK started a policy to attract highly skilled migrants, there was nearly a void of policies to attract or even allow skilled migrants to come to Europe outside of the internal mechanisms put in place by multinational corporations and other businesses (and various bilateral agreements, for instance for health care workers). Iredale (2008) explains that the UK’s policy then allowed ‘individuals with special skills and experience to immigration, initially for a year but with the opportunity to renew. […] This is the first time in nearly three decades that foreign workers, other than EU member nationals, have been able to enter the UK without guaranteed employment,’ (p. 160-161).
2008; Peri, 2005) or on the general policy setting in Europe (Zimmermann, 2005). Other topics of research interest in Europe include scientific mobility (see e.g. Ackers, 2005a; 2005c); employment of immigrants in the IT industry (Leung, 2001); high-skilled employment of individuals from new member state nationals after EU-enlargement (Csedo, 2008; Ferro, 2004; Guth & Gill, 2008; Liverasage, 2009); and topics related to return migration of various types of skilled migrants (Fontes, 2007; Gill, 2005; Williams & Baláž, 2005), to name a few. Additional research on scientific mobility will be discussed later in this study.

Students as skilled migrants

Understanding recent trends in international student mobility is important for discussions of skilled migration for several reasons. First of all, there have been substantial changes in student mobility in the past two decades, from 1.3 million students in 1990 to 3.7 million in 1999, as shown in Figure 1.

FIGURE 1 LONG-TERM GROWTH IN THE NUMBER OF STUDENTS ENROLLED OUTSIDE OF THEIR COUNTRY OF CITIZENSHIP

Growth in internationalisation of tertiary education (1975-2009, in millions)

1975 0.8m 1980 1.1m 1985 1.5m 1990 1.3m 1995 1.7m 2000 2.1m 2005 3.6m 2009 3.7m

Source: OECD and UNESCO Institute for Statistics.

Data on foreign enrolment worldwide comes from both the OECD and the UNESCO Institute for Statistics (UIS). UIS provided the data on all countries for 1975-95 and most of the non-OECD countries for 2000, 2005 and 2009. The OECD provided the data on OECD countries and the other non-OECD economies in 2000 and 2009. Both sources use similar definitions, thus making their combination possible. Missing data were imputed with the closest data reports to ensure that breaks in data coverage do not result in breaks in time series.

Source: OECD, Available at http://dx.doi.org/10.1787/888932461617

These changes have implications both for developing countries, where students with sufficient resources may use international education as a springboard to access better job opportunities either in their home country, the region they are from, or further abroad. It also has an impact on destination countries, as more countries aim to actively ‘attract’ international students (see Hawthorne, 2009; Kuptsch, 2006), which can occur even where more restrictive labor migration policies or labor market protection mechanisms are present. International students have also been
coupled into discussions of skilled migration, also linked to their contribution to a destination’s knowledge economy (Kuptsch, 2006, p. 59) as part the potential future, skilled migration workforce in the country where they study (Mosneaga & Winther, 2013), and due to increased focus on defining ‘skills’ for relative migration policies (Raghuram, 2013, pp. 139-140).

Therefore, the growth in international student mobility also reflects broader institutional changes. According to Cervantes and Goldstein (2008, p. 333):

> Until the mid-1980s, EU countries did not take any specific action to recruit foreign students in developing countries outside or beyond their traditional spheres of influence. During the 1990s, as private higher education providers have increased and universities were give more autonomy and greater financial responsibility (including the right to levy tuition in some countries), European countries have strengthened their efforts to recruit foreign students, especially from Asia.

Receiving international students is seen as an attractive policy option to a range of countries for diverse reasons:

- National demographic decline in combination with the growth of the knowledge economy means that there are expected future workforce shortages in key occupations;
- Individuals who have been educated in the national context are perceived as likely being a better fit for employers, and as already accustomed to the country, and therefore as suitable long-term skilled migrants;
- The possibility of international students paying higher tuition than locals/nationals has been seen as a way to contribute to financing education systems;
- The further internationalization of research systems and increasing research collaborations mean that internationalization is seen as improving research outputs. Furthermore, institutions are assessed on their internationalization, as a metric in national or international competitiveness rankings of universities. The number of international students is seen as an indicator of how attractive a university is and how integrated it is in international networks.

It is also important to note that while data on sectors of employment is not always be available and data on skilled migration tends not to be internationally comparable (given that they are often based on very specific qualifications for work or residence permits), there has been improved international data collection on international students, including some data by field of study. The US has long had an interest in this topic, collecting data on international students since 1948 and publishing them in the yearly *Open Doors* report, internationally comparative statistics are more recent (Institute of International Education, 2008; OECD, 2007). Given that international students may then become employed in the countries where they study, looking at changes and varying patterns, including both in the countries from which the students come from and the countries where they go to, may offer be a preliminary indicator of potential destinations and changes in skilled migrant labor.
International students in general, have been increasing across all continents since the year 2000, although not necessarily with consistent rates of increase across time, with the growth rates slowing some in 2009, after the economic crisis. The largest number of international students, nearly half come from Asia.

A few main trends characterize changes in international student mobility in the past decade (see Box 1), as explained below:

<table>
<thead>
<tr>
<th>BOX 1 PATTERNS OF INTERNATIONAL EDUCATION ACCORDING TO UNESCO STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Data collected in 2010)</td>
</tr>
<tr>
<td>Top destination countries:</td>
</tr>
<tr>
<td>• United States (19%)</td>
</tr>
<tr>
<td>• United Kingdom (11%)</td>
</tr>
<tr>
<td>• Australia (8%)</td>
</tr>
<tr>
<td>• France (7%)</td>
</tr>
<tr>
<td>• Germany (6%)</td>
</tr>
<tr>
<td>• Japan (4%)</td>
</tr>
<tr>
<td>Top 3 destinations by region:</td>
</tr>
<tr>
<td>• Arab States: France (29%), United States (13%), United Kingdom (10%)</td>
</tr>
<tr>
<td>• Central and Eastern Europe: Germany (16%), Russia (10%), United States (8%)</td>
</tr>
<tr>
<td>• East Asia and the Pacific: United States (28%), Australia (17%), Japan (12%)</td>
</tr>
<tr>
<td>• Latin America and the Caribbean: United States (26%), Spain (15%), Cuba (11%)</td>
</tr>
<tr>
<td>• North America and W. Europe: United Kingdom (23%), United States (15%), Germany (8%)</td>
</tr>
<tr>
<td>• South and West Asia: United States (38%), United Kingdom (18%), Australia (11%)</td>
</tr>
<tr>
<td>• Sub-Saharan Africa: France (19%), South Africa (17%), United Kingdom (12%)</td>
</tr>
<tr>
<td>Top sources of international students:</td>
</tr>
<tr>
<td>• China</td>
</tr>
<tr>
<td>• India,</td>
</tr>
<tr>
<td>• Republic of Korea</td>
</tr>
<tr>
<td>Regions that host the largest number of internationally mobile students:</td>
</tr>
<tr>
<td>• North American and Western Europe (58%)</td>
</tr>
<tr>
<td>• East Asia and the Pacific (21%)</td>
</tr>
<tr>
<td>• Central and Eastern Europe (9%)</td>
</tr>
</tbody>
</table>

1. There are new destinations and patterns of student mobility. All OECD countries have seen an increase in the number of foreign students in the past decade (see also Table 4). A few decades ago, the US was the clear leader in hosting international students. However, the share of students going to the US has declined as new destination options emerge, from 28% in 2001 to 19% in 2011 (Institute of International Education). Previous destination choices were thought to be led mostly by institutional prestige in a few countries, such as the United States and UK, and language of study, with a strong demand to learn English, now the global language for many international activities. The language at the destination influences not only moves to English-speaking countries, but also accounts for the large numbers of individuals from French-speaking African countries studying in France, from Latin America studying in Spain. New study destination choices in Europe were further shaped through extensive marketing programs and government agencies with the task to attract foreign students, particularly in Germany from the 1990s and France and the UK in 1998 and 1999 respectively (Kuptsch, 2006, pp. 36, 44). Additionally, awareness built of low tuition in many European countries, for instance, in Austria, Germany, Finland, Sweden, and Norway. The start of Bachelor’s and Master’s programs offered exclusively in English in countries such as Denmark, the Netherlands, Finland and Sweden (OECD, 2012, p. 365), and later spreading to other European countries, further change study options for international students. Singapore and Malaysia, and more recently, China, have also been active in trying to attract more international students and other forms of ‘talent.’ These new destinations also attract a different student body; for instance, in Malaysia the leading countries of origin are far afield and include Iran, China, Indonesia, Yemen and Nigeria. Supported by widespread air travel as well as more information and cheaper communication through the internet, patterns of international mobility are becoming increasingly complex. One argument has been that studying abroad is an important step in attaining a desired job later. Others have argued that studying abroad is becoming less elite, or rather more chances to study abroad for all students rather than just the ‘best and brightest’ (see Kamat et al., 2004, p. 11 for case of Indian students abroad).

2. There are rising numbers and proportion of Asian students, particularly from China, studying abroad and in OECD countries. China is the top country of origin for international students in all of the Anglo-Saxon countries (US, Canada, UK, Australia, and New Zealand), Japan, Republic of Korea, Germany, and is the second largest sending country for students in France. These statistics reflect the trend that Chinese students are aiming to access international academic locations, without being tied to geographic proximity or the destination’s language. Indians are the second largest sending country to most of the Anglo-Saxon destinations (Canada is an exception) but make up a much

lower percentage than Chinese students in most OECD countries (see Table 5), despite that both are populous countries of more than a billion people.

3. Europe hosts the most international students of any continent (over 1.6 million in 2010), and more than double the amount of international students in North America (over 880,000 in 2010). The UK, France and Germany are all among the top countries for numbers of international students globally. Intra-European flows shape an important part of changing student mobility. Some of this mobility in the EU is supported by the EU’s Bologna Process (Teichler, 2012) to harmonize education across its member states. Furthermore, the EU has invested heavily in EU-sponsored study abroad programs such as Erasmus, Socrates, to promote further student mobility in Europe. The majority of mobility among doctoral graduates from Europe has been to other European countries. In addition, the expansion of the EU’s territory to include many countries in Central and Eastern Europe in 2004 and then again in 2007 has also likely had a significant impact on the changes in student mobility patterns. Individuals from these countries now have the possibility to move freely throughout the EU, and the United Kingdom has since become a top destination choice, particularly for individuals from the Baltic States (Lithuania, Latvia and Estonia) and Poland. However, much intra-EU mobility reflects students going to bordering countries or to those with linguistic similarity to their own country (for example, between Czech Republic and Slovakia; from Romania to Italy, given similarities in their respective languages; or native German-speaking students going to Germany, Austria, or Switzerland)\(^7\). Although various patterns of EU mobility have been observed, the effects of these moves on employability in the country of study, the home country, and elsewhere are not well understood.

Academic literature: Student migration in Europe

The topic of student migration in Europe in recent years falls into a couple of strands. One strand of literature addresses the policy changes that have increased student mobility in Europe, including changes that influence international students’ visa policies and rights to work (Suter & Jandl, 2006), university recruitment initiatives abroad and the start of English-language programs in many European countries (Kuptsch, 2006) and intra-European study abroad or student mobility programs, such as Erasmus, supported by the EU (King & Ruiz-Gelices, 2003; Teichler & Janson, 2007). The other strand of literature addresses individuals’ personal and career motivations for migration to various destinations (Glorius, 2009; Guth & Gill, 2008; Williams & Baláž, 2005).

\(^7\) Location choices in this section are based on UNESCO’s Global Flow of Tertiary Students map, accessed 12 December 2012 at http://www.uis.unesco.org/EDUCATION/Pages/international-student-flow-viz.aspx
TABLE 4 TRENDS IN THE NUMBER OF FOREIGN STUDENTS ENROLLED OUTSIDE THEIR COUNTRY OF ORIGIN, BY REGION OF DESTINATION AND ORIGIN (2000 TO 2010, IN REVERSE ORDER)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>155,293</td>
<td>147,338</td>
<td>142,811</td>
<td>123,874</td>
<td>115,490</td>
<td>107,851</td>
<td>107,575</td>
<td>103,538</td>
<td>100,428</td>
<td>93,260</td>
<td>99,117</td>
</tr>
<tr>
<td>Asia</td>
<td>486,076</td>
<td>446,055</td>
<td>398,817</td>
<td>367,361</td>
<td>344,050</td>
<td>322,449</td>
<td>297,804</td>
<td>264,598</td>
<td>242,575</td>
<td>205,649</td>
<td>214,744</td>
</tr>
<tr>
<td>Europe</td>
<td>1,968,418</td>
<td>1,665,829</td>
<td>1,580,212</td>
<td>1,483,312</td>
<td>1,437,362</td>
<td>1,388,027</td>
<td>1,311,098</td>
<td>1,186,161</td>
<td>1,043,809</td>
<td>980,883</td>
<td>920,140</td>
</tr>
<tr>
<td>North America</td>
<td>880,427</td>
<td>850,966</td>
<td>809,943</td>
<td>728,190</td>
<td>733,051</td>
<td>738,401</td>
<td>712,292</td>
<td>712,296</td>
<td>695,806</td>
<td>576,059</td>
<td>569,640</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>77,735</td>
<td>77,546</td>
<td>60,889</td>
<td>57,926</td>
<td>39,951</td>
<td>39,227</td>
<td>41,873</td>
<td>44,343</td>
<td>37,418</td>
<td>34,063</td>
<td>31,058</td>
</tr>
<tr>
<td>Oceania</td>
<td>350,013</td>
<td>335,305</td>
<td>298,176</td>
<td>283,573</td>
<td>258,696</td>
<td>251,904</td>
<td>240,531</td>
<td>219,191</td>
<td>202,023</td>
<td>136,728</td>
<td>118,646</td>
</tr>
<tr>
<td>OECD</td>
<td>3,181,939</td>
<td>2,838,027</td>
<td>2,646,999</td>
<td>2,534,414</td>
<td>2,446,164</td>
<td>2,373,011</td>
<td>2,272,064</td>
<td>2,092,527</td>
<td>1,904,154</td>
<td>1,647,622</td>
<td>1,588,862</td>
</tr>
<tr>
<td>EU countries</td>
<td>1,686,306</td>
<td>1,413,462</td>
<td>1,322,936</td>
<td>1,313,343</td>
<td>1,257,612</td>
<td>1,201,503</td>
<td>1,152,244</td>
<td>1,036,527</td>
<td>895,903</td>
<td>844,627</td>
<td>806,286</td>
</tr>
<tr>
<td>of which in EU21 countries</td>
<td>1,647,730</td>
<td>1,378,961</td>
<td>1,287,768</td>
<td>1,285,443</td>
<td>1,231,028</td>
<td>1,174,107</td>
<td>1,124,315</td>
<td>1,010,002</td>
<td>869,944</td>
<td>813,471</td>
<td>776,672</td>
</tr>
<tr>
<td>G20 countries</td>
<td>3,418,367</td>
<td>3,040,151</td>
<td>2,849,469</td>
<td>2,632,351</td>
<td>2,551,098</td>
<td>2,488,585</td>
<td>2,369,403</td>
<td>2,225,874</td>
<td>2,049,207</td>
<td>1,793,070</td>
<td>1,718,429</td>
</tr>
</tbody>
</table>

Source: OECD Education at a Glance 2012, p. 381 Table C4.6
TABLE 5 SHARE OF INTERNATIONAL/FOREIGN STUDENTS IN SELECT COUNTRIES, AS TOTAL %, INDEX OF GROWTH SINCE 2000, AND SHARE OF INDIAN AND CHINESE CITIZENS, 2008

<table>
<thead>
<tr>
<th>% of foreign students in total tertiary education</th>
<th>Index of change in the number of foreign students, total tertiary (2000 = 100)</th>
<th>% of foreign students in advanced research programs</th>
<th>% of students from India</th>
<th>% of students from China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional &quot;Immigration&quot; Countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>23.6</td>
<td>218</td>
<td>33.8</td>
<td>11.5</td>
</tr>
<tr>
<td>Canada</td>
<td>13.1</td>
<td>196</td>
<td>38.6</td>
<td>3.5</td>
</tr>
<tr>
<td>New Zealand</td>
<td>24.4</td>
<td>726</td>
<td>46.9</td>
<td>13</td>
</tr>
<tr>
<td>United States</td>
<td>n/a</td>
<td>131</td>
<td>n/a</td>
<td>15.2</td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>12.2</td>
<td>109</td>
<td>31.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Denmark</td>
<td>8.3</td>
<td>149</td>
<td>16.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Germany</td>
<td>10.9</td>
<td>131</td>
<td>n/a</td>
<td>1.8</td>
</tr>
<tr>
<td>Ireland</td>
<td>7.2</td>
<td>173</td>
<td>n/a</td>
<td>3.4</td>
</tr>
<tr>
<td>Netherlands</td>
<td>6.8</td>
<td>291</td>
<td>n/a</td>
<td>0.2</td>
</tr>
<tr>
<td>Spain</td>
<td>3.6</td>
<td>255</td>
<td>24.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Sweden</td>
<td>8.5</td>
<td>135</td>
<td>23.7</td>
<td>3</td>
</tr>
<tr>
<td>Switzerland</td>
<td>20.3</td>
<td>175</td>
<td>45.9</td>
<td>0.5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>19.9</td>
<td>151</td>
<td>47.7</td>
<td>7.7</td>
</tr>
<tr>
<td>France</td>
<td>11.2</td>
<td>178</td>
<td>39.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Asia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>3.2</td>
<td>190</td>
<td>16.9</td>
<td>0.4</td>
</tr>
<tr>
<td>Korea</td>
<td>1.3</td>
<td>1195</td>
<td>6.6</td>
<td>1</td>
</tr>
<tr>
<td>OECD average</td>
<td>8.5</td>
<td>263</td>
<td>21.1</td>
<td>n/a</td>
</tr>
<tr>
<td>EU19 average</td>
<td>7.6</td>
<td>220</td>
<td>18.6</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Notes: International student data not available for France, defined only as foreign students; n/a indicates where data was not provided in OECD'S 2010 Education Outlook.

Skilled labor migration represents largely uncharted territory in modern migration theory (for theoretical discussion of approaches relevant to professional movements see Koser & Salt, 1997). Given the relative ‘novelty’ of skilled migration research, theoretical discussions of skilled migration largely borrow from the interdisciplinary theoretical perspectives that are used for other forms of migration, particularly low-skilled and other forms of labor migration. There is not one main theory that has been developed and adopted for skilled migration itself, although various typologies are being formed (e.g. Abella, 2006; Iredale, 2001; Mahroum, 2001).

Migration, with its multiplicity of actors, motives, and time and place contexts, has been difficult to theorize. Theory must assume a possibility of continuity and consistency. In other words, theoretical models should be applicable across a wide range of situations and with certain assumptions holding as relatively constant. Yet, migration processes are largely contingent on the macro-economic, political and legal environments, determining who is allowed to go, to where, when, and why, and therefore in some ways binding the theories to the here-and-now. The types of migrants are often controlled by quotas for either nationality or other individual criteria. Policies towards highly skilled migration are no exception. Countries with fairly open systems, the US, Australia, and Canada, all set quotas on various forms of visas for skilled workers. These quotas are often revised, either expanded or contracted, to meet the current demand. Hence, the observable pieces of migration, those which most theories are based upon, are often context bound, while this context seems to be continually shifting, as new policies are past, plus it takes time to see the impact of former policy. Such shifts are not limited solely to policies for high-skilled workers, but apply to policies for immigrant classes in general.

Migration theory has excluded analysis of temporary workers or students, an important category for highly skilled labor migration. For example, Malmberg (1997) argues, “Migration is often defined as a permanent and long-distance change of place of residence, as a short-distance move is regarded as local mobility, and moves of short-term residents are regarded as temporary mobility” (p. 23). As discussed in the introductory sections, skilled migration has largely occurred, at least initially, through temporary visas such as the H1B visa in the US. Hence, the analysis of skilled migration theoretically presents a few challenges to existing migration theory.

While this first section outlines problems with defining skilled migration, limits of temporality, and questions of longer-term effects beyond the immigrant himself, the next section will place skilled migration within existing theoretical frameworks. As also outlined in other chapters, migration theory as relates to labor migration has occurred within various disciplines. The most frequently applied theoretical frameworks used build from concepts related either to economic restructuring or individual determinants for migration. This section primarily outlines economic theory as applied to labor migration in general, and skilled migration in particular focusing on those that look at macro-level effects, including neo-classical economics arguments on wage effects and job displacement, dual labor market, and globalization theories, as well as micro-level (individual) determinants of migration and a brief discussion of social networks.
Neo-classical economics and skilled migration

Given that skilled migration is a form of labor migration, it is important to place it within the macro-economic theoretical context. Economic theories, and especially neo-classical economics, have been central to much migration theory in general. Neo-classical economic theory is based on the assumption that free competition leads to the greatest market efficiency and that individuals will move to areas where they can maximize their own well-being. Within the neo-classical framework, protectionist legislation for both capital and labor is viewed as impeding competitiveness (Rodrik, 2001). Additionally, neo-classical economics assume that general equilibrium can be reached. In terms of immigration, this then would lead to the assumption that if full mobility was possible, then markets would become more balanced and wage disparity between regions would diminish. More than just a theoretical notion, the idea is also applied in practice, for instance through the premise of the ‘common’ or ‘single’ market in the European Union, whereby the benefits of the EU are seen to stem from free mobility of capital, goods, services and, persons across the EU member states.

Neo-classical economics have been broadly applied to migration and remains the core of much migration theory and policy (even though there is much critique that it is too rational and individualistic) both on the micro- and macro- levels. For one, they have been applied on an individual level (to answer the more micro question of why people stay or go) via push-pull models, with economic concerns often considered one of the primary root causes “pushing” people to migrate to destinations with better opportunities or higher wages. Push-pull models were later modified, to include non-rational personal factors and intervening obstacles (Lee, 1966). Using the definition of Dorigo and Tobler (1983), “The push factors are those life situations that give one reason to be dissatisfied with one’s present locate; the pull factors are those attributes of distant places that make them appear appealing” (p.1). This formulation of push-pull model is often used on the national (or regional) level, although it implies an understanding of individual motives as well as assumes a rational approach. More recently, it has further been applied to advocate and better understand global economic integration. As Zolberg (1989) notes, “One of the sharpest contrasts between the old and new literatures is the conceptual shift from a view of ‘ordinary’ international migration as the aggregate of movements of individuals in response to different opportunities, to a view of this process as a movement of workers propelled by the dynamics of the transnational capitalist economy, which simultaneously determines both the ‘push’ and the ‘pull.’” (p. 406-407). In this formulation, supply is the “push” factor, while demand is the “pull.” The equation of push-pull models with supply and demand has interesting policy implications for highly skilled migration. Push-pull models can be applied on a variety of levels for better understanding migration flows. However, in general, push-pull models still give the feeling that we can predict migration flows based on various, mostly economic, factors. This in turn can lead to the assumption that migration may be “predictable,” a viewpoint that is often debated.

The equating of push-pull models with the concepts of supply and demand has interesting policy implications for highly skilled migration. Policies in OECD nations towards skilled migration often seem to assume that the supply is greater than the demand. The emphasis is typically on quotas to limit the supply allowed to enter, rather than on countries actively seeking out hot job
candidates to fuel their demand. For example, in Canada, quotas are set each year to determine the number of highly skilled migrants that will be allowed to enter and criteria are set as to who would meet these qualifications. DeVoretz (2003) notes that the Canadian government policies toward the highly skilled “amount to a ‘tap on, tap off’ approach: allow the target to fluctuate widely while officials imaginatively search out new source countries. When Canada was unable to meet its yearly target for skilled workers, it widened the entry gate for family-class entrants. Such imaginative tactics fail to obscure the fact that the supply of skilled immigrants to Canada is not infinitely elastic” (p.12). Similarly, studies from Australia have found that skilled migrants often have a list of destinations they would be interested in, and only come to Australia after doors to top choices, the US and Canada, have been closed, often due to restrictive policies (Cobb-Clark & Connolly, 1997). Therefore, while neo-classical theory may imply the availability of an endless flow of labor as needed, the reality may not hold up to this simplistic assumption.

Third, wages are often viewed as the critical element in both understanding labor migration and in applying neo-classical economic theory, with the work of Borjas having been particularly influential. Borjas (1994) found that there is little impact from skilled migration on the wages of American natives. However, in general the findings on the effect of skilled migration on wages, as well as job displacement, are inconclusive. Saiz (2003) notes that the impact of immigration is dependent on the skill characteristics of the immigrant versus the native population. Saiz argues that it is critical to include high-skilled labor as a factor to understand the impact of immigration on wages. He explains,

…if the composition of skilled and unskilled workers is different in the immigrant and native populations, relative wages will change. For example, if immigrants tended to be more highly skilled, this would increase the relative supply of highly skilled individuals, reducing wages for the highly skilled and increasing wages for low-skilled workers. In reality, economists have worried about the potential impact of immigration on low-skilled natives (p.16-17, italics original).

In other words, knowing the composition of immigrant qualifications compared to the native population is necessary to understand impact of migration (for a more detailed discussion see also Borjas, 1989; Ghosh, 2005, pp. 166-167), particularly as related to wages, and impacts how migration is interpreted and theorized.

The dual labor market, world systems, immigration, and global cities

Turning from general ideas of globalization and mobility, national economic restructuring has also become part of immigration theory through the dual labor market theory and the global cities thesis. The dual labor market theory (Piore, 1979) ascertains that the there is a division of labor based on shortages, with current economic environment is made up of a primary sector of high-skilled jobs and a secondary sector of low-skilled, labor-intensive jobs with few opportunities for advancement. The dual labor market theory is considered to be “non-neoclassical” in that it assumes that institutions and discrimination keep people from moving out of the low waged, secondary sector, and hence the market will not necessarily by its nature reach
equilibrium and equality. World systems theory (Wallerstein, 1974) also contributes to debates on immigration as the theory posits that skilled labor will move from the periphery, or developing countries, into the core, developed economies.

These elements of the dual labor market theory and global systems theory are also applied to immigration and concerns about internationalization/globalization via Sassen’s global cities thesis. Sassen (1991) looks at the increasing communications interconnectivity of cities and notes that industries in cities have shifted from Fordist, factory production, to a more globally interconnected knowledge society. Sassen sees this as creating a divided economy and creating similar divides within the population of cities. In this view the city is marked by an increasing polarization between the high-skilled workers and with low-skilled workers providing services to cater to the needs of the higher skilled knowledge workers, often through the informal economy, of which immigrants play a large role.

Individual-level: Determinants of migration and migration decision-making

Studies on the reasons for moving, often called the determinants or drivers of migration, are not new and are a key concern of migration research. A good overview of this research and the related conceptual issues can be found in de Haas (2011).

Discussions of the individual determinants of migration have been considered to be important, particularly with the growing focus on the need of countries to ‘attract’ skilled migrants, given the sense of a ‘global competition for talent’ as well as due to the views that skilled migration can lead to human capital development in the way of new skills and knowledge and improved international contacts.

While push-pull models have contributed to this discussion, there are also other important theoretical developments. Chiswick (1978) first discussed motivations of high-skilled immigrants to the US, showing a ‘self-selection’ that is beneficial for the receiving economy. Although there has been a sense of self-selection leading to higher qualifications of migrants compared to their native population (Borjas, 1989; Carrington & Detragiache, 1998), skilled migration literature currently tends to present individuals as ‘talent’ to be wooed and lured to various countries. In this light, models of migration decision-making are important not only in anthropological and sociological discussions, but also for the purpose of policy-making.

The literature on the determinants of migration is quite fragmented and new determinants emerge via different case studies. In general, it has been argued that it is not only wages that impact migration decisions among the highly skilled, but also greater career considerations including the reputation of the company where the individual is employed. The development of skills has also been seen as crucial, with gaining competency in English or other languages as one of the drivers for educated individuals to move abroad. Beyond career considerations, other authors have argued for the importance of place as magnets, building again on the theoretical premises of the global cities theory as well as lifestyle preferences of individuals (Ewers, 2007; Florida, 2002; 2005). Next, family considerations should also be considered, as pioneered by the new economics of labor migration (Stark & Bloom, 1985).
Network theories: Migration systems and the role of social networks

Network theories have also been applied to skilled migration. Meyer (2001) looks theoretically at the role of networks for high skill migrants in particular. He argues that a focus on ‘brain drain’ has led to a predominantly economic focus in the study of skilled migration (p. 94-95). Meyer stresses the importance of analyzing knowledge networks for understanding skilled migration beyond notions of just supply and demand and that the focus on networks shows more interconnectivity between these two aspects and allows for more balanced discussion of not only brain drain, but also brain gain. Saxenian (2002) focuses on similar aspects by highlighting the role and development of such diaspora or transnational networks among Indians and Chinese working in the Silicon Valley. As noted earlier, this example has become well-cited and influential in the discussions of benefits of skilled migration on whole. Kuznetsov & Sabel (2008) argue that networks are not only important for migration chains for low-skilled workers as highlighted by Piore (1979), but that for high-skilled migrants as well, ‘migration chains become open mobility networks – means for discovering where to go to learn how to prosper in the reorganizing economy’ (p. 89). According to these authors, the networks are useful for sharing information for skills development, recruitment, and to enable and facilitation contributions to the home country, in the form of not only remittances but also other forms of development. Beyond the role of social networks, Kuznetsov & Sabel also discuss changing economic structures and networks of firms in the global knowledge economy.

While discussions of ‘networks’ in migration theory really encompass several different phenomenon ranging from recruitment practices and systems, chain migration, international economic systems for production and division of labor, and transnational social connections among immigrants (see Rindoks, Penninx, & Rath, 2006 for a discussion of economic implications of networks for migration to Europe), the skilled migration literature so far has predominantly focused on the last aspect related to social and professional networks of skilled migrants. In an assessment of the global competition for talent, the OECD (2008) particularly focuses on policies for supporting ‘scientific diasporas’ through websites and organizations as one of the main ways to promote links among scientists abroad in order to support scientific development in the home country.

LOCATION CHOICE

Micro-level: Factors influencing an individual’s location choice

Migration drivers on the individual level as linked to recent globalization and institutional changes have scarcely been discussed. Much of the research discussing the global competition for talent assumes that the US will be the top destination choice for most skilled migrants, followed by the UK (see e.g. discussion in Boekholt, Edler, Cunningham, & Flanagan, 2009, pp. 3-4). This is based on factors such as economic strength of these countries, the English-language environment, past immigration creating more diverse and/or open societies, and the competitiveness of their universities and companies. Location choice is also expected to involve rational choice, the assumption that individuals are making a conscious, comparative mental checklist of the pros and cons of each place. While this process does not always play out, the
more general assumption is that individuals are searching for the place with the best returns on their human capital investments. One of the main barriers in understanding the extent and form this really happens is that little research examines the individual drivers of skilled migration in a framework that fits into global context, without focusing analysis on a single destination. One exception is the work of Florida (2002, 2005). Florida’s work has been influential in linking immigration, growth of creative and high tech industries, and place competitiveness to understand both the attractiveness of destinations and overall economic growth potential of various areas, mostly applied to cities and regions. Research on skilled migration drivers analyzing in multiple countries is also currently underway at IMI Oxford, but no papers had been published yet at the time of writing this chapter. Discussions and frameworks related to mobility of scientists in particular will be discussed in more detail in Chapter 6.

Meso-level: Company location choice

Other research that is relevant for discussing the global competition for talent focuses on where companies choose to locate. One research (Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007, pp. 3-4) conducted in the US found that multinational companies decide where to locate based on the reasons listed below in Box 2.

<table>
<thead>
<tr>
<th>BOX 2 CRITERIA FOR MULTINATIONAL COMPANIES TO CHOOSE A LOCATION FOR OPERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cost of labor (professional and general workforce).</td>
</tr>
<tr>
<td>• Availability and cost of capital.</td>
</tr>
<tr>
<td>• Availability and quality of research and innovation talent.</td>
</tr>
<tr>
<td>• Availability of qualified workforce.</td>
</tr>
<tr>
<td>• Taxation environment.</td>
</tr>
<tr>
<td>• Indirect costs (litigation, employee benefits such as healthcare, pensions, vacations).</td>
</tr>
<tr>
<td>• Quality of research universities.</td>
</tr>
<tr>
<td>• Convenience of transportation and communication (including language).</td>
</tr>
<tr>
<td>• Fraction of national research and development supported by government.</td>
</tr>
<tr>
<td>• Legal-judicial system (business integrity, property patent protection).</td>
</tr>
<tr>
<td>• Current and potential growth of domestic market.</td>
</tr>
<tr>
<td>• Attractiveness as place to live for employees.</td>
</tr>
<tr>
<td>• Effectiveness of national economic system.</td>
</tr>
</tbody>
</table>

Source: Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology et al. (2007, pp. 3-4)

As the list compiled by the National Academy shows, among the thirteen factors found, five of them relate to the availability of quality of individuals and research in the area, whereas most of the other drivers relate to costs.
More recent research suggests that companies are increasingly concerned about the ability to find a suitable workforce, whether in advanced markets or developing ones. According to research done by Deloitte the top concern of companies interviewed was “competing for talent globally and in emerging markets” (Eggers & Hagel, 2012, p. 33). A study by the World Economic Forum and Mercer Consulting (2012, p. 106) found similar results, but makes even stronger statements on the importance of talent for multinational companies’ location decisions as quoted below:

- “Among the 41 factors that organizations used to make actual site selection decisions, talent availability was the only factor important in virtually all cases (over 95% of decisions).

- After talent availability, talent costs, talent quality and the competition for talent were the next most often used criteria in making site selection decisions.

- Not only was talent availability factored into more site selection decisions (over 95% of decisions) than cost considerations (82% of decisions), but availability of a qualified labor pool was weighted more heavily in the decision criteria (31% on average versus 28% for all cost considerations).

- The importance of talent availability, cost competitiveness and talent quality to site selection decisions showed the widest variation among all factors, indicating that companies often trade off among these key talent factors when making location decisions.

- While talent availability factors into almost all location decisions, there is no ‘standard’ weighting of criteria employed by every organization. Instead, decision criteria reflect those issues that are essential to the business success of the individual organization.”

These results were reflective of businesses of various types and may be even stronger when limited to innovation-based activities. The European Competitiveness Report (European Commission, 2010, p. 103) stated that differences in costs have been found to be less important for the location of R&D and innovation than it is for manufacturing. The availability of skilled personnel and linkages within innovation networks are more essential. A study on the offshoring of science and engineering activities (Manning, Massini, & Lewin, 2008) also found, “Access to qualified personnel” as increasing as a decision-making factor from 42% of companies surveyed in 2004, to 54% in 2005 and to 66% in 2006 (p.36). As shown in the previous chapter focusing on competitiveness, skills and talent are becoming an important part of business decisions.
NEW PARADIGMS IN SKILLED MIGRATION: SKILLED MIGRATION, GLOBALIZATION, AND COMPETITIVENESS

As discussed in the preceding sections, skilled migration research largely borrows from other existing migration theories; nonetheless, new paradigms are developing, which seem to largely draw on economic geography, particularly given the rising attention turned towards the knowledge economy. Theoretically, the relationships are discussed in new growth theory (Romer, 1990), as an alternative to neo-classical economic explanations; however the ideas are typically used more implicitly and few analyses on skilled migration have cited this theory directly. Immigration policy towards the highly skilled has been largely focused on filling the shortage of IT workers in the mid-1990s and early 2000s and hence is intertwined with other national policies for boosting technology and international competitiveness (Mahroum, 2001, p. 27). Generally, these perspectives can be summarized as discussing relationships between skilled migration, globalization, and competitiveness. Within this discussion, there are two main lines that hold importance in current skilled migration literature, including that which continues to emerge in Europe:

1. Skilled migration is presented as a ‘race’ or ‘competition’ for global talent or a ‘battle for the brains’ – Goal of ‘attracting’ skilled migrants to Europe, particularly for the knowledge economy

2. Skilled migration as a contributor to economic and human capital development – Human capital theory and brain drain theory are closely intertwined in research (for a good overview of past research, see Cañibano & Woolley, 2015), even developing around the same time in the 1960s. In more recent decades, there has been a move to also use human capital to discuss circular migration, as a way to mitigate the brain drain in developing (sending) countries, especially in healthcare and education sectors, while promoting knowledge transfer as benefit of skilled migration for scientific and technological sectors.

The increasing attention to skilled migration for the knowledge economy, and particularly for the IT and software industries, has not only shifted the paradigm on the need for skilled migration as an economic benefit, but has also tilted the scales in the debate on the effects of skilled migration for developing countries (as sending countries). In the 1960s and 1970s, ‘brain drain’ became a concern. This debate was largely linked with the loss of scientists from Europe (and Canada) to the US and later also to the healthcare sector as countries such as the UK and United States hired doctors and nurses from developing countries. The loss of these trained individuals then aggravated the already strained health or other public services (especially in the case of developing countries) or limited scientific development. ‘Brain drain’ of scientists to the US has long been, and still is, considered to be a barrier to scientific advancement. However, different employment patterns and immigration flows, including return migration, gained attention in the IT and other knowledge-based sectors in the 1990s and 2000s. As a result, skilled migration is now seen as offering many potential advantages for developing economies. Table 6 from Guellc & Cervantes (2002), highlights the effects, as shown in Table 6. As mentioned earlier, the Silicon Valley not only became recognized as having a significant portion of skilled Indian and Chinese (Mainland China and Taiwan) contributing to its workforce, but also as contributing to
positive ‘knowledge spillovers’ when these individuals returned to their countries of origin and contributed to the growth of the knowledge economy there as entrepreneurs and as individuals with personal networks in the US or other countries, contributing to the expansion of markets in one or both locations (Kuptsch & Pang, 2006; OECD, 2002). Hence, the IT industry seems to have been perceived as a sort of gold standard for the positive impact of skilled migration and hence adds fuel to the concept of the global competition for talent.

Given that much skilled migration is seen as temporary, there is a greater likelihood of return migration and discussions of ‘circular migration’ have emerged as a core part of the skilled migration literature as well as in policy discussions. This literature emerged largely in light of contributions of Chinese and Indian high-skilled workers to new business and sectoral development in their countries of origin. The concept of circular migration has come into focus with skilled migration seen as a way of advancing human capital and knowledge transfer. The paradigm of ‘circular’ migration also debates previous perspectives that looked at the effects of emigration of skilled individuals as causing a permanent loss of qualified labor in the form of a ‘brain drain’ with the (often already privileged) receiving society experiencing a ‘brain gain.’ However, implicit in discussions of circular migration is an underlying expectation that skilled migration should primarily encompass temporary labor movements. Circular migration is often used to argue for ‘improved’ or ‘win-win’ outcomes, although it should be noted that the benefits can be overstated as actual results depend on both personal and structural factors in various destinations. There has to be sufficient development of the sector in question and general infrastructure for skills to be utilized upon return. Furthermore, the circular migration focus can suggest that mobility only takes place between two countries. However there are now more destinations, with skilled movements not only happening to advanced economies, but also to emerging ones. In other words, there seem to be increasing options for highly-educated individuals to move to or among various countries. While individual migration choice cannot be said to be purely rational, there is still a need to better understand which destinations are even considered as options within this decision-making process. These concerns are also addressed, although generally not systematically, in discussions of the ‘global competition for talent.’ Furthermore, skilled migration is often assumed to be a win-win situation, with economic benefits for both the migrant and the receiving country. Although negative impacts have also been discussed, these are typically only from the angle of the sending society, focused on the risks of ‘brain drain.’ In policy circles, as reflected for instance in the papers for the Global Forum on Migration and Development, skilled migration is often presented a win-win-win solution, meaning that the individual in addition to the sending and receiving countries also have substantial gains in skills or income. Yet, the combination of changing flows of people and a lack of data means that we likely only have a partial picture of the true impacts of skilled migration for the receiving country as well, with most of the information based on return migrants from the US IT sector moving back to either India or China. Other studies on return migration of skilled migrants to developing countries show varying success in re-integrating into the labor market, based on various structural factors ranging from an essential prerequisite of political stability and adequate infrastructure to specific factors regarding the unemployment levels and employment practices, such as the need to have close contacts to find work.
<table>
<thead>
<tr>
<th>SENDING COUNTRIES: POSSIBLE POSITIVE EFFECTS</th>
<th>RECEIVING COUNTRIES: POSSIBLE POSITIVE EFFECTS</th>
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<tr>
<td><strong>Science and technology</strong></td>
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<tr>
<td>• Knowledge flows and collaboration, return of natives with foreign education and human capital, increased ties to foreign research institutions</td>
<td>• Increased R&amp;D and economic activity due to availability of additional highly skilled workers</td>
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<tr>
<td>• Export opportunities for technology</td>
<td>• Entrepreneurship in high-growth areas</td>
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<tr>
<td>• Remittances and venture capital from diaspora networks</td>
<td>• Knowledge flows and collaboration with sending countries</td>
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<tr>
<td>• Successful overseas entrepreneurs bring valuable management experiences and access to global markets</td>
<td>• Immigrants can foster diversity and creativity</td>
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<tr>
<td><strong>Human capital effects</strong></td>
<td>• Export opportunities for technology</td>
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<tr>
<td>• Increased incentive for natives to seek higher skills</td>
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<tr>
<td>• Possibility of exporting skills reduces risk/raises expected return from personal education investments</td>
<td>• Offset ageing of university professors and researchers</td>
</tr>
<tr>
<td>• May increase domestic economic return to skills</td>
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<th>SENDING COUNTRIES: POSSIBLE NEGATIVE EFFECTS</th>
<th>RECEIVING COUNTRIES: POSSIBLE NEGATIVE EFFECTS</th>
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<tr>
<td><strong>Human capital effects</strong></td>
<td></td>
</tr>
<tr>
<td>• ‘Brain drain’ and lost productive capacity due to (at least temporary) absence of higher skilled workers and students</td>
<td>• Decreased incentive of natives to seek higher skills in certain fields, may crowd out native students from best schools</td>
</tr>
<tr>
<td>• Lower returns from public investment in tertiary education (waste of national public resources)</td>
<td>• Technology transfer to foreign competitors and possible hostile countries</td>
</tr>
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**POSSIBLE GLOBAL EFFECTS**

• Better international flows of knowledge, formation of international research/technology clusters (Silicon Valley, CERN)
• Better job matches, including: greater employment options for workers, researcher’s ability to seek work most interesting to them and greater ability of employers to find rare/unique skill sets
• International competition for scarce human capital may have net positive effect on incentives for individual human capital investments.

Source: Guellec & Cervantes 2001, p. 86 (which cites OECD, expanded on the basis of Regets, 2000)
Filling in the research gaps

There are many limitations in the existing research on skilled migration in Europe. First, most studies are based primarily on national models of economic through a focus of differences seen by groups, generally based on either ethnicity or citizenship (foreign populations versus nationals). However, this perspective ignores the possibility that nationals too may move abroad and this can influence the availability of skilled labor locally. The perspective also assumes that it is easy to identify main ethnic or national groups working in a given field, which given the increasing scale of student mobility and skilled migration, may or may not still be true.

Furthermore, within Europe a political distinction, that has been carried over to some extent into research, has been made between ‘mobility’ of EU nationals across EU borders, including to live and work, and ‘migration,’ which technically only includes populations without citizenship from any of the EU member states, further limiting understandings on the extent to which cross-border skilled mobility really occurs. Third, with arguments of globalization of corporations and industries, as well as a change to a service economy, the movement of skilled migrants, and increasingly also university students, is typically encouraged. Yet, it is often mentioned that there is a lack of data on skilled migration flows lead to a rather incomplete analysis. This gap in the data has made it difficult to assess how recent policy developments and changing flows have had an impact on skilled migration to and from Europe.

Developing a more integrated framework for the ‘global competition for talent’ is a promising way to extend current knowledge of skilled migration processes and effects. Is there really a global competition for talent? What is really meant by this phrase? Building from the theoretical discussion given in this chapter, assessment of the individual words used in the ‘global competition for talent’ is helpful:

- **Global** – Recent increases in skilled migration in terms of occupations in focus, skilled migrants coming from more countries of origin, and going to new destinations, mean that a more ‘international’ rather than national assessment of skilled migration is helpful. While the US offers a leading example, it cannot be said to be a proxy for skilled migration patterns on the whole. There is a need to look at whether or not the ‘global’ competition occurs across all countries versus a limited subset both in terms of ‘sending’ and ‘receiving’ skilled migrants. Furthermore, in discussions of the ‘global competition for talent’ it has not been clear whether the global aspect refers to increasing demand across countries or whether it refers to the changing diversity in the workforce (implying that skilled migrants are now coming from a range of both developed and developing countries). Both of these aspects will be explored by focusing on one field of study, life sciences, in an international context.

- **Competition** – The word competition also suggests various strands of literature. Often, an assumption made in regards to the global competition for talent is that there are ‘winners’ and ‘losers’ in terms of overall economic performance and that the destination choices and numbers of migrants are reflective of this competition. There seem to be two main lines of reasoning influencing this discussion. The first interpretation rests on theories of economic competitiveness, as discussed in the previous chapter, and when
applied have led to various rank-orders in country performance. This interpretation also often implies the associations explained previously that have been made between skilled migration as a *contributor* to national competitiveness. The second interpretation rests instead on how *attractive* various places are for companies and people, assuming that countries, companies or universities are trying to find ways to make potential skilled labor or students choose them over other choices. This part is linked in part to marketing of places or study programs, for example, and more generally to the ways information about how opportunities in often far-away countries, spread. Four main ways the information spreads have been identified: networks, marketing, media, and personal experience. These two interpretations are interlocked but rest on different theoretical foundations, with the first being more macro-economic and the second looking at the effect of micro-level determinants as well as reputation.

- **Talent** – There are also discrepancies on how ‘talent’ is defined. One version would assume that anyone who is classified as a skilled migrant – either by education levels at a certain threshold, often defined as having a tertiary education or higher, or those with skills or working in occupations in demand – can also be considered to be ‘talent’ to be wooed. Another definition would instead focus more narrowly on individuals of exceptional ability – the ‘star’ scientists, big-name athletes, successful entrepreneurs, prominent academics and so forth.

These differences are more than just words – they represent different policy options for addressing the global competition for talent, with variations ranging from a restrictive to open approach to skilled migration. As argued by Peri (2005, p. 16):

… for advanced economies human talent may very well be one of the most important factors for growth and development. As scientific and technological progress is the recognized “engine of growth” in economies at the technological frontier (such as the U.S. and Europe), creative minds in the fields of science, engineering and technology have an incomparable role in advancing economic development and well being.

The global competition for talent is a useful phrase for assessing a number of institutional changes, as it can be conceptually applied across, the macro-, meso- and micro-levels and their intersections. Researchers, businesses and politicians have spoken of the global competition for talent, but analytic frameworks, business programs and policy guidelines for fostering positive effects are only beginning to emerge. On the macro-level, governments need to respond both to ensure the competitiveness of their country as a whole and to ensure workforce availability. Skilled migration is sometimes part of this strategy. It is important to realize that skilled migration levels vary immensely across countries in numbers, but growth to OECD countries has been observed. The global competition for talent has therefore emerged in discussions of institutional changes surrounding skilled immigration (see Kuptsch and Pang, 2006, OECD, 2008) as well as international student mobility (see Kuptsch, 2006). It is also influenced by policies and institutions that have an effect on R&D or the business environment (for overview of institutional issues, see Reiner, 2010, Dachs et al., 2005). On the meso-level within the topic of the global competition for talent, organizations, including companies, universities, research
labs, and others, are creating more proactive strategies to attract and/or retain the best employees internationally. In part, this aspect is reflected in discussions of ‘talent’ in immigration studies (Solimano, 2008) and a rapidly expanding discussion of ‘international talent management’ within the literature in human resources and related fields. However, the concept is also starting to gain broader policy attention (see, e.g. OECD, 2008, World Economic Forum and Mercer Consulting, 2012). The ‘talent’ perspective is promising as it links the needs of greater economic regions to both the needs of the organization as well as to the needs of the individual.

CONCLUSION

This chapter has argued that theory for explaining and understanding skilled migration is still being developed. Given the lack of standard definitions as well as frequently changing policies to support skilled migration, empirical evidence is still scant. Currently skilled migration research draws on other theories of labor migration, particularly push-pull models of individual movement and theories related to economic restructuring. However, new paradigms for research are emerging, mainly discussing skilled migration as a contributor to human capital development and knowledge transfer and the ‘global competition for talent’. While these elements have not fully been placed in a full theoretical framework, they have become implicit in much discussion surrounding skilled migration.

The 1990s was an important turning point in skilled migration polices in many countries and in media and policy discussions across the world and a basis was built for discussing a “global competition for talent”. Although skilled migration was common in earlier decades, the movements were less influenced by specific state directives, but rather from internal mobility in companies and particularly of managers in multinational corporations or from specific bilateral agreements, such as those found for health care workers. These movements were seen as unproblematic by governments in advanced countries and did not receive much policy attention, with the exception of concerns about brain drain and its impact on developing countries. However, the IT boom in the US and in the case of Europe, the desire to emulate this success (as indicated by the goals of the Lisbon Agenda), triggered discussions of ‘competitiveness’ and in growing the knowledge economy. The growth of the IT sector in the US had also become associated with skilled migration, and particularly due to the visibility of Indian and Chinese (main recipients of H1B specialty visas in the US, as is discussed in more detail in Chapter 2) IT professionals and engineers. As countries aimed to ‘catch up’ with the US growth, more attention was also turned to the US as a ‘magnet’ for foreign ‘talent,’ indicated not only in the presence of skilled labor in IT, but also in the high number of foreign nationals in the US higher education system, and particularly in science and engineering graduate programs. By the mid-1990s, discussions of ‘competitiveness’ had become part of the immigration discourse in Europe as more countries aimed to move from restrictive systems to selective systems, favoring (temporary) skilled migration and also trying to further advance the attractiveness of the university system and higher education for foreign students. At the same time, it also seems to have brought increasing attention the potential of ‘circular migration’ as a contributor to development and expanding demand for ‘talent’ from all parts of the world. Although policies and trends will continue to change due to the current financial crisis and changing economic
needs in general, the past forms an important backdrop for assessing the attitudes, beliefs, and experiences that have influenced policy decisions and mobility to date. There is reason to question how much the phenomenon of skilled migration is understood in the European or even global context and a strong need for new research to fill in these knowledge gaps.
CHAPTER 3: STUDY METHODOLOGY AND ANALYTICAL FRAMEWORK –
ASSESSING THE GLOBAL COMPETITION FOR TALENT

RESEARCH OBJECTIVES

The primary aim of this study is to critically analyze the concept of a global ‘competition for talent,’ (see Table 1 in the introduction) a term that is widely used but typically not applied in a theoretical way that has been built up through research. This research both defines aspects that are important in understanding the global competition for talent and then applies the research to a narrower field for work and study, life sciences and biotechnology, which has scarcely been researched in regard to general workforce characteristics or skilled migration paths.

The secondary research objectives include: 1) theoretically discuss and empirically delineate factors influencing the (assumed) global competition for talent; 2) utilize individual scientist and industry perspectives to explain the attractiveness of cities and countries for work and study 3) discuss and compare regional/national ‘situations and strategies’ related to attracting and retaining the scientific workforce; 4) describe recruitment processes/barriers in light of European and international mobility.

The biotechnology industry was selected as the main field of study, given strong attention to its development in various policy reports, but the near absence of discussion about these scientists in the migration literature. I also wanted to simultaneously be able to examine this sector both in view of global and national contexts and concerns. While it is not possible through my research design to state the effects of interactions between the global, national and local, it is possible to identify key topics and recent changes that have occurred on each level.

RESEARCH CHALLENGES

Many challenges were confronted in setting up this research project, which also influence the analysis. These challenges related both to the data availability and its international comparability, issues related to assessing deciding on correct units of analysis for competitiveness (micro-, meso- or macro-), and the start of the global economic crisis during the fieldwork period. These challenges also influence the applicability of this data to other contexts, whether to other countries or regions, years, or industries.

International comparison and statistical gaps

Internationally comparative statistics are either not readily available or complete for the main topics of this study. A standardized definition of biotechnology was not implemented until 2004, and there are still differences in how countries calculated and count biotechnology companies, for instance. Furthermore, collecting comparative immigration statistics involve similar problems. Similar to the issues seen in finding a common definition for ‘biotechnology,’ definitions of ‘skilled migration’ are also varied. As discussed further in chapter two, although skilled migration is in no way a new phenomenon, the magnitude of it and policies that guide it have been rapidly changing across the globe, particularly since the 1990s. Furthermore, little data
is available on an international level that allows for comparison of the life science or biotech workforce. Further details on data availability can be found in Appendix D.

These data shortcomings, changing dynamics and lack of research on the topic also present theoretical challenges, which are further discussed in this study. Given these limitations, the research undertaken could not yet adopt a comparative, case study methodology in the strict sense (for instance, as defined by Lijphardt, 1971), although this would be insightful as the concepts and theory surrounding the global competition for talent becomes more developed. It does, however, aim to collect various examples in diverse contexts and frame them within larger global mobility patterns and for life science jobs in particular.

Assessing competitiveness

In the past few decades, there has been increasing attention on creating various indexes for competitiveness, to compare the relative positioning of places and for policy guidance, for both the regional and national levels. One of the most utilized reports is the World Economic Forum (WEF) Global Competitiveness Rankings of countries, which was started in 1979, along with the International Institute for Management Development (IMD) World Competitiveness Yearbook started a decade later in 1989. Both of these indexes use a combination of statistics and survey data among executives. These studies were used for ideas on assessing competitiveness, but were not found as the most relevant to discuss biotechnology competitiveness.

Another of the biggest challenges in this research was to create a framework, data collection and analysis framework that can aptly address the various levels with an impact on competitiveness and hence the global competition for talent, ranging from the micro-level of individuals and/or individual research institutes or companies, to city or regional competitiveness and clusters, to the macro-level with countries as the main units of analysis. All of these levels are influential and while earlier versions of the research proposal tried to narrow the focus to just one level, the final result aims to collect information that combines all of these aspects, through both a global survey of life scientists. The benefit of this approach is its breadth, and the possibility to use the information for further exploration. The risk of this approach is a lack of depth for some of the aspects discussed.

Global economic crisis

The third, unexpected challenge occurred when the global economic crisis hit around 2008, when the empirical research was just beginning. Initially, the research plan involved launching the surveys and interviews in various waves, first in a broad global survey and later with a slightly revised survey focused only on specific case countries. However, given the complexities of building a meaningful project to discuss the new topic global competition of talent, without being influenced by the political and economic changes from the recession, it was decided that the primary data collection, that is the surveys and interviews, should be limited to the earliest stages of the research, from late 2008 to the middle of 2009.

RESEARCH QUESTIONS AND METHODS OF DATA COLLECTION
In order to better examine skilled migration concepts and processes, this analysis comes in the form of an exploratory study, with the goal of generating or building theory. This approach was deemed as necessary to answer the research questions, given the limited data collection on the biotechnology workforce and its mobility, as discussed in more detail later in this chapter. Although theory building is an accepted and commendable goal of research, its methodology is much less defined than that of the most predominant stream of research based quantitative hypothesis testing or the qualitative-based hypothesis-generating research often associated with grounded theory approach. The *SAGE Dictionary of Social Research Methods* (Jupp, 2006, p. 111) explains, “Exploratory research is a methodological approach that is primarily concerned with discovery and with generating or building theory.” Jupp further argues that exploratory research has often been misconstrued as being limited to pilot studies and qualitative research, whereas it actually can contain any range of methods. Exploratory research has been linked most closely to not only qualitative research, but also specifically to grounded theory (Glaser and Strauss, 1967), as is implied for instance by Stebbins (2001); although by definition it can contain any number of methods that best illuminate the theory in question. While this study on the global competition for talent represents the outcome of an exploratory study, it does not utilize a grounded theory approach. Grounded theory, as set up by Glaser and Strauss (see Glaser & Strauss, 1967), avoids looking at existing theoretical discussions before the research occurs and preconceptions and instead aims to create keywords to be explored further. However, my goal is to further understand the ‘global competition for talent,’ not as a buzzword, but instead theoretically and building on *existing* theories and research (where possible) falling under two main theoretical strands that have scarcely been combined: 1) workforce availability, including aspects of skills, mobility and migration 2) economic competitiveness. As discussed in other chapters, there are clearly shortcomings in applying theories related to labor migration to current day skilled migration in the knowledge economy, as well as a general lack of theory which can link economic change and workforce characteristics within the knowledge economy or more generally to the global competition for talent. Stebbins (2001, p. 42) explains that “literature reviews in exploratory research are carried out to demonstrate that little or no work has been done on the group, process, or activity under consideration and that an open-ended approach to data collection, is, therefore wholly justified.” These wide gaps in both theory and data are the primary reasons that make exploratory research the necessary choice for this study, and the gaps are addressed through the extensive review of the theoretical literature in the first part of the study and empirically as relates to life science careers in the second part of the study.

It should also be noted that in saying I am undertaking theory building or theory developing research, I do not presuppose that a grand theory is presented here. Development of theory, that is ideas and hypotheses which can be tested, refuted and revised and then hold to a wide range of situations (cases), takes a lifetime of work of not one researcher, but of many advocates and opponents. Rather, this study contributes to theory building primarily through adding conceptual understandings and empirical observations linked to the global competition for talent as a building block or stepping stone which could be catalysts for additional research, as further reflected upon in the concluding chapter. It could also be said to focus on concepts and generalizations rather than causal “laws” and their verification.
Exploratory research, by its very nature, calls for a large degree of ‘flexibility’ on the part of the researcher, a willingness to redefine goals (Stebbins, 2001) and a possibility of adopting any range of qualitative and quantitative methods (Jupp, 2006; Stebbins, 2001). The ‘flexible’ nature of this research process was important in this study as well. The original goals entailed focusing on the global competition for talent by observing specific biotech clusters and welfare state models. Yet, as the research progressed, it became clear that not enough work had been done yet for this work to proceed: Too little was known about both skilled mobility in Europe and the biotech workforce. Furthermore, the clusters assumed in the literature to be important for advancing competitiveness were not necessarily easily identified. How should the cluster be defined – a science park, a district, a city, a group of nearby cities in one country, or a cross-border cluster? Other research on biotechnology has been inconclusive on how to define a biotech cluster (see e.g. Teigland & Lindqvist, 2007) as biotechnology encompasses a wide range of both research disciplines and goals – from medical technologies, to environmental solutions such as biofuels, to improvements in industrial processes, to name a few. Is it fair that clusters for these various forms of biotechnology are the same? As a result of this gap in the supporting research, the focus became more generally on looking at the development of the global competition for talent on the whole and then linking this to observations in the context of life science careers. Both the issues examined in this research and the ones that were considered but not assessed will likely remain as key issues in the future, as the global competition for talent develops and understandings of its mechanisms advance. Reflections on topics for further research are presented in the concluding chapter.

The research questions and methods adopted are listed in Table 7.

Exploratory research and an original survey are both appropriate methods to look at how the global competition for talent is developing as seen through the life sciences, because few (if any) studies have been able to address this topic. Part I set out to better understand what structures, the global competition for talent, as a concept. It was recognized that more research is needed first to understand the various elements that are shaping the global competition for talent. This was done primarily through desk research, including reviewing academic sources in a range of disciplines, compiling statistical data, and reviewing government reports to answer the research questions on the structural aspects. Following that analysis, there is a need to better assess them globally, as statistical data on the life science workforce is not comparable or detailed enough to address these research questions. I therefore decided to design an original survey to find out more information about topics where statistics and research were scarce.

Understanding life scientists’ international mobility through survey data

The second research question involves understanding individual life scientists’ work history and individual goals related to mobility. Namely, how important/prominent is international mobility in life science careers? Which countries are attractive to life scientists and why? Which factors are considered and influence life scientists’ intentions to move or their actual moves abroad? In order to explore life science and biotechnology careers and international mobility within these fields, the Careers in Life Sciences (CiLS) project was developed, in partnership with the Young European Biotech Network. The first phase of the project utilized an online survey method to
**Main question for exploration:** What structures the global competition for talent? How can concepts and data (policies, statistics detailing changes) related to skilled migration and competitiveness be linked to better understand the global competition for talent? (Part I)

Which patterns have influenced the development of the global competition for talent as observed in the life sciences/biotechnology in particular? (Part II)

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<th>Sub-questions for further exploration</th>
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<td><strong>Structural factors</strong></td>
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<tr>
<td>How have skilled migration policies and other policies facilitating international mobility of students and scientists developed in Europe? What are the main features of these policies within the European Union? What are the features of the labor market within which life scientists work?</td>
<td>- Various policy reports, statistical data and other desk research - Desk research combined with CiLS data on interest in various employers, working within industry versus academia, and international mobility</td>
</tr>
<tr>
<td>Which cities and countries are seen as the most competitive for biotechnology globally?</td>
<td>- Desk research and policy analysis including a summary of biotechnology competitiveness, based on existing competitiveness indexes and other reports - CiLS survey results regarding biotechnology competitiveness</td>
</tr>
<tr>
<td><strong>Individual Life Scientists: Explore individual goals related to mobility</strong></td>
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<tr>
<td>How important/prominent is international mobility in life science careers? Which factors are considered and influence life scientists’ intentions to move or moves abroad? Which countries are attractive to life scientists and why? Which duration of stay is most desired for moves for life science jobs in the US and in Europe? What effect do life scientists expect international mobility to have, in terms of staying abroad or returning to their home country to work?</td>
<td>- International survey of approximately 600 life scientists and their career goals and mobility - Review of academic literature and governmental reports - Participant observation as member of the Young European Biotech Network - In-person interviews with life scientists, expert interviews</td>
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better understand the career and mobility interests of life scientists. An online survey method was deemed most appropriate for numerous reasons:

- It was expected that young scientists, a highly-educated group, would be both comfortable with and easily reached through an internet-based study.
- It allowed the study to easily be international, rather than focused on a single receiving country as has been done in most skilled migration research to date.
- Given the very limited human resources to work with the data, it allowed parts of the research to be ‘automated’ in order to facilitate data processing and analysis, given that this study was undertaken independently, without any financial backing for the data collection secured.

The survey was researched (based on desk research on the determinants of skilled migration and studies on the biotech workforce), written and programmed, as well as the data cleaned and processed, primarily by me. The CiLS project team (made up of five other PhD or students in various life science disciplines from various nationalities and living across Europe) gave feedback for the survey content and helped with online testing of the survey. A pilot study was conducted among 15 life scientist from their personal contacts before the survey was launched to test the wording for an international audience, relevance, and web-programming of the questions and look and feel of the survey. The survey was designed to take roughly 30 minutes to complete, but given both skip patterns to make questions relevant (for example longer section on employment for full-time workers), and numerous rating scales as well as some open-ended questions, actual times varied largely by respondent. The main results of the scientist survey, as linked to understanding the global competition for talent, is discussed in the second part of this study.

The survey was programmed and hosted through the service, SurveyMonkey.com. This site allows for custom design, unlimited response collection, for full data to be exported easily to SPSS via Excel, and features such as sophisticated skip patterns. The survey was set up to be an exploratory tool and contained both closed-ended questions (such as yes/no and Likert scales of agreement for attitudes) and open-ended questions, to better understand the global competition for talent. Coding was done as responses were read and emerged from the data, rather than being predetermined. SPSS was used for the quantitative analysis and MaxQDA 10 was used to code and analyze the open-ended survey responses. Open coding was used, whereby main categories were created and codes were put into these classifications.

It is important to note that the survey was not set up as a study on international mobility per se, but rather as discussing life science careers. Although my own research goal involved exploring

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8 SurveyMonkey currently has a feature for exporting data directly into SPSS, but this was not available when the data was first processed.
the concept of the global competition for talent, the research also aimed to see if it existed, and as such, international mobility was not required of respondents. The survey contained seven main sections: Profile of highest education completed; current studies or current work; internships; perception of skills and competencies needed in life science careers; interest in international mobility and factors influencing international mobility; perceived ‘strength’ of various regions and countries in the life sciences and biotechnology; and demographics and other classification categories that could be important for mobility opportunities (such as completion of degrees with honors) or mobility intentions (dual careers of spouse either in or outside of life sciences; currently being in a long-distance relationship).

The survey data shown in the quantitative section was collected between 1 November, 2008 and 1 July, 2009 and include 594 completed surveys.

Only completed surveys were analyzed and there was a completion rate of 39.20%. Response rates cannot be calculated due to disperse forms of collecting the data through links to the web survey. However, to better monitoring the survey, the percentage of completes can be calculated based on the link selected, as unique ‘collectors’ were created based on the source of the link clicked on. Respondents were found through four main avenues:

- A button, inviting ‘young scientists’ to participate in the study was placed on Naturejobs.com, one of the largest life science job search engines globally for one month (5 November – 4 December 2008). As Nature is one of the most highly esteemed publications for life science researchers (in terms of both reputation and factors such as citation indexes). This extended a possibility to reach a group active in the life sciences, whether working in academia or industry, and broadly could be seen as offering as close to a random sample as possible without a list being available (keeping aside the personal factors that determine whether or not someone chooses to participate). According to a report supplied by Naturejobs, approximately 58,700 unique users were exposed to the button from 5-28 November 2008 and the click through rate during this period was 0.11%. From the records recorded by SurveyMonkey, the link posted on Naturejobs led to 194 (32.7 %) of the completed surveys.

- The survey was announced within the Young European Biotech Network (YEBN), with a link to the survey on its homepage and newsletter, and YEBN members were encouraged to personally invite their own contacts to participate in the study. The Young European Biotech Network is an umbrella organization of various biotechnology student groups and is particularly strong in Germany, Italy, Poland, Switzerland, and Spain. 176 completes came from either the YEBN electronic newsletter’s announcement (86 completes) or the YEBN website (90 completes) and an additional 18 from the blog setup and hosted by BTmagazine (established by the largest student biotechnology association in Germany) as part of YEBN’s career conference, February 2009 in Frankfurt. The links to the survey sent by emails to various contacts of YEBN members yielded 18 responses.

- Universities within countries where YEBN is strong were contacted in order to increase the sample size. Email invitations for the survey were circulated at interested universities and institutions in countries in Spain and Italy (distributed through personal contacts,
with most completes made through either the link on the YEBN website or the YEBN newsletter), and through Swiss Universities (ETH Zurich, University of Bern, and EPFL Lausanne – 93 responses, with 70 from EPFL). MDC graduate school in Berlin, Germany also agreed to participate (25 responses).

- In additional, the study was announced through articles in two academic journals *Nature* and *New Biotechnology* (see Danilowicz, 2007; Rindoks & Danilowicz, 2008). As these were print publications, unique survey links were not designed for them, but rather for simplicity, readers were encouraged to access the survey on the YEBN website. It therefore is not clear how much interest was generated by these articles. A list of number of responses from the various collectors is provided in Appendix A.

Respondents were not able to go back and change their answers after completing a screen, and were informed of this in the introduction. In the testing phase, it was found that going back had led to some inaccurate data collection on survey monkey. In order to measure if respondents had made any mistakes, some key questions were asked multiple, related ways (for example, citizenship at the beginning of the survey and country of birth at the end). There were also a number of open-ended questions where respondents could explain their reasoning for their choices. In some cases, respondents mentioned previous errors, which could then be changed as the survey results were processed and the data cleaned.

No quotas were used, as statistics on the demographic and educational profile of biotechnology students and workforce were not readily available at the time of launching the survey (more information on the availability of statistics is discussed in Chapter 5) to allow appropriate quotas to be set. The sampling, therefore, is a form of non-probability sampling, as is common for web-based surveys (Baker et al., 2013), since it relies on self-selection for participation. Sampling error therefore cannot be determined9. Diverse methods of data collection were used in order to have better web survey sampling. All survey methodologies contain some form of bias or error, whether from sampling error or measurement error. The CiLS survey used very broad screening criteria in order to have a sample that could be used to further explore the concept of the global competition for talent and life science careers, as is recommended for exploratory research (Stebbins, 2001). The CiLS survey used an internet methodology in order to reach a broader group, which was not limited to nationality, stage of career, or the current workplace in either academia or industry. Rather the goal was to collect information from anyone active in the life sciences. The only screening requirements are having a higher education (above the high school level, ranging from apprenticeships to postdoc positions) focused on the life sciences, chemistry, or medical sciences or work experiences in ‘life sciences or a related industry’. While the sampling method does not allow for ascertaining or projecting the main characteristics of all global life scientists, it is a first step in filling in the data gap to discuss observed differences. Additional description of the main characteristics of the sample is found in Appendix B.

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There are several unique departure points for this study. First, most previous work on scientific mobility and migration focuses one or two specific, national contexts, that is scientists residing in, coming from, or returning to one or a few specific countries. The CiLS study aimed to reach an international audience. Second, some of the research focuses on scientists as one group, rather than looking at field of work and study, although research suggests there are very different career trajectories by scientific field. By looking at life scientists in particular and their careers, broader nuances of the global competition for talent and potential strategies in various countries can be discussed. Third, much of the current survey research on life scientists utilizes databases of published scientists for sampling or various bibliometric techniques (Jonkers, 2011; Jonkers & Cruz-Castro, 2013; Zucker & Darby, 2007). Although this method allows for random sampling, it is also limiting in that it contains a narrow group of scientists, namely those who are at a senior enough stage to have published and largely those working on research in academia, instead of in various companies (where publication is often not seen as a core part of the job). Another sampling approach sometimes taken involves sampling at select schools. However, taking this approach limits the geographical spread of the data and typically limits the data collected to current students, who may not yet be clear on what the job market for life scientists can offer. The broad data collection used in the CiLS survey allows for a look for key career and mobility issues of global importance, while also allowing the YEBN a tool for finding issues relevant to career planning. The CiLS survey was presented at several life science career workshops around Europe (see list in Appendix C), which also gave good feedback from those involved with the issue, including students, employers, and policy makers.

Scientific mobility was identified as the best term to apply to the CiLS research, and is viewed as being a particular category or type of skilled migration. While there is not one strict definition of scientific mobility, it generally assumes an importance of shorter stays, which is in contrast to the permanence assumed by much of the skilled migration literature. A very broad definition of scientific mobility is applied throughout the chapters in this study and data from the CiLS project: Scientific mobility is defined as individuals with a higher education in the life sciences who have moved internationally for “stays of two months or longer, not including holidays/vacations.” This definition also allows for scientific mobility to include a broad range of forms, whether from international degree programs where study occurs in multiple universities, internships abroad, or employment abroad.

The data are analyzed primarily by country of current residence and/or countries of citizenship, depending which is more relevant to the question being discussed. Information was also gathered on city of residence, but it was too disperse to be used as an analytical unit. Country of birth was also collected, but citizenship is used instead as the main analytical unit, as this is what most effects access to various labor markets, including the crucial example of free mobility within the EU. The data on citizenship is typically presented based on a few main groups. One of the main classifications is by countries where there is a sufficient sample, namely Germany, Italy, Spain, Switzerland, Poland, and the other EU-10 countries as a group, for Europe, and India.. A third classification is based on developing countries, outside of the EU. This list was compiled based on the World Bank’s classifications. India is not included with the other developing countries, given the large number of responses. While not all countries are represented evenly, the
combination allows for a broad analysis of career goals or patterns of scientists from developing countries to compare with those within Europe.

Like any methodology, this survey has some advantages and shortcomings. Its main advantage is that it is international, with 594 responses from citizens of 69 countries (see Figures 2 and 3), and very little research of this type on mobility exists. However, it is not representative of all countries equally, nor of the scientific population in each place. For example, the total sample contains few scientists residing in the US or UK, both seen as top scientific markets globally, as the focus of the original study was on understanding dynamics of other European countries. The survey was also only available in English, which would also influence the response rates. The uneven sampling across countries means that the CiLS data is not suitable for many advanced, statistical analyses, but instead lends itself mainly to descriptive statistics and qualitative discussions based on answers to various open-ended questions. It is important to note that the data therefore cannot be used to ascertain the ranked position of destinations globally, but rather for discussing changes and highlighting similarities and differences in various countries to attract or retain life science talent. The survey could also be used as a springboard for new research, which then could use a different sampling method and inferential statistics and statistical modelling to determine rankings. In other words, the data is used for discovery-based research on a new and relevant topic, not for hypothesis testing or statistical modelling.

Interviews in Lithuania

Another qualitative element of the study was conducted in Vilnius, Lithuania, where I was living in 2008-2009 during the data collection time period reflected in this study. Interviews from Lithuania allow for the perspective of a new EU member state. Lithuania is considered to be a transition economy following the collapse of the Soviet Union, independence around 1990, and then EU membership in 2004, which includes the right of free mobility to other EU countries. It often has not even been featured in comparative reports on biotechnology, yet has a handful of internationally competitive biotech companies. Also, along with EU membership also comes the requirement to invest in R&D as set out in the Lisbon Agenda, the period of time in focus, the interviews were primarily gathered here through interviews with various experts, including scientists, policy makers, and researchers on migration and brain drain in Lithuania. These interviews are used to further interpret contextual differences related to the impact of international mobility of scientists as relates to a new EU member state.

The original intention was to launch the CiLS scientist survey in Lithuania and company interviews. However, given the broad effect of the economic crisis threatening making the first and second waves of data incomparable, this stage never materialized. However, the interviews and observations are still relevant to allow for a broader look at both the life sciences in various European contexts and dynamic of the global competition for talent, but cannot be said to add systematic comparison.

Participant observation

While not initially conceived as part of the research design, participant observation has held a crucial role in this study. Even without saying anything about my own life to the respondents, my
FIGURE 2 CAREERS IN LIFE SCIENCES (CILS) SAMPLE - CITIZENSHIP
FIGURE 3 CAREERS IN LIFE SCIENCES (CILS) SAMPLE - COUNTRY OF RESIDENCE
personal experiences have undoubtedly shaped the questions explored in this study. Stebbins (2001, pp. 52-55) notes that the strength of exploratory research is often built not just as a project, but in that it is often reflective of the researcher’s lifestyle.

One aspect of the ‘participant observation’ regards my own experiences with international mobility, both in developing and developed countries, and discussions I have had with other ‘migrants,’ including many skilled migrants or international students, across the world. In the time I spent completing this PhD, I lived in four countries: I was formally based the Netherlands, had a one year Fulbright scholarship in Lithuania, another year-long scholarship from the Swedish Institute to study in Sweden, and finished the writing while living in Slovakia, where my husband is from. In addition, I also spent several months working on the proposal while in the US, my own so-called home country, unsure if funding would come through and if I’d be able to attain the residence permit to complete this study in the Netherlands. I know firsthand that while others either often idealize or are completely perplexed by such an ‘international lifestyle’, it comes with both advantages and challenges. I have personal experiences as to how a lack of skilled migration in the past in Europe can mean that systems are not in place, ranging from things such as no online banking outside of the national language (for instance no English-language webpage in major banks in the Netherlands when I first arrived, and none in the Swedish bank during the course of my stay there in 2009), to policies that seem deliberately designed not to ‘attract’ but to prevent people from outside the EU from sticking around too long. It also means that I am in many ways seen as an ‘outsider’ and other ‘migrants are often comfortable discussing their true feelings about the place where they are living. In every place, some common negative perceptions experienced by the ‘foreigners’ can be identified, often regardless of their own national background, and although these ‘common problems’ vary greatly by country, they are largely tied to either dominant cultural differences or institutional difficulties (quality of medical systems, for instance; bureaucracy). My personal mobility experiences began long before this PhD period and Europe, and includes life in seven US states, completion of junior high and high school at an American school in Germany, being one of very few US citizen active in the international students association in college, through a Bachelor’s semester abroad at the University of Ghana in Accra and working as a skilled employee in a multinational marketing and advertising research consultancy in Taipei, Taiwan. While I am generally a researcher who is inclined to keep the personal details and anecdotes out and focus on the objective results, I find I am inevitably asked about my background just about every time I present my research. Additionally, in setting up the survey later, I made sure it could capture complex mobility patterns, like the ones experienced by myself and of others I have known closely, without overemphasizing international mobility for those who have lived primarily in one location.

Another aspect of participant observation occurred through the partnerships I formed with the YEBN, which I had found online listed as conducting research on brain drain. After contacting them about my research interests, I was invited to join one of their meetings in Bern, Switzerland in June 2007 and from there, not only a partnership, but a new synergy for this research project merged the initially expected distance between social and life sciences. We created a new project, Careers in Life Sciences (CiLS) during that first meeting. In other words, from the start,
I have been enthusiastically welcomed and have acted as a YEBN member and not as an outside observer. In turn, as one of the founders of the new CiLS study, I presented our project design and results at YEBN annual meetings and conferences, as well as also attended one or two internal CiLS team weekend meetings, scattered across Europe, a year and was accepted as an important YEBN member, rather than as an outsider. This participation allowed me to get feedback on whether or not the findings fit and were relevant for biotechnology, as many of the YEBN meetings included expert panels with people from the European Commission, national research agencies, or companies and confirmed that findings ‘fit’ within other known contexts. I was also able to hear about issues relevant to life scientists, not only abstractly, but through one-on-one conversations, based in daily life and concerns, rather than as a research agenda. While I would not find it appropriate to detail their ‘life stories’ in this study and methodologically using too much description is seen to distract from theory development (Stebbins, 2001, pp. 44-45), the observations I had held immense value for me. Particularly illuminating were their international mobility experiences— for instance stories of short-term projects of students in Western Europe to places unexpected, such as Kazakhstan (science has no borders) to Cuba (quite strong in biotech, as I was told in that conversation) and barriers – including feelings of discrimination or exclusion when based in some labs in foreign countries to family concerns, have been influential in identifying issues, in questioning how questions can and should be asked in understanding the current dynamics and drivers of the global competition for talent.

My experiences allow me to have a critical lens when reviewing other studies, both to identify where conclusions may be missing critical examples, as well as where findings may be too enthusiastic, based on the more negative side of the realities surrounding the other side of the noted success. These experiences influence the creation of ‘interpretive theory’ (Jorgensen, 1989, pp. 16-17):

The methodology of participant observation provokes concepts and generalizations formulated as interpretative theories. These concepts and generalizations may be used to examine critically existing hypotheses and theories. Concepts, generalizations, and interpretations inspired through participant observation are useful for making practical decisions (see Chenitz and Swanson, 1986; Williams, 1986).

In other words, participant observation helped to shape concepts and find ideas for further exploration particularly for discussion of the individual’s attitudes and experiences within the concept of the ‘global competition for talent’, while the survey and interviews allowed an initial gauging of the predominance of these ideas on a larger scale and for specific groups, such as those based on nationality, of life scientists.

ANALYTICAL FRAMEWORK FOR UNDERSTANDING THE GLOBAL COMPETITION FOR TALENT

Increasing productivity has become associated with ensuring economic competitiveness and economic prosperity, as discussed in the previous chapter. The project builds from the theories discussed in Chapter 1, applying Porter’s emphasis on competitiveness evident through productivity with the importance of workforce characteristics, as explained by the ‘competition’
for workers and Florida’s viewpoint on *individual* preference for choosing regions for employment. In this section, the various arguments implied in the ‘global competition for talent’ are divided into a new schematic with four basic classifications: productivity, people, place, and policies. Each of these will be explained to further highlight what is implied in the ‘global competition for talent’. Although the framework presented above lists out the four main components that drive the ‘global competition for talent’ separately, each of these factors cannot be seen as acting in isolation and understanding the overlap among these various topics is essential. For instance, the interactions of productivity, people, place, and policy have become central to analysis on skilled migration and can be seen both in *processes* such as ‘knowledge spill-over’ or ‘knowledge transfer’ as well as in their *effects*, reflected in terminology such as ‘brain gain’ and ‘brain drain’. The 4P framework clearly echoes the work of Florida’s (2002; 2005) 3Ts (technology, talent and tolerance) and the research behind his thesis are important in its development, although his data is not necessarily accepted as the best measures. The 4P concept was developed both to give Florida credit where it is due and also so that the ideas are not equated with the research of Florida, as this research feels the concepts each need to be defined further. Productivity is a much broader concept then technology alone and is one that will apply to any economic activity, even for regions that aim to compete but do not have relative technological advantages. As a theory building study, the definitions and examples used in this typology will be further expanded through original data collection and coding of the CiLS survey.

**Productivity**

In the rest of this research, competitiveness is defined as “status as a leader”. While this is clearly a simplified definition, it is important to note that this definition of competitiveness can tie into several different levels of analysis, ranging from the national to the individual. Productivity would then examine the underlying reasons why a place is seen as a leader. According to Wyckoff & Schaaper (2005, p. 12),

> The market for the highly-skilled has transformed from one where demand originated largely from a single buyer, the US, in the 1990s to one where demand is now more differentiated across buyers, including the EU, Japan, Canada, Australia as well as the large supply countries themselves – China and India. This shift is just beginning, and will probably move in fits and starts, but several indicators suggest that it will continue and strengthen, leading to the formation of a truly global market for the highly-skilled (Harris, 2004). This evolution of the market could have profound implications for individual national innovation systems, macroeconomic policy, the generation and flows of knowledge and correspondingly the shape and operation of the network through which knowledge is shared.

Hence, discussions on productivity are both highly relevant to science and technology personnel and are an essential component in understanding the development of the conceptual underpinnings of the “global competition for talent” and policy developments more generally. The productivity aspect frames the economic goals that are used to argue in favor of skilled migration policies, particularly as related to knowledge-based sectors or other fields where
‘global’ labor shortages have been reported, particularly at the time of the initial rise in global attention to highly skilled migration in the early to mid-2000s.

The term, productivity, like competitiveness, can be assessed at different levels. These can range from identifying the most productive individuals (talent) to the most productive countries in a given field or industry. It applies to various institutions as well, whether in speaking about the most successful or efficient companies or the most prestigious, for instance in numbers of publications or awards, university departments. It also applies to region, for instance in identifying top clusters in biotech. To the best of my knowledge, the concept of productivity has not been applied in other research to discuss the global competition for talent.

The goal of this study is not to measure productivity, but rather to use it as a basis to better the biotechnology industry as well as, more generally, how productivity relates to the other aspects of the framework, and hence to immigration.

People

The category of ‘people’ covers the aspects of the ‘global competition for talent’ that are linked to individual choices to migrate as well as those linked to defining the concept of talent:

- **Based on the individual determinants of migration.** In other words, why is it that some people stay and others go? This has long been a top question of migration research. Many of the factors seen as determining migration fall into other categories – particularly the long-held belief that people migrate predominantly to maximize their income. However, outside of economic opportunities, a number of other factors have been determined as important in individual and family decision-making, based on career opportunities and lifestyle choices, as explained more in the section on place. Demographic factors and their influence on location choice are also important, including but not limited to gender, age and life stage, and citizenship.

- **Based on human capital.** Human capital has long been seen as one of the most important elements of skilled migration. Human capital is usually assessed based on an individual’s skills, education, training, and work experience. Human capital is a concept that is used in literature looking at individual job outcomes, in an organizational capacity, and also for migration policy-making (for instance, in the form of points based systems that assess and individuals ‘desirability’ for migration).

- **Based on demand for high-skilled labor in given occupation.** The term ‘talent’ seems to increasingly be associated with certain occupations in demand, rather than solely individual characteristics and qualifications. In other words, ‘talent’ seems to be emerging as a buzzword whose use points both to the areas where labor is in demand. This perspective is often used in skilled migration policy-making, through assessment of labor demand or for simplified and expedited visa processes for specific occupations.

- **Based on assessing individual merit and excellence (talent):** This classification is based on various measures of merit, when talent is defined by excellence. For scientists,
these include scholarship recipients, academic citations, patents and prestigious awards such as the Nobel Prize. This narrower definition of talent can be incorporated into policy. It is also often used simply as a rhetoric for promoting skilled migration, with claims that it brings in ‘the best and the brightest’.

- **Based on organizational needs**: ‘Talent’ or ‘top talent’ have become core concepts in human resources and in company strategies and planning. The talent perspective in the human resources literature and that in the skilled migration literature seem to have evolved independently, and few studies examine the overlap. From the organizational view, talent encompasses the individuals with strong skills in core areas of their business, and includes not only human capital based characteristics, but also soft-skills and personality factors that influence whether the person is a good fit for the organization and specific job role.

(Perceptions of) Place

The next aspect of the ‘global competition for talent’ relates to the image that one holds of the place and how this influences the decision on where to move, and more generally to economic geography. The ‘place’ element of the global competition for talent also includes recognition that an individual can make a great contribution to the country they move to; an aspect closely linked to the use of the word ‘talent.’ As eloquently summarized by Trippl & Maier (2007, p. 1),

In the past years, there has been a growing recognition that knowledge and highly skilled individuals as “carriers” of knowledge are a key driving force for regional development, growth and innovation (Lucas 1988, Romer 1990, Glaeser 2004, Florida 2002a, 2005a). Given the importance of well educated people for regional dynamism, the geography of talent and the mobility patterns of the highly skilled class are increasingly attracting the attention of both academic scholars and policy agents. Zucker and Darby (2006) find that ‘star’ scientists tend to ‘become more concentrated over time, moving from areas with relatively few peers to those with many in their discipline.

Ackers (2005b) found a similar result indicating ‘clustering’ towards specific institutions of ‘networks of excellence’ in Europe when examining Marie Curie scholarship holders and a similar clustering effect was reported by Millard (2005) in research on scientific clustering in the UK. The perception of the place can is formed on a multitude of levels and can be divided further into three main categories:

- **Country and city image**: As Metz (2002, p. 96) states about economic development, “Image is no longer the result of developments; it is their cause.”. Some countries have become viewed as holding more opportunities, being more open and tolerant, allowing individual freedom, or simply as being seen as ‘nice’ places to work and live, based on a multitude of factors such as the lifestyle, atmosphere, climate, and ‘culture’ they offer. While some images are directed by personal experience (from one’s self and the experience of others who are known or trusted), they are also formed through mass channels of communication. Here media plays a strong role in forming images, as does
the place marketing that directs these images and associations. Place marketing is currently seen as one of the processes for boosting economic competitiveness. As Anholt (2002) comments, most place marketing is not about creating a brand new image of a place, but rather about brand management, about supporting existing positive associations and limiting the negative ones. It is also about the communication of opportunities in order to ‘attract’ tourists, investors, and the ‘desired’ would-be migrants (skilled or occupations in demand). Communication aimed at any of these audiences may in fact spur the image and associations formed among other groups as well; that is to say that a place that seems attractive for a vacation may also seem like an attractive option for a place to live. The image can also be driven by associations related to the business environment or even the reputation of specific corporations operating in and associated with this city or country.

- **Opportunity structure -- Work life and professional opportunities:** Economic opportunities have long been viewed as the main driver of international migration. However, as noted by D’Costa (2008, p. 59), ‘Salary differentials alone do not explain international mobility. Challenging assignments, favourable working conditions, and access to relevant peer groups are significant professional factors…’ In other words, place must be examined not only in the context of the city or country one is moving to, but also in terms of the specific job offer or study program and all the conditions that surround it. It is further influenced by other aspects that shape the opportunity structure, including but not limited to competitive versus non-competitive hiring practice or discrimination.

- **Quality of life and lifestyle:** Quality of life and lifestyle point to two very different aspects, that of the availability of amenities (leisure consumption) and that related to the provision of needed services. This is the aspect of place related to amenities and consumption is discussed in the most detail by Florida (2005, p. 218). Florida asserts that ‘Creative people (that is ‘talent’ in other words) are not moving to these places for traditional reasons… What they look for in communities are abundant high-quality amenities and experiences, an openness to diversity of all kinds, and above all else the opportunity to validate their identities as creative people.’ Cities such as London or New York are seen as attractive not only due to economic opportunities but also because of the lifestyle and general diversity of population they can offer. On the other hand, the availability of social services can also be important. Favell (2003) discusses some of the barriers to ‘free’ mobility in Europe on the individual level among highly skilled Europeans, largely that many of the factors that influence ‘quality of life’ as relates to provision of services, are still determined on the national or local level. Furthermore, the same factors discussed in ‘integration’ of low-skilled migrants can apply to assessing the situations of the highly skilled: patterns of friendships with locals, ties to the ‘homeland,’ access and use of various community institutions or services, political participation, or involvement in the neighborhood, to name a few. Favell further explains that among ‘expats’, who often move from city to city as decided by their company or firm, various
degrees of attachment to the ‘place’ exist ranging from indifference to a stronger involvement.

Policies

Recent research (Eggers & Hagel, 2012, p. 10) argues:

*The global contest for talent is likely to define which countries lead the world economy for years to come. [...] Talent competitiveness represents a multidisciplinary policy challenge.*

Building from the work of Eggers and Hagel (2012), policies for ensuring adequate supply and quality of the workforce can be grouped into four main aspects:

1) Skills and education
2) Immigration
3) Innovation, research and development policies
4) Competitiveness in international markets, which also includes foreign direct investment, intellectual property law

The first two aspects are directly related to ensuring the availability of a skilled workforce, while the third aspect of innovation, research and development policies may include the human capital dimension in addition to other policies, such as research funding. The aspects related to international markets are crucial for looking at the competitiveness of knowledge-based economic activities, but are both complex and are assumed to be more related to firms location choices than to individuals, and hence are only briefly discussed in this study. This list may not be exhaustive, as understandings of how various policy fields intersect to impact the global competition or talent are still developing. Furthermore, the framework is best suited to looking at policies on the regional or national level.

Another change is that governments are increasingly seeing it as their role to foster ‘attracting’ skilled immigrants, in addition to also facilitating processes for companies to hire people they feel meet their needs. Immigration is increasingly being viewed as part of a country’s labor market strategy (see Niessen & Schibel, 2005). Trippl and Maier (2007, p. 6) insightfully recognize two main drivers. They explain, ‘Over the last two decades a global “migration market for skills” (Salt, 2005) has emerged. The main driving forces of this trend are a growing demand in advanced countries for IT and other skills in science and technology as well as the emergence of more selective immigration policies that favour highly skilled migrants (Cervantes 2004, Salt 2005).’ These drivers also reflect various assumptions made in discussing the ‘global competition for talent. First, it is the idea that there is a demand to recruit internationally. This assumption applies most to specific jobs and industries that are in demand, where there is either a labor shortage (with IT as the most commonly cited example and global labor shortages reported from the 1990s on) or where exceptional skills are seen to make a large contribution (top scientists, medical specialists, artists and athletes). Second, it is often assumed that people with the education and skills levels desired can choose where they would like to relocate. Yet, in reality migration policies are not the same across countries and some nationalities face greater
restrictions, for instance Africans often seem to face barriers in migration. Third, it is assumed that policies, particularly immigration policies for receiving countries and policies aimed at creating networks through the diaspora for sending countries (see OECD, 2008; Solimano, 2008) help to steer both the processes and effects of international mobility. Mobility of the highly skilled has increasingly been explained as a win-win situation, enabling skills development for individuals and resources in the form of both financial remittances and knowledge transfer for developing countries (e.g. Kapur, 2001; Mahroum, 2005; Solimano, 2008).

While Eggers and Hagel’s analysis involves diverse policy types, the nuances are even more complex yet. For instance, policies that explicitly support the migration of ‘talent’ range from setting general, more global skilled migration programs to allow individuals to come in from across the world to specific grants aimed to attract a specific type of researcher or other specific occupations. When skilled migration policies are adopted, there is a varying continuum of forms. It is important to remember that while policy is not the only factor that influences migration and mobility patterns as discussed in the previous section, it is important in shaping the type and magnitude of the inflows (Grogger & Hanson, 2008) and changes across time. Abella (2006) looks at policy goals and distinguishes four policy approaches (which are not mutually exclusive) to skilled migration:

- the human capital: often permanent migration through points based systems,
- labor market needs: based on labor shortages and specific skills in demand,
- business incentives: special incentives given to investors or managers, such as permanent residency, citizenship, or labor market access for family members,
- academic-gate approaches: focused on attracting international students to university degree and research programs and facilitating their labor market access after graduation.

Understanding policy influence on the global competition for talent is also challenging as it occurs on a wide range of scales. Reiner (2010, p. 15) presents a framework (see Figure 4) of the various policies for what he calls “brain competition policy,” and notes that policies occur on multiple levels ranging from the global level such as the GATS treaty, to the international level such as through the EU, the national level and the regional level in his framework. In addition to migration and mobility, Reiner points out that labor market policy, particularly nondiscrimination measures, university recruitment and recognition of foreign credentials, and business policy all play important roles. All of these various policies have an impact on the global competition for talent. Given this complexity, policies relevant for the global competition for talent cannot be examined in full in this study. Instead, the study aims to point to some key features of policies that are having an impact on scientific mobility within and to various European countries.
CONCLUSION

This study begins to map out the currently uncharted territory surrounding the concept of the global competition for talent. As a first drawing, it is a map that cannot be said to sketch the situation of the entire world, to detail each of its unique features and position therein or the borders surrounding the concept, but rather begins the outlines for further explorers to fill in. The data in Part II represents the views of life scientists across many corners of the globe, as well as discusses some of the specific ‘situations and strategies’ within various countries in Europe. These situations and strategies, or cases, to use the term loosely, discussed in this book have been chosen based both on availability of data, based on numbers from the original international survey results explained above, to illuminate a wide range of situations and understudied cases in the global competition for talent. For instance, one goal from early on was to include an example of biotech from an EU country in Central or Eastern Europe, while the data on Indian life scientists came about unexpectedly. Furthermore, the focus of this study is primarily on adding some examples to provide context for how the global competition for talent plays out within life science careers.
INTRODUCTION

As highlighted in earlier chapters, globalization is made up of mobility of goods, capital, and people. The human mobility aspect has received the most policy resistance to date. For instance, Sassen (1995) has noted this disparity between the various forms of international mobility and their acceptability to governments, focusing on issues of global economic integration. She explains,

Today we can see in all highly developed countries a combination of drives to create border-free economic spaces and drives for renewed border-control […] Current immigration policy in developed countries is increasingly at odds with other major policy frameworks in the international system and with the growth of global economic integration.

These tensions not only pose questions of selectivity, priorities and mechanisms among states for migration, including skilled migration, but also partially frame the attitudes towards openness to foreigners, in general. Hence, the tensions also influence the migrant’s individual experience and the opportunities afforded to people from other countries and backgrounds. Brown (pp. 26, 28, 29) refers to this outcome as “the myth of the global labor market,” arguing,

The view that workers now have to operate in a global rather than a national market is also a simplification of existing realities for most workers. This is because the global labour market does not operate as a ‘free’ market (Castells 1996; Held et al. 1999). Nationality continues to operate as a vital tool for restricting the competition for jobs by excluding millions of well qualified workers from other parts of the world, such as skilled software engineers from India competing for IT jobs within the European Community or North America (Kobrin 2000). […]

We must avoid conflating the deregulation of world markets with those of how nations are responding to these changing rules of international competition. […]

Contrary to proclamations of the end of the nation state (Ohmae 1995), the economic competitiveness that benefits the many rather than the few will depend on the way national governments respond to competitive pressures from ‘foreign’ countries, companies and workers. In other words, nations must confront new problems that threaten the living

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standards of workers and their families. Globalization has made it more important to have a
democratic political voice that serves the ‘national’ interest.

The conflicts named above are central in both the economic as well as in immigration policy
choices, as governments try to balance internal concerns for and against labor migration with
objectives for advancing economic competitiveness in the global context. While these two
factors, global economic participation and a national orientation in terms of welfare and security,
have become a necessary and nearly omniscient part of the political-economic landscape, they
have been met with varying responses. As discussed in the previous chapters on the paradigm of
a “competition for global talent”, there has been a strong increase in skilled migration
movements across the world, with the 1990s serving as an important turning point for
immigration to be acknowledged across more states as a contributor to economic
competitiveness (particularly in the knowledge economy/science & engineering). However, the
economic boon of the 1990s was followed by a deep recession in much of the world and higher
rates of unemployment during the economic crisis of the mid-2000s. In this context, immigration
was often put on hold and viewed as a barrier to lowering unemployment rates. In the European
Union, the policy complexity is compounded as 27 individual member states differ not only in
their current policy objectives but also in terms of histories, institutions, and economic structures.

This chapter begins to address some of the structural factors related to skilled labor movements
in Europe. It answers the following questions: How have skilled migration policies and other
policies facilitating international mobility of students and scientists developed in Europe?
What are the main features of these policies within the European Union? It looks at these
questions with evidence from three facets: for skilled migration as a whole, as well as European
policies for researchers, and at intra-European mobility. The chapter first defines the terms
mobility and migration and then outlines a few key aspects of the EU. It then examines the
development of common EU policies that impact skilled labor movements across various
countries in the EU, particularly the concept of free movement in the EU, and the beginning of
EU-level skilled migration and scientific mobility policies. It then highlights and compares
various policies and discourse towards cross-border skilled labor movements of several member
states in the EU, looking at both connections and disconnects in assumptions between
immigration and competitiveness. The next section then looks at studies that review a broader
range of policies in the EU that contribute to building the knowledge economy workforce. In
taking this approach, this chapter aims more specifically to highlight commonalities and
contradictions in approaches to skilled labor movements in much of Europe

KEY TERMINOLOGY

In the recent migration literature, a distinction has often been made between ‘migration’ and
‘mobility,’ although there is not one set of agreed definitions. The status of ‘migrant’ can be
based on place of birth, by various visa categories, and the term is typically used in the context of
cross-border movements. Mobility is often used in two different contexts. The first is based on
the intended length of stay. Mobility is usually seen as short-term moves, whether for study or
for work. According to the United Nations’ definition, migration is defined by stays of one year
or longer, but this definition has not been uniformly applied across places or even across
different forms of migration. For instance, some say international students are not migrants, but instead temporarily mobile individuals. The second context applies specifically to movements within and to various regions, whereby mobility is viewed as moves that are more unrestricted and typically do not require one to have a special visa. This concept has been applied within the European Union as mobility is a right of EU citizens, meaning there should be an unrestricted flow for residence and labor across the various EU countries. Migration policy in the EU is therefore aimed at ‘third-country nationals’ or those with citizenship from countries outside of the EU, and statistics are not always captured for these internal EU movements, as usually no permit is required.

While the distinctions between mobility and migration are important to policy, in this study they are defined loosely. Generally, migration is used to denote stays that require a special visa and with the possibility of lasting more than a year, whereas mobility is for unrestricted movements and shorter stays. However, these terms will often be used interchangeably throughout the chapters in this study. The reason for this is that studies show that individuals often stay longer than expected, on one hand, and may have intentions to move to several countries, on the other. Furthermore, while mobility and migration have different legal frameworks, the social, linguistic and employment concerns of individuals are similar. Understanding the global competition for talent entails identifying both mobility and migration patterns, and must also include the role of nationals in filling crucial job positions.

THE GEOGRAPHY OF THE EUROPEAN UNION AND EFTA

The EU is an evolving political entity, both in terms of its geography and in term of its policy reach. By the end of 2013 (see Figure 5), the EU includes 28 countries, shown in the map in the sections with the lightest shading and Croatia, which joined in July 2013. One of the biggest changes to the EU involves its enlargement in 2004 and 2007, unique both in the number of countries involved as well as the political and economic situation as the majority of these countries had communist systems following World War II and then liberalizing and adopting democracy in the late 1990s. The 2004 EU-enlargement included Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia, while the enlargement in 2007 added Bulgaria and Romania to the EU. The GDP of these countries is often much lower than the other member states, particularly those in Western and Northern Europe, although the economic woes of the Southern European countries of Greece, Portugal and Spain have also resurfaced in the economic crisis.

The European Free Trade Agreement (EFTA) includes the countries of the EU plus three others. These countries include Liechtenstein, Norway, and Iceland, which have selected not to be part of the EU, but are part of the EEA. The countries in the EEA also adopt the four freedoms, allowing economic integration and mobility as discussed in the next section, along with the 27 countries of the EU, but are not bound to other EU policies. According to the EFTA website “In addition, the Agreement covers cooperation in other important areas such as research and development, education, social policy, the environment, consumer protection, tourism and culture, collectively known as ‘flanking and horizontal’ policies. The Agreement guarantees
equal rights and obligations within the Internal Market for citizens and economic operators in the EEA.\textsuperscript{11} Switzerland is not part of the EEA, but as will be discussed later, has signed some bilateral agreements with the EU and hence applies some of its frameworks, including its framework for mobility of researchers.

FIGURE 5 MAP OF THE EUROPEAN UNION, 2013

Source: CIA World Factbook, 2013

RELUCTANT CONVERGENCE? THE INFLUENCE OF POLICIES FROM THE EUROPEAN UNION ON MOBILITY AND MIGRATION

This section will discuss various EU polices with an influence on international mobility. Three different but fundamental platforms of the EU’s adoption of policies to promote mobility are discussed: The principle of free mobility in the EU and Common Market including the level of labor market access afforded to citizens of the EU-accession states, support for the growth of the knowledge economy and its workforce, and finally moves to harmonize immigration policy across the EU and particularly debates surrounding the EU’s ‘Blue Card,’ a proposal for a high-

\textsuperscript{11} http://www.efta.int/eea/eea-agreement.aspx, Accessed 4 March 205
skilled visa allowing portable work and residence rights across the EU. This section argues that since free mobility, including international mobility of labor, is a crucial component of core EU strategies, many important initiatives fostering international mobility are currently occurring outside the realm of ‘immigration’ policy per se. Whereas immigration policy largely remains the prerogative of the individual member states and is a topic with much public resistance, policy to support the knowledge economy is a common, more readily accepted EU-wide objective.

Free mobility in the European Union

In order to create the best market efficiencies and security for the area, the premise of the EU is hinged on various ‘freedoms’, which are linked more broadly to ensuring mobility to create a common, or single, market. The EU was therefore formed on the basis of ‘Four Freedoms’: freedom of movement for goods, services, persons, and capital, forming the cornerstone of the European Union’s existence and operation of the common market throughout all of the EU’s territory as well as in the three countries of the EEA.

Despite the centrality of free mobility in the EU’s mission, there are a number of limitations to ‘free mobility’ in Europe. First of all, statistically labor migration across European regions has been low (Benton & Petrovic, 2013). Nonneman (2007) argues that there is ‘immobility of European labor’:

…despite high unemployment in the local area, [the European workforce] is disinclined to resettle in areas with more job opportunities. Less than 0.5 percent of European workers move to a different region every year. This is very little, compared, for example, with the 2.5 percent of Americans who take up residence in a different state every year.

Nonneman further discusses that the limited mobility is due both to varying social provisions, such as welfare, housing, and pensions, as well as to language and cultural barriers among the various EU countries. Overcoming such internal divisions therefore is an important priority in ensuring the longevity and functioning of the EU. One report on mobility (PricewaterhouseCoopers, 2006) found that less than 5% of applications for “senior management, professional and skilled manual positions” in Europe were from individuals from other EU countries (p.10). By comparing results from their surveys conducted among companies in 2001 and 2006, with the results on individual attitudes towards mobility reported by the European Commission’s Eurobarometer survey, the report concludes,

… employers clearly believe that higher levels of mobility will be needed in the future to support the development of their business. Individuals are less persuaded that mobility is a good thing for the labour market and individuals and a significant minority of both companies and individuals consider that mobility is not a good thing for families. There is therefore a perceived mismatch between the expectations of companies and those of individuals in relation to mobility, a gap which still needs to be bridged if the European economy is to move along the road of the Lisbon agenda (p. 13)

Yet, the study also cautions that much information on mobility within Europe has not been contextualized and that there are likely numerous different patterns based on individual goals or
the country the person is from (p. 10). Another factor that is not mentioned, but is crucial to this study, involves linking these to needs and patterns of a specific sector of employment.

Diverging labor market access and rights afforded to citizens of the EU-accession states

Although ‘free mobility’ in the EU is one of the main principles of the alliance, there are still variations across member states. Almost all the ‘old’ EU-15 member states met the idea of new workers in their territories with some resistance after the 2004 and 2007 EU enlargements. The majority of the EU member states responded to the EU-accession of Eastern and Central European countries in 2004 and 2007 by imposing either restrictions on labor market access or welfare rights for citizens of the new member states. The EU allowed for variation in national responses and said that restrictions on the mobility of individuals from the new states could be imposed first for two years, when they should be reassessed, and then could be extended for an additional five years (Gaillard, 2002: 17-18). Doyle, Hughes & Wadensjo (2006) classify the stance taken by the EU-15 members into four groups based on the level of access afforded to citizens of the accession states:

The enlargement debates across Europe resulted in four different regimes being in place in the EU15 Member States. The first regime (Belgium, Finland, France, Germany, Greece, Luxembourg and Spain) gives citizens from the Accession States no more rights than non-EEA nationals. The second regime (Austria, Denmark, Italy, the Netherlands and Portugal) adopts essentially the same rule as the first but opens the labour market to a quota of the Accession State nationals. The third regime (Ireland and the UK) allows unrestricted access to labour markets but restrict access to social benefits. In the fourth regime (Sweden) European Community rules apply. (p. 9)

In summary, only Sweden, the UK and Ireland did not impose work restrictions upon entry on citizens from the new accession states in 2004.

What has been the result of inflows from these twelve new member states for the open economies of Ireland, the UK, and Sweden? A few trends can be identified. First of all, Ireland and the UK received relatively more individuals than Sweden. Trends in the UK seem to indicate that they tend to employed in manual labor (such as construction) or lower skilled service sectors (hospitality sector, for instance), at least initially. A lot of research has shown that many recent university graduates from Central and Eastern Europe took up low to semi-skilled work in the UK (Black, Engbersen, Okólski, & Panțiru, 2010; Glorius et al., 2013). This employment pattern seems to be due in part to the Central and Eastern European individuals initially coming to the UK with plans to only stay short-term. However, caution should be taken in assuming that the employment of individuals from Central and Eastern European (CEE) countries is directed solely towards low-skilled streams. For instance in Ireland, while low to medium-skilled employment may be the predominant, employment in high-skilled sectors is not negligible. For example, the Irish Census showed that 13% of the employment in the Irish software sector was made up of individuals from the EU-10 accession states (Krings, Wickham, Bobek, & Salamońska, 2008, p. 7), a notable amount but much less than the 35.7% share of employment they held in the Irish construction sector in 2007 (European Commission, 2009, June 18, p. 8). Through qualitative
research among scientists in the UK from Bulgaria and Poland in 2005-2006, Guth (2008) concludes that free mobility within the EU had not had much influence on the number of scientists in the UK, but rather they felt that other channels had already existed for their mobility, and administrative procedures had improved.

Beyond identifying the main trends, the impact of the flows after the EU-enlargement on the labor markets in the older member states is difficult to determine; however, recent evidence seems to support an overall positive economic effect. The EU has officially announced that the mobility of individuals from the accession states has had a positive economic impact. According to analyses from the European Commission,

> Four years after the EU’s 2004 enlargement and over a year after the accession of Bulgaria and Romania, practically all of the available evidence suggests that the economic impact of recent intra-EU mobility has been positive on balance, and that it has not led to serious disturbances on the labor market, even in those Member States that have seen a relatively large inflow of migrants from new Member States (European Commission 2008: 15).

Yet, as the policy has only been in place for a few years and other EU countries have since further lifted restrictions, the data are likely still inconclusive and need to be assessed in terms of both sector of employment, other social and economic costs and benefits, and changing patterns of migration flows. An analysis from the OECD (2008: 38) suggests that Central and Eastern Europeans may have been able to improve their position in the UK labor market, compared to what was possible before EU-enlargement. However, it should be noted that the public response has not always been positive. For instance, a FT Harris Poll in March 2009, 54% ‘of Britons polled resenting the legal right of EU citizens to work in Britain’ (White, 2009).

The situation for the accession of two additional countries, Bulgaria and Romania, in 2007 was also marked by a large number of countries imposing restrictions on access to either work or welfare benefits, further indicating resistance to the idea that the free mobility of labor is beneficial. The specific roles taken by individual member states had changed and were marked by greater restrictions: Sweden once again adopted a policy free mobility and was joined by Finland, and nine of the ten new EU members (Hungary was the exception) from the 2005 accession. In the UK, a distinction has been made between low and high-skilled labor. The BBC reported,

> After an unexpectedly large influx of workers from Central Europe - an estimated 600,000 in two years - the UK announced that it would impose restrictions on workers from Bulgaria and Romania. Up to 20,000 will be allowed to take low-skilled jobs in agriculture or food processing, high-skilled workers will be able to apply for work permits to perform a skilled job, and students will be able to work part-time. Self-employed people from Bulgaria and Romania are already allowed to work in the UK, and this will continue (BBC News 2009).
In response to current restrictions on mobility of citizens of Bulgaria and Romania from various EU member states, Vladimír Špidla, European Commissioner for Employment, Social Affairs and Equal Opportunities stated: ‘The economic downturn is not a reason to keep restrictions. Free labor mobility is self-regulatory and provides a much needed flexibility in both directions: workers go to where there is demand for labour, not to be unemployed in another country.’12

Although data is not readily available, it is important to keep in mind that individuals from these new Central and Eastern European countries were gradually granted full access to the labor markets in the other EU countries. Although the flows have been seen to be primarily for low-skilled jobs at the time of writing, there may be an increasing possibility for the highest skilled, including scientists, to seek further employment in more scientifically advanced European countries.

STIMULATING EUROPEAN COMPETITIVENESS THROUGH RESEARCH AND THE KNOWLEDGE ECONOMY

As discussed previously, the knowledge economy has been touted across much of the world as a major contributor for enabling economic vitality and competitiveness in the future. In the case of the EU, is particularly evident in the priorities and support for the knowledge economy as set out in the Lisbon Agenda of 2000 in order to ‘make the EU the most competitive economy in the world and achieving full employment by 2010.’ The Lisbon Agenda has led to further measures to increase competitiveness such as by setting targets for R&D spends at 3 per cent of GDP for each EU country (also known as the Barcelona Declaration). According to Morano-Foadi (2008, p. 638):

All European summits from Lisbon 2000 onwards have underlined the contribution of research and education in setting up the European knowledge society. In March 2002, to achieve this target, the Barcelona Declaration first called for a rise in the share of European GDP invested in research (from 1.9 per cent to 3 per cent) and, second, for an increase in the number of researchers (a further 700,000 researchers or 1.2 million research related personnel).

In other words, supporting scientific sectors and ensuring significant numbers of scientific staff in Europe, whether through attracting from outside the EU or by training and retaining inside, have been catapulted as the top priority within the goals set by the European Union.

Within discussions of free mobility in the European Union, what is often not recognized is that the EU proposed a ‘fifth freedom’ – ‘free movement of knowledge’13 in the Presidency

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Conclusions from the Spring Summit on the 14 March 2008. Again, the acceptance of ‘knowledge’ as one of the pillars of the single market and the EU emphasizes the political emphasis placed on building the knowledge economy and supporting the goals of the Lisbon Agenda which basically relates to the goals of improving scientific centers of excellence in the EU and promoting and supporting the international mobility of researchers. The implementation of this ‘fifth freedom’ still seems to be underway; however, it is an important signal of the priority placed on development of scientific research in the EU (see Martens and Zuleeg 2008) and is also reflected through the European Research Area (ERA), discussed in more detail in the next section. What is clear is that interest in advancing this objective has continued in the EU, even during the economic recession. For example, the Horizon 2020 program has been approved to have additional financial backing for research. The European Commission describes it as, “Running from 2014 to 2020 with an €80 billion budget, the EU’s new programme for research and innovation is part of the drive to create new growth and jobs in Europe.”

European Research Area

One area where there have been great strides in setting common priorities and policies is in the advancement of the European Research Area (ERA). The advent of the ERA in 2000 is viewed as an essential part of advancing job growth and European competitiveness as set out in the Lisbon Agenda, seen as the primary goal for the EU’s member states. According to the EU’s (2007) green paper, *The European Research Area: New Perspectives*, ERA is based on six main objectives, two of which relate directly to European mobility and international migration: ‘an adequate flow of researchers’ and ‘a wide opening of the European Research Area to the world’ (p. 2-3). The other four objectives address goals for improving the research infrastructure, quality and knowledge sharing. There is a general perception that European science is flagging behind US and that competition is emerging from Asia as well. ERA therefore includes a range of policies to ‘attract’ and ‘retain’ MA and doctoral graduates and other scientists, including reintegration grants to attract scientists that have moved abroad to move back ‘home,’ measures to attract scientific ‘talent’ from outside of Europe, and harmonization of policies for residence permits for researchers accepted at European higher education institutions. The ERA is seen as essential to the supporting growth of the knowledge economy and the European Commission has called it “the lynchpin of the Community’s future action in this field” (Commission of the European Communities, 2005).

Ensuring the mobility of researchers from outside of the EU and hence knowledge transfer has also taken the form of a ‘Researchers Directive,’ which was to be implemented in national law (with the exception of the UK and Denmark) by October 2007. In brief, the Directive is designed to allow fast-track process for a one year residence permit for those who are accepted at a recognized European research institute and with the expectation of free mobility within the EU for conducting the research or teaching. The Researchers’ Directive (EC Directive 2005/71) also contains provisions to ease other restrictions, for instance family members of the researcher are also given permits and that the researcher may apply for an extension in the territory where the permit was offered. However, analysis by Euractiv (2007) indicated reluctance for many member states to adopt the legislation, with most countries not implementing it until pressured. The adoption of common policies, and the resistance toward participating, will be discussed later in
this chapter. The finding that mobility can occur despite resistance to explicit mobility or migration policies nationally point to the possibility that increased mobility of ‘talent’ are taking shape in Europe first through unifying EU policy, and not on the national level in the EU countries where there is reluctance to further open the labor market. In an assessment of the effect of the Researcher’s Directive, it was found that the policy has been effective and by having the visa based on hosting agreements it has created “a fundamental shift in the decision on the admission of a TCN (third-country national) from migration authorities to research organisations and private entities” (Hofmann, 2012, p. 3). The study also found that while the researcher’s visa gives the researcher many rights equal to citizens and allows for mobility to another EU country during the visa, many of its recipients were not aware of these rights.

Harmonization of education systems through the Bologna Process

The harmonization of education systems and the recognition of credentials across the various EU (and affiliated) countries has also been important in expanding intra-EU mobility. The Bologna Declaration of 1999 has created a common higher education system (Bachelor’s, Master’s and Doctorate) across European universities, equivalent European credits system to facilitate academic exchange programs, and various other measures to increase the quality and as well as the recognition of education credentials throughout Europe. A target date of 2010 was set for the implementation of the Bologna Process, which should then lead to the operation of the “European Higher Education Area” (EHEA).

This process is also important for mobility, which is set as one of the main action lines, and hence the global competition for talent in the EU context for a number of reasons. First, it facilitates international exchange, particularly among members of different EU countries. This aspect is important in terms of supporting both European integration (common education system and advancing skills recognition) and in trying to improve the training and possibilities to retain individuals that can operate in the growing knowledge economy. Second, the Bologna Process also contains goals of further attracting people from outside the EU. The EU document, *Strategy for the European Higher Education Area in a Global Setting* (n.d) states,

> Europe must also make concerted efforts to increase its international attractiveness to students, teachers and researchers across the world. To this end, all Bologna countries should designate an organization as having the prime responsibility for coordinating efforts for the international promotion of their higher education systems and institutions’ (p. 3-4).

In other words, the Bologna Process is not only trying to harmonize education, but also to promote each country as a destination for international student migration.

The European Union’s Blue Card for skilled migration

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14 The Bologna Process consists for forty-six countries in total as of 2009, including all member states of the EU plus some countries with close proximity to the EU, such as Turkey, Ukraine, and Georgia to name a few.
This next section looks at skilled migration in particular within EU policy. Although immigration still largely remains an issue considered central to national sovereignty, the EU is increasing its role in setting and harmonizing immigration policies across its member states. One of the most noted changes is the adoption of a Directive for a more unified, European skilled migration programme for third-country nationals (individuals with citizenship outside of the EU), known as the ‘Blue Card’ on 18 June 2009. EurActiv (2009), a private communications initiative, which reports on activities of the EU, traces its development:

The Portuguese Presidency was the first to tackle these issues, with a High Level Conference on Legal Immigration organised on 13-14 September 2007 in Lisbon. On this occasion, the Commission presented its proposal for the so-called Blue Card, part of its strategy for legal migration.

The Blue Card is the EU’s main policy initiative in the global competition for the best, highly mobile brains. The aim is to create a single application procedure for non-EU workers to reside and work within the EU. The proposal aims to attract up to 20 million highly skilled workers from outside the EU.

Again, the discussion indicates the associations made between immigration, competitiveness and feelings of an advancing ‘global competition for talent.’ However, tension between national and EU concerns were evident from the earliest phase in the discussions surrounding the proposal. According to the initial Blue Card proposal, the programme would allow a renewable visa and rights for family members of skilled migrants to work, if the individual met education and salary requirements. However, as discussed in more detail by Collett (2008), there have been many lines of opposition both linked to defining ‘highly skilled’ and also due to labor market protection concerns. One of the barriers is that the minimum wage levels vary greatly across European countries. Additionally, some countries, particularly the Czech Republic state concerns that the EU should not be considering policies for immigration from outside the EU until employment restrictions for citizens of the CEE have been fully lifted. Furthermore, it was recognized that EU countries still ‘compete’ between each other for migrants. Therefore, the Blue Card will act as an additional measure but will not replace individual member states skilled migration policies (Collett 2009). The UK, Ireland and Denmark, which each have previously signed agreements that allow them to opt-out of some EU policies, have decided not to participate in the Blue Card programme at all.

The Blue Card was implemented by the various participating countries in 2011 and 2012, during the global economic recession and often after the deadline initially set by the EU. As stated by

15 It is important to note that the Blue Card is not the only legislation created on the EU level that has an impact on skilled migration, as other policies have dealt with aspects indirectly related to skilled migration, such as the right of non-EU individuals married to EU nationals to work, and a proposed Directive on intra-corporate transferees, to name a few.
Collett and Zuleeg (2009): “It is far less contentious for governments to advocate skilled migration than any other type, as long as governments can argue convincingly that their numbers will be small and their impact on the local labor market negligible” (p. 346), but clearly fears of impact on native workers climbed during the recession. Initially the salary threshold was set at least three times higher than the minimum wage, but later discussions lowered this to one and a half times, and in the end each state was allowed to set its own salary threshold. Permanent residency is possible after five years of employment, although some countries, such as Germany, also require knowledge of the national language.

A brief summary of some of the various salary levels required to receive a Blue Card in 2012 are summarized in Figure 6. This table the wage differences for defining the highly skilled across various EU countries: “In practice, reported salary requirements existing in the Member States range from €1,293 (Lithuania) per month to a minimum annual salary of €67,842”(Luxembourg). (European Migration Network, 2013, p. 15)

FIGURE 6 EU BLUE CARD THRESHOLDS, REQUIRED SALARY AS A PERCENTAGE OF THE AVERAGE ANNUAL GROSS INCOME OF FULL-TIME EMPLOYED, 2010-12

Notes: Thresholds are calculated for the top bracket, in most cases shortage occupations are subject to a threshold of 80% of the main threshold, although the shortage threshold may be set lower. 1. Spain applies the threshold based on average salary for each sector; threshold shown is for average income overall.

Sources: Data on average annual gross income of full-time employed: OECD.stat.; EU Blue Card thresholds from official national publications for the first year of application and using 2012 exchange rates for non-Euro currencies. Figure available at OECD, http://dx.doi.org/10.1787/888932822598
Although it is difficult to summarize the position of Europe, given national divergence in immigration policies and flows, research generally states that Europe has many limitations in attracting skilled migrants (Cervantes & Goldstein, 2008; Zimmermann, 2005). The ramifications are also present in statistics for skilled movements. Cervantes and Goldstein report, In 2000 there were 3.4 million highly skilled foreigners (foreign-born and noncitizen) from developing countries in the OECD countries and Europe as a region (EU25, Norway, and Switzerland) hosted only 13 percent of them… Some European countries therefore appear not only to attract fewer higher skilled immigrants for settlement than the US, but those that come tend to come from OECD countries as opposed to from developing countries.

Simply put, Western European immigration has historically been built around post-colonial migrations, low-skilled guest workers (policy in the 1960s and 1970s) and subsequently their family members, and for international humanitarian reasons, such as asylum seekers (1980s and 1990s) and these are largely the categories that have been available for residence permits. With this backdrop, the number of skilled migrants in Europe is relatively low and makes up a small percentage of total migrants received. While some of the individuals that fit into these categories are highly-educated and skilled, the policies in place to date have typically not focused on this aspect per se. This is an important point, for instance, when looking at the occupational patterns of skilled asylum seekers, for instance, or of spouses that may come in on family migration programs and face restricted labor market access.

Skilled migration, as an explicit category of immigration with its own admission policy, has only recently been acknowledged as important to governments’ immigration strategies and priorities within the majority of European countries. Starting around 2000, interest in skilled migration, either specifically for the knowledge economy and particularly the IT sector, bloomed in more European countries. However, it should be kept in mind that the policies are often recent and not uniform across all EU member states. Policies for skilled migration are often changing, which makes doing assessments of them difficult. Several large, international studies have been done to compare skilled migration policies in either OECD or European countries (Chaloff & Lemaître, 2009; European Migration Network, 2007; OECD, 2008; Salt, 2005). In an overview of skilled migration policies in many of the member states, the European Migration Network (2007:5) concluded that high-skilled migration programs were not prevalent in Austria, Belgium, Germany, Greece, Italy or Sweden at the time the study was conducted in 2007. The development of skilled migration policies in Europe builds from a backdrop of restricting labor migration in general.

Statistics also show that immigration to the EU is predominantly low-skilled. More specifically, it is reported that, “the EU still tends to attract mainly less-skilled migrants: 48% of recent working-age migrants are low-skilled and only one in five is high-skilled” (European Commission, 2008, p. 15). According to the 2006 European Labour Force Survey, the highest
percentage of highly skilled immigrants and professionals in Europe are found in Luxembourg, Switzerland and Ireland. The lowest amounts are found in the former Central European member states that partook in the study, the Czech Republic, Hungary, and the Slovak Republic (cited in Chaloff & Lemaître, 2009, p. 16)

TABLE 8 COUNTRY COMPARISON: POLICY PRIORITIES AND STRATEGIES FOR HIGH-SKILLED MIGRATION, 2009

<table>
<thead>
<tr>
<th>Country</th>
<th>Policy background</th>
<th>Strategy</th>
<th>Outcome and issues to monitor</th>
</tr>
</thead>
</table>
| Canada        | Immigration as element of overall development strategy, with target entry levels  
Immigration to meet skills shortages                                                                                      | Selection of higher skilled immigrants and their spouses for permanent migration  
Facilitation for international students                                                                                   | Targets met.  
Some problems with overskilling of those who arrive without a job                                                  |
| Australia     | Immigration as element of overall development strategy, with target entry levels  
Immigration to meet skills shortages                                                                                       | Selection of higher skilled immigrants and their spouses for permanent migration  
Facilitation for international students                                                                                   | Targets met.  
Some question of language skills for international students                                                              |
| United States | Protect native workers while meeting employer needs  
Prevent low-skilled immigration and limit immigration in general                                                                 | Quotas for most high-skilled categories  
Job offer essential  
Large temporary programme  
Little facilitation for international students                                                                                           | Programmes oversubscribed, with long waiting lists  
Recourse to alternative visas (exchange, IC Transfers, etc.)                                                            |
| United Kingdom| Rely on free movement as much as possible  
Allow highest skilled to enter while limiting immigration of less skilled                                                 | Points-system for migration by highest skilled; no quota  
Shortage list for high-skilled employees sought  
Access for international students to above                                                                                  | New system yet to be evaluated                                                                                       |
| France        | Protect native workers while meeting employer needs                                                                                             | Strict labour market test and occupation list                                                                 | Limited immigration                                                                                                                                 |

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<table>
<thead>
<tr>
<th>Country</th>
<th>Policy Strategies</th>
<th>Exemptions</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>Reduce immigration by people with few skills and little Dutch language</td>
<td>Exemptions from strict language and labour market test for high skill, high salary</td>
<td>Satisfactory use of “high-skilled” permit, meets expectations</td>
</tr>
<tr>
<td>Germany</td>
<td>Limit immigration while allowing high-skilled to enter</td>
<td>Permanent residence for very high skill and high-paid foreigners</td>
<td>Limited immigration, mostly change of status of students, others.</td>
</tr>
<tr>
<td></td>
<td>Compete with other destinations for the highest skilled</td>
<td>Strict conditions for others</td>
<td>Flows fall short of expectations</td>
</tr>
<tr>
<td>Norway</td>
<td>Protect native workers while meeting employer needs</td>
<td>Quotas for most high-skilled categories</td>
<td>Quota undersubscribed</td>
</tr>
<tr>
<td></td>
<td>Free movement supposed to meet many labour needs</td>
<td>Job offer essential</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>Accept high-skilled migration while maintaining limit on low-skilled immigration</td>
<td>Strict definition of skilled positions</td>
<td>Little high-skilled migration despite openness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allow foreign students to seek work</td>
<td>Some students remain for employment</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Facilitate employment of high-skilled foreigners by Czech employers</td>
<td>Accelerate access to permanent residence for highly qualified foreign workers</td>
<td>Most beneficiaries are already in Czech Republic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Flows less than hoped</td>
</tr>
</tbody>
</table>

Source: Chaloff and Lemaitre 2009, p. 30-31

Chaloff and Lemaitre also classified the policy strategy for high-skilled migration of various OECD countries. A few points are important to mention. First of all, in the strategies, most countries have simultaneous goals of attracting some wanted immigration while limiting some other forms. Only Australia and Canada have strategies that lean more toward openness for skilled migration. The US, which is often seen as a magnet economy for skilled migrants, has few visas for this per se, but rather has inflows from family migration and other visa categories, such as students. The strategies in Europe vary from each other dramatically. For both purposes of illustration of the diversity and to build description of places that are discussed in more detail in subsequent chapters, a few brief examples of the discourse used that reflect the ‘novelty’ of skilled migration in Europe. As these examples show, there has been a changing discourse with more openness to skilled migration for competitiveness; albeit with many barriers of moving from restrictive to more open policies. It is also important to mention that these tendencies do not reflect the realities of financial or administrative backing for skilled migration programs, nor do they reflect whether or not the programs are able to successfully attract skilled workers from
other countries. Furthermore, a report titled, *The Global Competition for Talent: Mobility of the Highly Skilled* (OECD, 2008, pp. 14-15) found:

Only a few countries’ policy approaches are part of an explicit mobility strategy.

For those in which policies are not part of such a strategy, there is a greater risk of incoherence among policies on inflows, outflows and the diaspora. Ideally, mobility policies should be part of a wider mobility strategy that contributes to the country’s economic and social objectives and sets out the rationale for intervention. There is generally more support for inflows of researchers and other HRST than for outflows, perhaps because countries judge outward mobility to be adequate or because they are reluctant to encourage outward mobility, despite arguments about the benefits of brain circulation.

This quote points to a few important points about policy. First of all, skilled migration policy is not always linked to economic goals. This means that there can be a difference between groups targeted in skilled migration versus those targeted by innovation policies that also aim to increase mobility or attract skilled individuals. Second, in OECD countries, there has been little policy attention to the benefits of return migration, and hence few policies target out-going migration. However, this strategy has been adopted by some developing countries, such as China and the Philippines.

The next section discusses some of the discourse surrounding skilled migration and policies in various European countries.

**Germany**

Germany has typically taken a restrictive stance towards migration. Long holding on to the perspective that Germany is ‘not a country of immigration’, current immigration to Germany is mostly the result of guest worker policies, an inflow that was assumed to be temporary, inflows related to humanitarian concerns or related to right of return for ‘ethnic’ Germans after World War II. Yet, in terms of skilled migration policy in Europe, Germany is often named as a front runner in Europe. The Green Card for IT workers was adopted in 2000, with statistics for the programme broadly showing a large proportion given to individuals from CEE countries or parts of the former Soviet Union, and 26.4 per cent of the total permits given to IT specialists from India, which received the largest number for any single country. The policy was undertaken due to pressure from the IT industry, but later discussions revealed that the approach of bringing in foreigners to fill jobs was against the long-held German policy and standards of closed borders for labor migration, other than some bilateral agreements, and the programme ended in 2004. It

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16 The statistics given are not fully divided by country, and therefore a total for the EU accession countries cannot be given. The data groups provided that contain data for the recent accession countries include: Russia, Belarus, Ukraine and Baltic States 12.6 per cent; Romania 7.0 per cent; Czech/Slovak Republic 6.6 per cent; Hungary 3.4 per cent Bulgaria 2.9 per cent.
also became associated with the right-wing opposition slogan ‘Kinder statt Inder’ (‘Children instead of Indians’) (Saxenian, 2002), showing the plea for more protection of the national labor market while echoing possibilities of discrimination towards foreign workers in Germany.

Although the Green Card for IT workers was one of the earliest skilled migration policies in Europe, it can be seen as the exception rather than the rule. It is sometimes argued that the German Green Card was a failure, due to lower numbers coming than expected, and that Germany is not competitive in the global competition for talent; however, Kolb (2005) points out that it helped set a number of precedents that likely had an effect on immigration policy developments in Germany. The Immigration Act of 2005 made notable reforms in Germany’s immigration system, but is still quite conservative and scaled back from the original proposal. For instance, for skilled migration it was decided:

The ban on recruiting foreign labour remains in effect for unskilled and semi-skilled workers; it even applies to skilled workers except in specific, justified cases when it is in the public interest. Highly skilled workers are eligible for a permanent settlement permit upon entering Germany. (Immigration Act of 2005: 36, section 3.2)\(^\text{17}\)

However, the act expanded the possibility for high-skilled migration in sectors other than IT and, as mentioned in the quote, also eased work permit restrictions and increased possibilities for permanent residence.\(^\text{18}\) In this case, ‘highly skilled’ workers were defined primarily by having a high salary of at least €86,000.\(^\text{19}\) Immigration from the CEE countries was restricted, even for the highly skilled. Based on labor shortages, this restriction has been lifted at times; for instance, an immigration law website reports that in late 2007, ‘German employers are now allowed to hire electrical and mechanical engineering skilled migrants from the Eastern European nations that joined the EU in 2004 without giving priority to local applicants.’\(^\text{20}\) Hence, the German example indicates that despite relatively early adoption of a skilled migration programme for IT workers, ‘openness’ to skilled migration is still fledged by political debate and leans towards labor market protection (even before the recent global economic crisis), limited to specific occupations and is thus far from indicating an acceptance for skilled migration as a whole.

The Netherlands

\(^\text{17}\) In the German version of document, it reads ‘Für Nicht- und Geringqualifizierte, aber auch für Qualifizierte wird der Anwerbestopp beibehalten, für Qualifizierte mit der Ausnahmeregelung im begründeten Einzelfall, wenn ein öffentliches Interesse an einer Beschäftigung besteht. Für Hochqualifizierte ist eine Niederlassungserlaubnis von Anfang an vorgesehe’ and is found on page 32.


Like Germany, the Netherlands has had an overall restrictive approach towards immigration since the end of the guest worker programme in the 1970s, yet in the mid-2000s, there has been an important policy shift with attention turned to skilled migration as a way to advance the knowledge economy. On 1 October 2004, the Dutch government implemented its first formal skilled migration policy for knowledge migrants (*kennismigranten*). This policy was implemented as a response to labor shortages, particularly as related to supporting the growth of the knowledge economy. The programme waives work permits and labor market tests for non-EU individuals to work in the Netherlands, if they meet the minimum income criteria, which for 2008 were €47,565 or €34,881 for those under the age of 30, and the employer has been approved within the knowledge migrant programme. Academic researchers, including PhDs, post-docs and lecturers, are eligible for the knowledge migrant status without meeting the income requirement. There are no additional qualifications, such as educational level, outside of the salary requirement and approval of the employer. However, the knowledge worker category is also a form of temporary labor migration, with the permits valid for a maximum of five years. The policy sets the tone for discussions of immigration and competitiveness in the Netherlands. In 2006, the Dutch Ministry of Justice published *Towards a Modern Migration Policy* (*The Netherlands Ministry of Justice, 2006*). This document expresses the standpoint of the government that ‘Dutch migration policy can no longer be exclusively restrictive – it also has to be selective’ and includes measures to further ‘attract’ individuals, particularly those with high skills, including tertiary education students and skilled employees. The programmes are viewed as ‘modernizing’ immigration in the Netherlands and as it is argued, ‘To reinforce the international competitive position of the Netherlands, the country needs a society that is permanently in motion at an economic, cultural and knowledge development level. Migration forms part of this motion’ (*The Netherlands Ministry of Justice 2006: 17*). In another example, the Sociaal-Economische Raad (2007) issued a policy advice that urged the government to advance policies for skilled migration even further:

According to the Council, the Netherlands’ labour migration policy must undergo a change. The principle of “no, unless” should give way to a more welcoming attitude towards labour migrants who can offer Dutch society added value. Instead of “no, unless”, the underlying assumption should be “yes, provided that”. A more welcoming policy is particularly desirable when it comes to highly skilled labour migrants. Non-EU labour migrants in the lower and middle segments of the labour market should be made welcome if the supply of labour from within the EU is non-existent.

As this indicates, there is a potential move not only to increase support the mobility of the highly skilled, but also to better position the Netherlands as an attracter of needed labor in all forms.

The case of the Netherlands shows in part how this changing paradigm has been implemented. The knowledge worker visa allowed a broad basis for further bringing in ‘talent’, which was defined as individuals with a job offer and a relatively high salary. It is an indication that the earlier assumption that businesses can bring in whomever they want may have been too simplistic and the government aimed to simplify and speed up immigration procedures.
The United Kingdom

The UK has been viewed in the past at the EU’s leader for implementing a skilled migration policy and attracting skilled migrants, as well as for being a magnet for mobility of individuals from CEE, due to both the hard economics of relatively high wages and soft factors, such as English being the international business language and its cosmopolitan cities. While it is out of the scope of the chapter to discuss the nuances of the specific policies, it is important to note three main things. First of all, the UK policy towards skilled migration is relatively recent and implemented later than programmes in the US or Canada. Up until 2002, when the UK started a policy to attract highly skilled migrants, there was nearly a void of policies to attract or even allow skilled migrants outside of the internal mechanisms put in place by multinational corporations and other businesses and various bilateral agreements, for instance for health care workers. Iredale (2008) explains that the UK’s policy then allowed

[...] individuals with special skills and experience to immigration, initially for a year but with the opportunity to renew. [...] This is the first time in nearly three decades that foreign workers, other than EU member nationals, have been able to enter the UK without guaranteed employment.

Second, the rules are changing. The system of predicting labor market needs as originally instituted became burdensome and in 2008 the UK adopted a human capital based, points-system instead, whereby individuals were scored according to characteristics such as their education and age. In addition, after the economic crisis, the UK has made its policies for foreigners to come and the stay more stringent and once again had a major revision of its skilled migration policies. According to the European Migration Network (2010, p. 6), skilled migration in the UK has been declining: “The number of non-EEA nationals gaining skilled work visas (Tiers 1 and 2 of the Points Based System) has also declined over the period: with 78,400 issued in 2007, 74,600 issued in 2008 and 55,300 issued in 2009.” The tiers have been redefined and the quotas have been lowered.

Third, in line with the developments seen in the US, the UK used discussions of relationships between skilled migration and competitiveness to stress the importance of the issue, but this is not fully accepted by the local population. In the speech that began setting the new direction for the UK’s immigration policy and more attention on the highly skilled, Immigration Minister Barbara Roche (quoted in OECD, 2002, p. 338) said:

“As with other aspects of globalisation there are potentially huge economic benefits for Britain and best talents -the entrepreneurs, the scientists, the high technology specialists who make the whole economy if it is able to adapt to the new environment. We are in competition for the brightest and best talents - the entrepreneurs, the scientists, the high technology specialists who make the whole economy tick. In order to seize the opportunities of the knowledge economy and to play a constructive part in shaping these huge changes, we need to explore carefully their implications for immigration policy.”

However, debate continues as the skilled migration programme is redefined and public debate on the necessity of migration, in Britain (as elsewhere) continues.
Unlike many of the other countries in the European Union, the UK has a clause in the agreement signed when they joined the EU that allows them to opt-out of participating in some EU initiatives. As a result, they do not participate in either the Researchers’ Directive or in the Blue Card program, arguing that they already have suitable policies in place.

Other policies have also changed. For example, in February 2012, the UK revised the policy so that foreign students must have a job offer with a salary of at least £20,000 in order to work in the UK after graduation, with capital at least £50,000 to invest as entrepreneurs, or for others who have been deemed to have innovative ideas, versus the previous policy of allowing a two-year stay to work after graduation\(^{21}\).

The case of the UK shows that even in countries which are seen as having diverse populations, and have even been named as a leader in attracting skilled migrants, there has not been an open acceptance of skilled migration. The UK is careful to maintain ‘control’ over entry into its territory, including by excluding itself from EU directives related to migration, although at the same time it has been among one of the most open countries to intra-European migration.

Spain

Little attention has been paid to skilled migration in Spanish policy. Spain was a country of emigration until the 1980s and then experienced an immigration boom, and was considered one of the ‘new’ immigration countries in Europe in the 2000s. This immigration was mostly for sectors such as the service sector, construction and agriculture, where there were labor shortages in mostly unskilled or low-skilled occupations. However, the flows have again slowed, as Spain was hard-hit by the economic crisis. Spain has not had a large skilled migration policy, although fast-track visas exist for a few categories:

“A foreign employee is eligible for the fast-track process if he or she is:

- Hired by a Large Business Unit (Unidad de Grandes Empresas, or UGE) company.
- A university professor hired by a Spanish university.
- A highly-skilled scientist or technology expert hired by a state or local government.
- A renowned artist or technician participating in a culturally relevant project.
- A senior manager or highly-skilled employee participating in a project found to have significant public interest. Qualifying projects are those that can be shown to result in job creation, local socioeconomic investment or scientific or technological innovation.”

(BAL Corporate Immigration, 2013)

Various regions publish lists of occupations for which there is a shortage of workers and hence are open for immigration, yet Bruquetas-Callejo, Garcés-Mascareñas, Morén-Alegret, Penninx &

Ruiz-Vieytez (2008, pp. 15-16) argue that in practice these lists have not had much influence on actual hiring of foreigners. Spain has allowed for foreign students who have been in Spain for at least three years to seek work there after graduation (Chaloff & Lemaître, 2009, p. 49), yet the number the visa granted in this area are low. According to a recent review of student migration in Spain (European Migration Network, 2012, p. 61):

… the presence of international students is not an important subject of public debate in Spanish society, although there is a notably positive opinion regarding the mobility of EU students, driven by the Erasmus programme.

Consequently, the strategies and policies for attracting third-country international students are barely visible in the public agenda, albeit constituting a central topic within the university sphere.

Although it is primarily, a medium to low skills economy, Spain has been successfully advancing its position in scientific research through larger R&D investments, including targeting fields such as biotechnology. However, there are widespread structural problems, according to a report prepared to assess the country’s strengths and weaknesses (Heijs, 2011, pp. 15-16):

Although Spain was one of the leading countries in relation to the growth of the gross expenditures in public R&D (EC, 2011a) the long term impact of these growing financial efforts will be almost zero if they are not accompanied by measures that ensure structural changes and modernisation of the public research system (Heijs, 2010). The lack of meritocracy and excellence; the inefficient use of resources, the lack of critical mass and the fragmentation of its public research system (in public research organisations and especially in universities); the small number of academic spin-offs of technology based firms and the mismatch between academic research and commercial or societal needs has a negative effect on the usefulness of the research results and the quality of the generated human capital. These problems make technology and knowledge circulation more difficult and impede multiplier effects for the Spanish innovation system as a whole.

In other words, Spain presents an interesting example of an economy trying to improve its position in knowledge-based economic activities. However, this occurs with little supporting structures to guide aspects such as human capital development, which are shaped by both education policies and skilled migration. Spain’s skilled migration policies currently and in the near future will likely be mostly linked to the initiatives of the EU, particularly the Blue Card and Researchers’ Directive, and these could give Spain a slight boost in attracting foreign talent. However, Spain has been among the slowest countries in the EU in implementing either of these visa changes, as it is not in line with political priorities.

Switzerland

Switzerland has a relatively unique position in Europe, and one that poses several challenges in terms of understanding its immigration situation. First of all, it is not part of the EU, yet agreed
to participate in free mobility agreements with the EU. EU citizens have been able to work in Switzerland and vice versa since July 2004\textsuperscript{22}, with the exception of individuals from the new member states in Central and Eastern Europe. Second, Switzerland has an image of being international and one of the highest rates of international skilled migrants (see Table 8) and students in Europe, and at the same time, has long been associated with having a highly protectionist approach to its labor market. How has this contradiction come about?

Switzerland adopts a labor-demand perspective to immigration. In the past decades, there have been major revisions to Swiss immigration policy (Becker, Liebig, & Sousa-Poza, 2008), to change from a policy geared around seasonal workers to more skills-based admissions since the early 1990s. There is also a priority on first filling positions with nationals or other EU citizens. Therefore, the majority of labor migrants to Switzerland come from countries within the EU, with the highest numbers coming from Germany, as it both borders Switzerland and German is one of the national languages. However, free mobility for EU citizens has not been fully embraced, and additional constraints were put in place in 2012 especially for mobility from the new EU member states in Central and Eastern Europe, with a quota of approximately 2,000 permits set for citizens from Estonia, Latvia, Lithuania, Poland, Slovakia, Slovenia, the Czech Republic and Hungary\textsuperscript{23}. This shows that the Swiss exercise their own judgment in terms of when to apply free mobility for EU citizens, as the restrictions came after the date that the EU required open access for these citizens in EU territory.

Although Switzerland has long had one of the highest percentages of international students in the world, particularly in graduate programs where nearly 50% are foreigners, it only recently allowed these graduates to look for a job in Switzerland after graduation. In 2011, foreign graduates from outside the EU were allowed six months to find a job\textsuperscript{24} that “involves an activity of particular scientific or economic importance.”\textsuperscript{25} Graduates before this time were required to leave Switzerland after their studies.

Taken together, the examples from these five countries, a small subset of countries within Europe, shows a reluctant acceptance of skilled migration. Migration, as a whole, is often politicized and met with resistance or is not seen as necessary. There is a move to framing labor market needs into a context of global \textit{competitiveness}, but the global ‘competition’ is not yet truly global in that there are restrictions both on countries of origin of those immigrating and variations in programmes and accepted occupations for skilled migration across countries.

\textsuperscript{22}http://www.migrationpolicy.org/article/switzerland-faces-common-european-challenges, Accessed 4 March 2015
\textsuperscript{23}http://www.dw.de/swiss-limit-eastern-central-european-immigration/a-15902745, Accessed 4 March 2015
\textsuperscript{24}http://www.swissinfo.ch/eng/swiss_news/Foreign_graduates_allowed_to_job_hunt.html?cid=9073812
\textsuperscript{25}http://www.bfm.admin.ch/content/bfm/en/home/themen/arbeit/nicht-eu_efta-angehoerige/hochschulabgaenger.html, Accessed 4 March 2015
POLICIES FOR INCREASING HUMAN CAPITAL IN THE KNOWLEDGE ECONOMY IN THE EUROPEAN UNION

As discussed in the last chapter, it is important to note that immigration policy is just one type of policy that can support having the workforce needed for innovation and the knowledge economy. It has been further argued that immigration policy often is not the most important factor. For instance, Peri (2007) states that the prestige of various universities has helped draw in ‘talent’ to the US, not the country’s immigration policies. Ackers (2008, p. 413) argues that in EU policy, mobility is often over-emphasized as a “proxy for internationalization, excellence and competitiveness.” In other words, mobility is used as a metric, particularly within universities, and those with more international students and scholars are often considered to be more successful and competitive, but this overlooks some of the dynamics and policies that promote or hinder mobility.

Pontikakis, Fernández-Zubieta, Henriques, Moguérou & Pietrogiacomo (2009) took a different approach and reviewed human resource policies for research, quantifying the forms of policies used in the 27 countries of the EU (Figure 7). They utilized data from two public databases, one that assess the European Research Area, ERAWATCH, and the other contains policies for innovation, the TRENDCHART. This research is interesting to mention as it focused on the goal of support for human resources, and their analysis looks at policy domains other than immigration. Their study included “policies employing a diverse range of policy instruments, ranging from direct funding for employment, training or mobility, to awareness raising measures and the establishment of new organisations with a specific mission related to human resources” (p. 10). The majority of the initiatives fell under the category of research and innovation policy (56% of nationally focused initiatives and 70% of the internationally focused, followed by education policy (23% of nationally focused and 12% of the internationally focused initiatives).

They found that internationally focused initiatives had increased across Europe dramatically since the 1990s, and most the majority of international policies targeted incoming researchers and a smaller amount targeted PhD students. Policies for other categories of attracting other knowledge workers, such as R&D staff or human resources for science and technology, were not found on the national level. These authors also found a distinction between the types of policies undertaken by countries that have a large percentage of researchers in their working population, versus those that are seen as having medium and weak capacities. Those with low or medium numbers of researchers were more likely to build awareness through offering prizes and competitions. Furthermore, these activities were more likely to be handled by the central government. In contrast, the countries that have the most researchers also were more likely to have created sub-branches or regions to handle the innovation activities (p. 17). These authors also reported that most of the policies in the EU did not have a thematic focus (75%) and among the target themes identified, biotechnology had the highest number of initiatives, but this was only at 3% (followed by 1.9% each for nanosciences and nanotechnology and social sciences and humanities) (p. 13).
FIGURE 7 POLICIES IN THE EU-27 TARGETING HUMAN RESOURCES FOR RESEARCH

Source: Pontikakis et al. (2009), page 10

The OECD’s (2008, p. 3) publication, *The Global Competition for Talent: Mobility of the Highly Skilled*, looks at the “dimensions of HRST (human resources for science and technology) mobility, particularly of scientists, engineers and researchers, and the range of policies available to manage and shape this mobility, by drawing together analysis on international mobility, knowledge transfer and innovation, and related government policy.” Their analysis also points to a continued lack of attention to the aspect nationally, stating that “…analysis of questionnaire responses suggests that national policies generally target the same population and that there is little specialization according to national scientific and technological interests” (p. 138).

In combination, the findings discussed above are interesting for several reasons. On one hand, they indicate the growing number of human resource designated policies for the knowledge economy since the mid-1990s. This is evidence that although immigration has long been considered an issue of national sovereignty, the common policies put into place by the EU and in line with the goals of the Lisbon Agenda are now having an overarching effect on mobility of scientists in Europe. There is a striking similarity in approaches in much of Europe is due to the common framework set up by both free mobility in the EU and the Researchers Directive particularly, which has allowed easier flows of researchers regardless of their nationality. There were a relatively low number of initiatives related to the internationalization of researchers before the ERA had begun. On the other hand, as both the research of Pontikakis et al. (2009) and the OECD (2008) show, only a small number of policy types have been utilized to date in Europe, with the focus generally on the type of work, for instance researcher, rather than in building certain economically viable sectors. This shows that there is still a large potential for polices related to the workforce to diverge in the future across various countries, as policies for
promoting human capital in knowledge-based sectors are further developed by various countries or regions within these countries.

CONCLUSION

Although globalization includes some forms of economic integration, it does not change the role of national governments in meeting the needs and demands of their citizens. Terminology like the ‘global competition for talent’ seems to suggest an unequivocal acceptance of skilled migration as an economic necessity in the globalizing world, immigration remains one of the most hotly debated topic across countries and also in contexts of both economic boom and bust, with concerns about the impact of immigrants on job displacement, depression of wages and welfare burdens. Countries in Europe often have a more inward (protect local labor markets), rather than outward (recruit the best internationally) orientation. Although immigration still largely remains an issue considered to be central to national sovereignty, the EU is increasing its role in setting and harmonizing immigration policies across its member states. Among the countries of the EU, these tensions are magnified on another level as well as there are tensions between furthering European integration and protecting national ways of life and welfare. These tensions have been used to argue against the potential longevity of the EU and present a challenge for European integration and harmonized standards.

Policies implemented by the EU are also gradually leading to a more common framework for both labor mobility and skilled migration across European countries. In Europe, a distinction is made between mobility of individuals from within the EU and ‘migration’ from those outside. However, despite the common market of the EU hinging on ‘free mobility’ not only in issues of trade or capital but also in terms of labor, the majority of the ‘older’ member states initially set restrictions on their labor markets for individuals from the new Central and Eastern European countries. Only Sweden, Ireland and the UK opened their labor markets, showing the strong resistance to labor mobility in the EU and a general attitude of not ‘attracting’ but of ‘preventing’ increased labor mobility. Nonetheless, these changes may indicate a move from the previous restrictive regimes to a new openness, as restrictions on the movement of EU nationals were to be fully lifted by 2011. Furthermore, initiatives such as the Researchers’ Directive or the harmonization of educational systems through the Bologna Process set precedents and created new frameworks for increasing mobility in Europe, although most have fallen outside of the realm of immigration policy per se and are seen instead as part of supporting the knowledge economy.

The EU has passed a Directive to further enable skilled migration through the Blue Card; however this Directive has changed forms and is now a ‘watered down’ version due to concerns of various member states which want greater control nationally or a more restrictive policy than what the EU initially recommended. The Blue Card will likely have a further effect on the convergence in policy approaches taken in the EU, but it is too soon to judge the extent to which it will be utilized, in comparison to other nationally based skilled migration programs. However, as was seen for the Researchers Directive, in countries where no skilled migration program existed before, the Blue Card will be especially influential in allowing for new skilled migration
inflows. At the same time, decreasing quotas for the highly skilled in the UK, may lead some to decide on a different destination either within or outside of the EU. Therefore, skilled mobility patterns in Europe in the near future may differ substantially from what has been seen up until now.

On the national level, there is often either a lack of attention to skilled migration or some resistance when new programs are in place. Germany and the UK were among the first countries to adopt a specific policy for skilled migration in Europe, but both have since either scaled back or stopped the original programs, in part due to public outcry. At the same time, other countries, such as the Netherlands, are starting to put new skilled migration policies in place. In Europe the new policies have mostly been demand-driven, often requiring an employment contract and a minimum salary, or for one to work in job that is currently on a labor shortages list. Switzerland has had high numbers of foreigners, but at the same time expresses its resistance to increasing immigration.

Policies to target to attract the scientific and technological workforce have been found to be similar across European countries and do not utilize the full range of policy possibilities available, such as by using thematically targeted initiatives to build particular research areas or sectors. The majority of initiatives are based on building the skills of nationals, although internationally focused initiatives have been increasing, particularly since the mid-2000s, in conjunction with the formation of the ERA.

In summary, while the ‘competition for talent’ has gained attention, national policy responses have been fragmented and often clearly resistant to implementing more migration programs or supporting labor mobility. At the same time, there are social barriers nationally, including public attitudes at times characterized by resistance to immigration due to both assumptions about immigrants straining national resources and competing with natives for jobs, as well as due to resistance towards cultural differences and societal change. European countries also grapple with various issues related to population change, both decline in numbers of working age populations as well as accommodation of different cultural groups, including those from intra-European mobility. The tensions between national interests and regional and international economic integration not only pose questions of selectivity, priorities, and mechanisms among states for migration (including skilled migration), but also partially frame the attitudes towards openness to foreigners in general, including those from other EU countries, and hence influence the migrant’s individual experience and the opportunities afforded to people from other countries and backgrounds. The implications of these mixed reviews likely have a multitude of effects on both the country’s ability to attract migrants, in general, where programmes are in place, to the individual’s ability to secure a job pursuant to their qualifications when moving to another country. The first part is crucial when looking at the ‘failure’ of some high-skilled migration programmes to attract the people expected. The second may be helpful in analyzing processes of ‘deskilling’ of foreign populations present, whereby individuals tend to work in jobs well below their qualifications, an issue also pertinent to early post-accession mobility patterns of individuals from CEE who work in Western European countries.
PART II: THE GLOBAL COMPETITION FOR TALENT IN PRACTICE – LIFE SCIENCE CAREERS, INTERNATIONAL MOBILITY, AND COMPETITIVENESS
PREFACE TO PART II

“Let me also say that even were it possible to force the professionals to stay home, it would be a foolish policy. Lack of congenial working conditions, absence of peer professionals to interact with, and resentment at being deprived of the chance to emigrate can lead to a wholly unproductive situation in which one has the body but not the brain. The brain is not a static thing; it can drain away faster sitting in the wrong place than when traveling abroad to Cambridge or Paris! So the only practical policy is to accommodate to the fact that outmigration of one’s skilled citizens will surely occur.”

(Bhagwati, 2004, p. 214)

The first part of this study set out to explore international changes that are structuring the global competition for talent. The story framing the global competition for talent grew largely from the expansion of the knowledge economy. Innovation and technology have been said to be both the key and engines of economic growth; they are both perceived to get economic growth started and propel it forward. The story behind the global competition for talent also involves a noticeable increase in young, educated migrants, and particularly students, to more diverse destinations, which has been supported only in part by new policies. These changes include new groups in the traditional immigration countries, for instance, the numerous IT workers coming from India since the 1990s to the United States. It also includes new groups and forms of migration to places that have not had a skilled migration policy per se, and often international student migration is among the first noticeable change. The increase in student migration is seen across the globe, including within developing countries. In the European context, there has been more discussion about the merits of skilled migration by both politicians and businesses.

In other words, it is increasingly recognized that human mobility forms an essential part of current processes of globalization, and is happening in different forms and patterns, in more places, and to a greater extent than before. Yet, one important critique of phrases like “the global competition for talent” is that they suggest a uniform phenomenon is taking shape; it is a blanketing phrase. In an attempt to catch a new phenomenon linked to new forms and interest in high-skilled international mobility, there is a risk that the phrase will instead be used without view of differentiation in situations. The strategy related to the global competition for talent can therefore vary substantially, not only across countries, but also across different fields of employment or topics of research.

There has long been international policy interest in supporting education or work for scientific and engineering fields. The acronym STEM (science, technology, engineering and mathematics) fields has become widely used in media and policy discussion, originating in the US (and now also used by the OECD), while the UK has adopted a similar discussion around the need to increase skills in SET (science, engineering, and technology), and Germany has had extensive discussion of MINT (mathematics, information sciences, natural sciences, and technology). While there may be debates on what to call it and which specific fields are included, the common view is that scientific, mathematics, and technical skills are crucial and study programs and research for these fields need to be supported and this discussion spans international borders,
even in times of recession (albeit there may still be budget cuts).

At the same time, research has shown that skills shortages are nearly impossible for governments to predict. There is also the question of whether booming fields end up saturated, in that more individuals seek out these fields of study, with more expectations that a ‘good’ job will be available than the actual number of opportunities.

Scientific moves in particular have long been assessed through a paradigm of brain drain versus brain gain, although many researchers suggest the brain circulation paradigm is now more relevant (see e.g. Edler, Fier, & Grimpe, 2011; Gaillard & Gaillard, 1998; Guellec & Cervantes, 2002; Meyer, 2001). The brain gain and brain drain literature contains a judgment of a negative result for the sending country (brain drain) or positive result for the receiving country (brain gain), whereas attention to brain circulation more rightfully points out that new knowledge can be gained from migration and then utilized upon return.

Scientists, as a particular form of skilled migration, have also been discussed as ‘scientific mobility.’ I believe this term is more appropriate than ‘brain circulation’ which generally implies migration and later return to a less developed home country. The scientific mobility literature looks at international movements of scientists more generally, including the movement of scientists between two developed countries. In contrast, scientific mobility instead focuses on dynamics related to the career choice as a researcher. The topic of ‘scientific mobility’ has gained increasing attention in Europe due to a range of policies to support the R&D, including the ERA policies that facilitate international scientific moves (see Chapter 4); however statistics on the scientific workforce are lacking and fragmented.

The global competition for talent should not be seen as one phenomenon, but instead as a myriad of individual lifestyle choices, career paths, and structural influences acting together. While my own academic background has me approaching this topic first from a view of changes in mobility, it could just as well be approached from a view of human resources, skills and employer needs, or from that of political-economic systems, to name a few. Yet, the complexity of the global competition for talent does not mean that it cannot be understood in a deeper way, through carefully watching for statistical changes and finding examples that are of broad interest.

The second part of this study looks at the case of one area of employment important to the knowledge economy, the life sciences and biotechnology, as an exploratory study to identify some of the dynamics driving the global competition for talent. It addresses the main research question, “Which patterns have influenced the development of the global competition for talent as observed in the life sciences/biotechnology in particular?” The geographic focus is mainly on Europe, as compared to the often assumed top competitor, the United States, and individuals from developing countries, who would be expected to have different push-pull factors and motivations. The primary data is drawn from the perspective of the scientists, including both students and employees seeking careers in the fields of life sciences and biotechnology. The life sciences and biotechnology blend two aspects that were found to be important and discussed in Part I -- they are innovative, research-intensive fields of interest to governments and the international mobility of scientists is also a topic of interest for policy and competitiveness. The next few sections will give a brief overview of the biotechnology industry and an overview of scientific mobility and skills shortages relevant to the global competition for talent in the life sciences.
A BRIEF INTRODUCTION TO THE BIOTECHNOLOGY INDUSTRY

Biotechnology has been one of the rapidly developing areas within the knowledge economy of the past decade. With a broad definition that includes “knowledge, goods, and services” and continual expansion into new research areas, biotechnology plays an increasing role across various aspects of the life sciences research and hence company types. Conducting international research on the biotechnology industry is complex, given the diversity of topics considered as part of biotechnology.

One other common way to further define biotechnology is by four main categories, which are based mostly on the function of the biotechnology, or how it is applied: red, white, green, and blue. Red biotechnology is related to medicine and health care biotechnology; white to industrial processes; green to agriculture; and blue to marine organisms. Within Europe, red biotechnology is the largest (Ernst & Young & EuropaBio, 2012, p. 88). White biotechnology is rapidly growing and has been supported by numerous policies. The three main areas of research and utility for white biotechnology are industrial production, biomass, and biofuels. White biotechnology can improve industrial processes, for instance an enzyme may be used that allows for fewer stages to be needed in production. White biotechnology is seen as key way for companies in many sectors to both reduce their production costs and reduce the amount of dangerous wastes. Developing biofuels is also currently a key goal that falls under the category of white biotechnology. Green biotechnology involves research related to plants, animals and food. Green biotechnology is also associated with genetically modified food, which has been viewed as increasing agricultural outputs due to having more resilient plants for a given environment. This form of green biotechnology is underdeveloped in Europe (Ernst & Young & EuropaBio, 2012, p. 89), due to having some of the strictest legislation in the world regarding use of genetically modified organisms. Blue biotechnology researches how marine organisms can be used and is the only form of biotechnology that is defined based on its research source rather than the products. Its applications can be for any range of functions, including medicines, industry, and environmental cleanup. Blue biotechnology is considered the least mature sector of biotechnology research globally and its role within global and European R&D is still marginal. Its use is reported much less frequently than the other forms of biotechnology. The varying applications to biotechnology also mean that the structure of the biotechnology sector may differ substantially in various places, being strong in certain research areas and weaker in others.

Biotechnology is not necessarily a large economic sector in some OECD countries, yet due to the topics it covers, particularly healthcare and improving the environment, it is considered an important part of the knowledge economy globally, for both developing and developed countries. The US is seen as the top country in biotechnology, as is discussed in more detail in Chapter 8, which looks at statistics for biotechnology competitiveness. Much of the research on the biotechnology industry and its workforce is therefore also found in the US.

SKILLS SHORTAGES IN THE LIFE SCIENCES AND BIOTECH SECTOR

There were indications in the early 2000s that the high-growth life science and biotechnology industry faces a shortage of workers in many countries. The fast-changing nature of the industry
and impact of new innovations also make predicting labor shortages difficult. Furthermore, some studies found that life science graduate students (or potential life science students) are ill-informed about specific skills needed for biotechnology or life science research career (European Science Foundation, 2009; Human Frontier Science Program & European Science Foundation, 2002; New Economic Systems & The Leonard Resource Group, 2004, pp. 24-26). Biotech industry articles also indicate that there were crucial shortages of skilled workers in the biotech sector both on a global level and within Europe (EPOHTE 2003, p.39-40; Sevier and Dahms 2002; Gwynne 2004; Hodgson 2006). These concerns are 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 aim to build a biotechnology sector, competition for qualified employees increases globally. US scientific advantage has often been attributed in part to its ability to attract talented foreigners (see Peri 2005; Gordon 2004), while in comparison, ‘brain drain’ has been considered as a barrier to European scientific advancement (Mergent 2004, p.1). There have been fears that European trained scientists will leave to work in the US or elsewhere, which may also lead to lack of qualified personnel in certain regions or fields of expertise.

Biotechnology industry articles suggest that a lack of qualified personnel creates challenges that may hinder the industry’s success. There are indications that the growing biotechnology industry faces a shortage of workers in many countries and that national education programs alone may not be enough to remedy it. Science and biotech industry publications have contained sections devoted to the need and use of immigrant labor in life science sector. For example, Sevier and Dahms (2002) state, “Although the biotechnology industry has encouraged US educational institutions to increase the production of specialists in phase with industry needs, there has been a continual shortfall in a variety of areas and expertise, requiring access to foreign workers outside of the US labor pool” (p. 955). Gwynne (2004) similarly reports, “Whether they are based in Europe or Asia, life science organizations face a common problem: Their own countries generally do not produce enough top notch scientists to satisfy their needs.” Furthermore, as more regions and countries support the growth of a biotechnology sector, international competition for qualified employees mounts. Given the demands of the knowledge economy and economic changes, these observations require further investigation.

Sumption (2011) explains why there are difficulties for governments to assess the link between vacancies and skills shortages:

The number of unfilled vacancies provides a potential measure, but occupations with short job tenure and high turnover experience higher vacancy rates even when plenty of job seekers are available to work. And more fundamentally, the fact that employers would like to find workers with a particular skill set does not mean they can realistically expect to find them.

To see why, consider a firm designing software to help farmers track the genetic characteristics of rare breeds of cows. Ideally, they would like to hire a software programmer who understands cow breeding and genetics. But how many of these people
exist? This is not a case of a shortage in expert programmer-breeder-geneticists, but rather an instance where an employer must lower their recruitment expectations.

During the economic boom of the 1990s, which was fueled in large part by advances in the field of technology, US employers did exactly that. Employment in the IT industry ramped up at an impressive speed, and firms hired much less experienced candidates. When the dot-com crash reduced demand for their services, firms once again raised their expectations and began to hire more highly qualified workers. Was there a shortage of qualified IT workers during the boom? Did that shortage cease to exist because employers "made do" with less qualified employees? The answer is not clear-cut.

Although current and fear of future skills shortages have been reported in the media for scientific and technical sectors, there is less research that looks at individual areas to show what this means in practice.

**CHARACTERISTIC FEATURES OF SCIENTIFIC MOBILITY AS A FORM OF SKILLED MIGRATION**

The term scientific mobility in the academic literature is frequently cited from the research of Mahroum (2000a; 2000b; 2000c) and Ackers and her team (see e.g., Ackers, 2005a; Gill, 2005; Morano-Foadi, 2005) on scientific mobility in select European countries. Scientific mobility is linked with the broader literature on skilled migration, as a specific type of skilled mobility. Much of this research also focuses on academic settings, in part due to the greater visibility of these jobs through online databases as well as likely due to the EU’s policy on promoting mobility of researchers, who are often researchers in academic settings. However, scientific mobility can also apply to scientists working within industry or businesses, and is particularly relevant to individuals working in R&D. The term could also apply to certain positions in international companies, for instance in multinational pharmaceutical firms, which may require both technical and other, particularly management or sales, skills. Another important reason to use the term scientific mobility is that it takes into account that there may be any number of international destinations in a scientific career and also includes stays of diverse durations. This is a good contrast against ‘skilled migration’ research, which in many cases looks at a single destination and at times is limited to only permanent moves. Scientific mobility was also deemed as more appropriate than the brain drain/brain gain/brain circulation concepts, which also typically only analyze effects for only the home country versus one country of destination.

A brief review of some of the recent literature on scientific mobility is given below, with a focus on discussing the extent to which scientists move abroad as part of their career and their motivations for moving to help frame the discussion of scientific mobility that arises from the CiLS survey results, discussed throughout the remaining chapters.

Within the discussions of scientific mobility, it is often assumed that moving across national borders is a positive way to either build a career and also is seen to reflect the status of an institution. As Ackers (2008, p. 418) explains,
Academic careers, especially in the natural sciences, have long been associated with high levels of physical (geographical) mobility. Over time this ‘practice’ of mobility has become deeply embedded in career structures to the point at which it has become an ‘expectation.’

She further argues that there are multiple forms of international collaboration in the sciences possible today, including shorter-term visits, and moving abroad should not be regarded as the only, or most valued, strategy of internationalization among scientists. Schiermeier (2011, p. 563) expresses a similar view:

Changing countries has become a rite of passage for many young researchers, especially in Europe, where cross-border mobility is common. The call for mobility has become the motivating mantra of organizations such as the Marie Curie fellowship programme, which promotes and supports mobility across Europe. In Germany, for example, to avoid academic ‘inbreeding’, in which universities hire their own graduates as professors, university tenure rules require scientists to change labs during the course of their postdoc or graduate education, and trips abroad to the United States or elsewhere are all but expected. In many countries, recruiters and funding agencies see international mobility as a mark of an applicant’s ability and dedication, making changing labs a key to scientists’ professional success almost everywhere.

Schiermeier further argues that some scientists need to move abroad to access the best labs in their fields, but may also be disenchanted when they expect that things will be ‘better’ abroad than in their home country (p.564).

Meyer, Kaplan and Charum (2001) discuss that scientists and engineers have long been one of the most internationally mobile groups, but what has changed more recently is a greater dispersion of where they go to and new forms of scientific networks, which are linked to the increased transnational nature of scientific work. Some scholars also argue for the need to understand scientific student and researcher mobility patterns of and constraints in relation to gender, family concerns, and the effect of a move on the partner’s career (Ackers, 2003; Geddie, 2013).

Less is understood about variations in scientific mobility across fields of study, countries, and employers, and very specific norms may guide patterns for each of these. For instance, Vallas and Kleinman (2008), argue that studies looking at life science jobs in either industry or in academia have limited understanding of career dynamics by ignoring ‘cultural-ideological processes,’ or in other words norms and behaviors often exhibited in various life science institutions (p.288). I would like to add to their critique that it is not only institutional norms

26 For example, these authors note that academic researchers tend to be reluctant to discuss their work with colleagues until it is published, whereas those in industry benefited greater from information sharing and teamwork with colleagues at all stages of a research project.
that matter, but also the accepted norms and values that scientists hold and which guide their career decisions, including whether or not they hold an ‘expectation’ of international mobility. In the migration literature, it is long accepted that some countries or areas have higher rates of mobility than others, but less is known about specific fields of work and the individuals’ expectations within their own careers.

Brain circulation has become a very pervasive topic in policy discussions. Yet, despite the policy interest in developing research and for specific fields such as biotechnology, and the expected high mobility as part of the career path, very little is understood in regards to mobility decisions of the scientists. Thorn and Holm-Nielsen (2008) tried to identify some of the push-pull factors for scientists from developing countries. They argue, “These decisions are not well understood and documented empirically, especially as regards researchers and scientists compared to other highly skilled migrants” (p.146). Although they hoped to model how development in the home country versus abroad effect migration decisions by using three data sources: “data from the World Development Indicators of economic growth rates, The Global Competitiveness report on the rule of law and the quality of public services, and OECD data on R&D expenditure as a percentage of GDP” (p. 151), they found none of their inputs to be a good fit with the data. They stated, “Consequently, the available data do not shed much light on what motivate researchers and scientists to migrate and return to their country of origin.” (p. 151).

Some research shows that the motivations of life scientists’ moves differ in part from other types of skilled migrants, including other types of scientists and engineers. Mahroum (2000a) found:

Engineers and technicians, for example, are reportedly pulled and pushed primarily by economic factors. They go where this skill are most needed and most rewarded. In contrast, mobility among researchers and scientists is a normal part of scientific life and a well established norm. Researchers and scientists are motivated mainly by the content of their work and the concrete conditions under which they conduct their research. This assertion is substantiated by Shapin (1998) who – as part of an analysis on the role of trust in science – finds that scientists are attracted towards expertise and the institutions that have a reputation for being cutting-edge.” (as summarized by Thorn & Holm-Nielsen, 2008, pp. 151-152)

The potential for conducting high-quality scientific research in ideally a prestigious location is considered as one of the strongest motivating factors of scientific mobility (see e.g. Delicado, 2010; Díaz-Briquets & Cheney, 2003; Guth & Gill, 2008) and is considered to be more important than salary (Wood, 2004, p. 113 ). While salary or financial rewards can be an important factor for some individuals, it is found that it generally intrinsic motivations are considered in addition to the purely financial reasons (Lam, 2011).

Destination choice as linked to the broader range of choices due to globalization and institutional changes, such as from more countries adopting skilled migration policies for the first time and larger scale student migration, have scarcely been discussed. Much of the research discussing the global competition for talent as applied to scientists assumes that the US will be the top
destination choice for most skilled migrants (Reiner, 2010), followed by the UK. However, as has been argued by (Laudel, 2005, p. 378):

While there is a widespread feeling that ‘whoever can go to the USA does so and tries to stay there’, we have at best only anecdotal evidence of this happening, and less to explain whether it does so across the entire spectrum of science.

The assumed top destination choices have been based on factors such as past patterns of migration, economic strength of these countries, perception of widespread opportunities, the English-language environment, image as having diverse and/or open societies, and the competitiveness of their universities and companies which allow for greater returns on human capital investments.

State et al. (2014) recently published the results of their study, which looks at international mobility of professionals globally from 1990-2012 by analyzing LinkedIn data, and focusing particularly on migration to the US versus other countries. Although they do not focus on scientific mobility specifically, STEM (science, technology, engineering, and mathematics) employment versus any other field is analyzed. Their approach of using LinkedIn data is a novel way to examine international migration of professionals on a more global scale. These authors recognize that one short-coming of their design is that citizenship cannot be determined. This means that little can be said about return migration of US citizens or circular migration. Furthermore, not all professionals used LinkedIn. Their data shows a drop in the percentage of migrants choosing the US as a destination for both stem fields and other fields, and across all levels of higher education. They attribute this decline in the attractiveness of the US to both the economic recession as well as the changing global systems of migration. Notably, they found:

…while the U.S. became a less prominent destination for professional migrations during the 2000s, Europe and Canada also saw a decrease in their share of the world’s professional migration flows – albeit a gentler one – while Australia and Oceania, Africa and Latin America increased their proportional intake. The most prominent increase was recorded for Asian countries, which attracted, in sample, a cumulative 25% of the world’s professional migrants in 2012, compared to only 10% in the year 2000. (p.4)

They argue for better recognition in the decline of popularity in the US as a destination due to both policy reasons and changing global structural dynamics. Their data also shows that the number of international students going to the US was declining in the early 2000s but was again on the upswing from 2010-2012 (p.3).

In conclusion, the literature on scientific mobility provides some information on its main characteristics and how it may differ from other forms of mobility. First of all, there is a long history of scientific mobility and it has been said to be an integrated part of the career path. There is a widespread ‘expectation of mobility,’ which is relevant to scientists both in developing and developed countries, although the rates and forms of mobility will differ some across various countries. Scientists are said to be driven primarily by wanting to produce quality research, rather than by financial motives. The US has long been considered the top destination
choice for scientists, but its position as the leading destination is being questioned within new dynamics of global, international migration.

Reaching for the stars: Star scientists and international mobility

Another area of interest within the research on scientific mobility is on ‘star’ scientists, a body of literature that was briefly mentioned in the discussion on ‘talent’ in the analytical framework in Chapter 3. The research on star scientists is important to mention, as this is an important subset for understanding the global competition for talent, whereby talent is defined more specifically as *individuals* who are seen as especially strong in their respective field. It is also important as a great deal of work has been done regarding star life scientists. This topic has been brought to attention by the work of Zucker and Darby for over fifteen years and only a portion of their work that represent some of the key findings are listed below. A good summary of their work, and particularly that which is related to international mobility, can be found in Zucker and Darby (2007). Their research has focused mostly on ‘stars’ in the biosciences, particularly genetic sequencing, and biotechnology and has involved research both on the US as well as other situations globally. Their work defining stars based on their work in genetic sequencing is relevant up to 1989, when new technology changed the need for these skills due to automatizing the process, and afterwards their studies are typically based on ISI citation indexes of publications. These authors demonstrate through a series of papers, and by analyzing a range of hypotheses, that breakthrough scientific discoveries of even one individual can have a profound impact on the innovation and hence productivity of the surrounding region (see e.g. Zucker & Darby, 2006; Zucker & Darby, 2007). Zucker and Darby (2007, p.6) discusses that although few scientists are involved in commercialization of research in the US, the firms that do have star scientists working for them have a much higher rate of staying in business for a couple of decades. Zucker, Darby and Armstrong (2002) focused on the ‘star’ scientists from the top 112 research universities in the US who made key discoveries in the field of genetics. They found that many of these star scientists were also employed with exclusive contracts by the firms that bring products to market or in co-publications with authors from these firms. This is a strong indication that the knowledge is embodied by the individual who discovered it, and cannot be easily replicated without intensive knowledge of the lab work and process through which it occurred. Due to institutional and legislative differences, the frequency of academics having industry contracts and the terms of those contracts will vary greatly by country. Zucker and Darby (2007) also look at the percentage of star bioscientists from 1973-1989 tied to firms in various countries. It ranged from a high of 42% in Japan, to none of the star bioscientists in Germany or Canada in that time period. In other words, only some knowledge is commercialized and converted into products and in this case the knowledge is also bound to a specific company; but in many other cases it is for advancing academic understanding in that particular field.

Zucker and Darby (2006) found that generally star scientists around the world cluster in specific cities. An exception is that there are high return migration rates of foreign star scientists, who move in particular from the US back to their home country, when it had developed scientific strength. This finding also points to the need for more studies of scientific mobility in diverse countries, to see if circular migration is particular to the institutional and work conditions in the US, or if it reflects a broader trend.
Star scientists and their innovation have been found to have an effect on regional innovation, not only because of their own research, but also because they draw other scientists to the area. Star scientists tend to go where the best facilities and support are available, and where they can benefit from networks with other strong scientists, which means that top regions have a double advantage. They are more productive from new discoveries, and at times the commercialization of these discoveries, and these regions are also better able to attract more ‘talent’ in the future. Zucker and Darby (2006, p. 2) also find that ‘star’ scientists tend to “become more concentrated over time, moving from areas with relatively few peers to those with many in their discipline.” Ackers (2005b) found a similar result indicating ‘clustering’ towards specific institutions of ‘networks of excellence’ in Europe when examining Marie Curie scholarship holders.

A similar clustering effect was reported by Millard (2005) in research on scientific clustering in the UK. Mahroum (2000c, p. 517) notes that there is a cyclical effect as well:

Prestige, which is usually built over a long period of time, increases access to resources, which in turn increases the level of faculty scholarship, and thus yields more institutional prestige—which again increases access to more resources. Research has shown that because of this cyclical effect, institutional prestige yields cumulative advantages for its purveyors over time which increase subsequent opportunities for higher achievements.

Mahroum argues that institutions that have gained such prestige are able to continue to receive strong resources, such as funding, even in times when their scientific productivity has decreased. Yet, as Zucker and Darby note in their work, new and strong scientific regions have also been able to emerge, for instance, in China. These areas are not necessarily hubs for attracting scientists globally, although there is often a considerable amount of return migration contributing to the scientific growth, but rather have demonstrated high research growth rates in recent years.

Star scientists and their effects on firms have since been of interest and some researchers have applied the findings of Zucker et al. to examine other cases such as Germany (Schiller & Diez, 2010), Canada (Schiffauerova & Beaudry, 2011), France (Corolleur, Carrere, & Mangematin, 2004), and Zucker and Darby (2001) themselves have also looked closely at the case of Japan.

Schiller and Diez (2010, p. 285) found that among star scientist in Germany, younger scientists tended to maintain academic collaborations, and only the more-established scientists were building long-term ties with industry. These star scientists could form ties with relevant industries for their research and this decision is based on quality, regardless of their own geographic location (p.287).

Trippl (2013) aimed to expand the research on ‘star scientists’ to better understand, the top regions where they are found, and also the extent they have moved internationally. Trippl’s paper draws on a survey of 720 scientists conducted in 2008, based on the most productive scientists as defined by the ISI citation index, for any scientific discipline, identifying the most cited 250 people by subject category (natural sciences; agricultural sciences; engineering and technology; medical and health sciences; and social sciences). The survey was global, but the majority of the top scientists in the citation indexes are based in either the US (56.6% of the sample) or Europe
(28.4%) and 70% of the total were based at universities, 18% at other research institutes, and only 2% working in companies. Her main conclusions were that star scientists are clustered in very few cities in the US and Europe. Trippl details out which cities attract scientists and the percentage of mobile and non-mobile star scientists in each. The main difference in patterns that she found is that the US has a much larger percentage of foreign-born scientists, most of who had been in the US for several decades, while at the same time native-born scientists also stayed. Some of the top US cities had a workforce where more than half of the scientists had not ever moved from that region. The key European cities had a different mobility composition. They were more likely to have scientists who had returned to their home country after being abroad. Furthermore, some cities in Europe were seen as highly productive academic environments, yet were not the locations of work for any of the ‘top’ scientists. This pointed to potential institutional or policy differences driving the attractiveness of various locations.

Trippl’s work is interesting to better understand past scientific mobility in a more international context, an under-researched topic, but it does not reflect recent changes in scientific mobility for several reasons. The first reason is due to the sampling method. Not surprisingly, the most productive scientists in terms of publication records, tended to be based at academic institutions and were older, on average 65 years old and predominantly male (93%) (Trippl, 2013). Furthermore, the study covered all disciplines, with half of the scientists were working in the natural sciences. This method therefore calls attention to academic institutions that have produced the most papers historically, and as can be expected, the top regions are where the world’s most elite universities are found, such as Harvard, Cambridge, Oxford, and other universities with global acclaim. It does not necessarily capture scientists that are active in patenting new innovations, but are not publishing, or those who are applying innovations to bring new products to market. Furthermore, it cannot identify places that have been competitive in one specific field, such as biotechnology. Third, the older, top scientists are more likely to have tenured positions, meaning academic appointments for life, than younger academics would, which likely limits their international mobility to shorter-term visits and only occasionally would they undertake new employment positions. With these caveats in place, it becomes clear that the work of Trippl should be interpreted as representing past scientific mobility, which was occurring mainly in the 1960s-90s.

The research on ‘star scientists’ is interesting to better understand scientific mobility and the importance of top regions and the best scientists. Yet, these studies’ sampling method means that they address a different group than the CiLS survey, which has more data on scientists who are younger and hence at an earlier phase of their career. These young scientists have experienced different career possibilities, due to the changes in the career structure (as discussed in Chapter 5), increasing student and scientific mobility to and from more countries, and changing biotech competitiveness, that is to say strengths and weaknesses in comparative perspective across countries, and also within new, emerging fields of study and research topics.
Part II of this study aims to add more understanding to changing mobility today by looking at three aspects related to the life science and biotechnology workforce: careers, competitiveness and international mobility. Part II analyzes the results of the Careers in Life Sciences (CiLS) study, starting from a broad, global perspective, and gradually sifting down to better understand the influence of differences, particularly on the national level, on individual career decisions. In this way, it explores both what are global and what are local drivers of biotechnology career goals and particularly international mobility decisions, as observed through the CiLS study. The chapters in Part II will use the CiLS data related to this topic to look more in depth at specifically at life scientists’ career path preferences (Chapter 5), patterns of international mobility and its importance for life science careers (Chapter 6), and the factors used for selecting a destination to move to for scientific work (Chapter 7). Chapter 8 adds additional information to better understand the competitiveness and opportunity structure for biotechnology and its potential influence on international mobility in life science careers. The conclusion, Chapter 9, summarizes the results within the 4P (people, place, productivity and policy) analytic framework that was introduced in Chapter 3.

All the discussion in the chapters up to this point have focused on dynamics that affect the global competition for talent and the competitiveness in various countries. But what can be said about the role of the workforce and their career preferences in shaping the global competition for talent? The next few chapters will use the CiLS data related to this topic to look more in depth at specifically at life scientists’ attitudes towards international mobility, its importance for life science careers, the factors used for selecting a destination to move to (Chapter 7), and the desired places for moving for work in the life sciences and biotechnology (Chapter 8).
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 norm27.

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 processes28. 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:

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 area 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 5,000 publications), Epigenetics (around 3,500 publications), and microRNA (also around 3,500) (Peng, 2010). In other words, fields such as proteomics 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.

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. Although females are often reported as being underrepresented in science and engineering, analyzing broad categories

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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**
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**

<table>
<thead>
<tr>
<th>Country</th>
<th>School and Institute</th>
<th>Enrollments</th>
<th>International Students and Staff</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total Students in University</td>
<td>% of Biology Doctoral Students</td>
<td>% Int'l Staff</td>
</tr>
<tr>
<td>BELGIUM</td>
<td>U Gent Faculteit Wetenschappen*</td>
<td>29,344</td>
<td>296</td>
<td>23.3</td>
</tr>
<tr>
<td></td>
<td>KU Leuven Faculteit Wetenschappen</td>
<td>29,257</td>
<td>148</td>
<td>16.1</td>
</tr>
<tr>
<td>DENMARK</td>
<td>Aarhus Universitet</td>
<td>30,141</td>
<td>67</td>
<td>36.2</td>
</tr>
<tr>
<td>FRANCE</td>
<td>U Strasbourg (Faculté de Sciences de la Vie)*</td>
<td>38,845</td>
<td>522</td>
<td>11.7</td>
</tr>
<tr>
<td></td>
<td>U Paris 6 (Unité de Formation et de Recherche (U.F.R.) Sciences de la Vie)</td>
<td>25,945</td>
<td>1100</td>
<td>na</td>
</tr>
<tr>
<td>GERMANY</td>
<td>FU Berlin</td>
<td>28,537</td>
<td>460</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>HU Berlin</td>
<td>24,010</td>
<td>783</td>
<td>13.6</td>
</tr>
<tr>
<td></td>
<td>U Münster</td>
<td>31,267</td>
<td>392</td>
<td>16.3</td>
</tr>
<tr>
<td></td>
<td>U Tübingen</td>
<td>24,273</td>
<td>560</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td>U Freiburg</td>
<td>21,622</td>
<td>429</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>LMU München*</td>
<td>40,431</td>
<td>28</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td>U Heidelberg*</td>
<td>24,584</td>
<td>888</td>
<td>31.1</td>
</tr>
<tr>
<td></td>
<td>TU München</td>
<td>23,891</td>
<td>580</td>
<td>15</td>
</tr>
<tr>
<td>ITALY</td>
<td>U Padova (Facoltà di Scienze Matematiche, Fisiche, e Naturali)</td>
<td>57,837</td>
<td>131</td>
<td>0</td>
</tr>
<tr>
<td>NETHERLANDS</td>
<td>U Groningen (Faculteit der Wiskunde en Natuurwetenschap)</td>
<td>26,342</td>
<td>193</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>U Amsterdam (Faculteit der Natuurwetenschap, Wiskunde en Informatica)</td>
<td>30,825</td>
<td>125</td>
<td>17.4</td>
</tr>
<tr>
<td></td>
<td>U Utrecht*</td>
<td>29,122</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Country</td>
<td>University and Department</td>
<td>Students</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------</td>
<td>---------</td>
<td>-------</td>
<td>-----</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>U Uppsala (Faculty of Science and Technology)*</td>
<td>28,907</td>
<td>186</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>U Lund (Faculty of Science)</td>
<td>46,000</td>
<td>96</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Karolinska Institutet - Stockholm (Biology)*</td>
<td>5,776</td>
<td>1538</td>
<td>1080</td>
</tr>
<tr>
<td>SWITZERLAND</td>
<td>U Lausanne*</td>
<td>9,895</td>
<td>366</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>ETH Zurich*</td>
<td>11,133</td>
<td>358</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>U Basel</td>
<td>11,593</td>
<td>210</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>U Bern</td>
<td>11,371</td>
<td>99</td>
<td>62</td>
</tr>
<tr>
<td>UK</td>
<td>IC London, Faculty of Natural Sciences*</td>
<td>11,394</td>
<td>249</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>U York, Dept. of Biology</td>
<td>12,787</td>
<td>119</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>U Manchester*</td>
<td>33,791</td>
<td>370</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>U Birmingham, College of Life and Environmental Sciences</td>
<td>26,073</td>
<td>140</td>
<td>20</td>
</tr>
<tr>
<td>SCOTLAND</td>
<td>U Edinburgh*</td>
<td>25,744</td>
<td>290</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>U Aberdeen</td>
<td>12,827</td>
<td>223</td>
<td>n/a</td>
</tr>
<tr>
<td>IRELAND</td>
<td>NUI Dublin, UCD College of Life Sciences</td>
<td>17,091</td>
<td>195</td>
<td>55</td>
</tr>
</tbody>
</table>

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 postgraduate 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.” 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

<table>
<thead>
<tr>
<th></th>
<th>EU-25</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers</td>
<td>%</td>
<td>Numbers</td>
</tr>
<tr>
<td>Nationals</td>
<td>14,600</td>
<td>75</td>
</tr>
<tr>
<td>Non-nationals</td>
<td>4,800</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>19,400</td>
<td>100</td>
</tr>
</tbody>
</table>


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, 31 http://www.nsf.gov/statistics/seind10/c2/c2h.htm#s3, Accessed 4 March 2015
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.\textsuperscript{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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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 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**

<table>
<thead>
<tr>
<th>Highest academic qualification desired</th>
<th>Gender - Counts</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Secondary school/high school</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Apprentice, technician or higher training in life sciences (outside of university)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Bachelor’s or equivalent</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Master’s or equivalent</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>PhD</td>
<td>79</td>
<td>80</td>
</tr>
<tr>
<td>Postdoc</td>
<td>50</td>
<td>64</td>
</tr>
<tr>
<td>Professor</td>
<td>78</td>
<td>57</td>
</tr>
<tr>
<td>Don’t know yet</td>
<td>39</td>
<td>66</td>
</tr>
<tr>
<td>Total</td>
<td>292</td>
<td>302</td>
</tr>
<tr>
<td>Country of citizenship</td>
<td>Highest Qualification Desired</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Bachelors or less</td>
<td>4</td>
</tr>
<tr>
<td>World Bank Developing, not in EU</td>
<td>Count</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Masters or equivalent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PhD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post-doc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Don't know yet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>Count</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>4.90%</td>
</tr>
<tr>
<td>China</td>
<td>Count</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>0.00%</td>
</tr>
<tr>
<td>EU-10</td>
<td>Count</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Poland</td>
<td>Count</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>0.00%</td>
</tr>
<tr>
<td>France</td>
<td>Count</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Germany</td>
<td>Count</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>5.26%</td>
</tr>
<tr>
<td>Italy</td>
<td>Count</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>12.24%</td>
</tr>
<tr>
<td>Spain</td>
<td>Count</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>7.46%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Count</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>7.14%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Count</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>9.09%</td>
</tr>
<tr>
<td>United States</td>
<td>Count</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>10.00%</td>
</tr>
<tr>
<td>All Others</td>
<td>Count</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>7.41%</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Percent</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>53.4%</td>
<td>39</td>
</tr>
<tr>
<td>Two</td>
<td>24.7%</td>
<td>18</td>
</tr>
<tr>
<td>Three</td>
<td>6.8%</td>
<td>5</td>
</tr>
<tr>
<td>Four</td>
<td>2.7%</td>
<td>2</td>
</tr>
<tr>
<td>Five or more</td>
<td>1.4%</td>
<td>1</td>
</tr>
<tr>
<td>Have not completed a postdoc position yet</td>
<td>11.0%</td>
<td>8</td>
</tr>
</tbody>
</table>

**TABLE 13 EXPECTED TIME IN POSTDOC POSITION**

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Percent</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>12.30%</td>
<td>9</td>
</tr>
<tr>
<td>1-2 years</td>
<td>23.30%</td>
<td>17</td>
</tr>
<tr>
<td>More than 2 years but less than 3 years</td>
<td>17.80%</td>
<td>13</td>
</tr>
<tr>
<td>More than 3 years but less than 4 years</td>
<td>15.10%</td>
<td>11</td>
</tr>
<tr>
<td>More than 4 years but less than 5 years</td>
<td>15.10%</td>
<td>11</td>
</tr>
<tr>
<td>More than 5 years</td>
<td>16.40%</td>
<td>12</td>
</tr>
</tbody>
</table>

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.
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.
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 SCORES

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

And, how interested are you in working in:

<table>
<thead>
<tr>
<th>Size of Company</th>
<th>Bachelors or equivalent</th>
<th>Masters or equivalent</th>
<th>PhD</th>
<th>Post-doc</th>
<th>Rating Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large company   (&gt;250 employees)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium-sized enterprise (50-250 employees)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small company   (10-49 employees)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micro enterprise (&lt;10 employees)</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
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 than 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.
“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.

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. 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

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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)

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>
<thead>
<tr>
<th>Country</th>
<th>Immigration into country:</th>
<th>Scientific mobility of natives:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% in Foreign country at age 18</td>
<td>Main countries scientists are from:</td>
</tr>
<tr>
<td>Canada</td>
<td>47</td>
<td>UK 14%, US 14%, China 11%</td>
</tr>
<tr>
<td>US</td>
<td>38</td>
<td>China 17%, India 12%</td>
</tr>
<tr>
<td>UK</td>
<td>33</td>
<td>Germany 15%, Italy 10%</td>
</tr>
<tr>
<td>Denmark</td>
<td>22</td>
<td>Germany 24%</td>
</tr>
<tr>
<td>Sweden</td>
<td>38</td>
<td>Germany 12%, Russia 10%</td>
</tr>
<tr>
<td>Belgium</td>
<td>18</td>
<td>Germany 15%, France 15%, Italy 13%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>28</td>
<td>Germany 15%, Italy 13%</td>
</tr>
<tr>
<td>France</td>
<td>17</td>
<td>Italy 14%</td>
</tr>
<tr>
<td>Germany</td>
<td>23</td>
<td>No country with more than 10%</td>
</tr>
<tr>
<td>Spain</td>
<td>7</td>
<td>Argentina 13%, France 10%, Italy 10%</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Country</th>
<th>Rate</th>
<th>Median Interest</th>
<th>Future Interest</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>3</td>
<td>16</td>
<td>40</td>
<td>Franzoni et al. (2012, p. 1251)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>43</td>
<td>33</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>7</td>
<td>8</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>1</td>
<td>40</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>5</td>
<td>3</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>44</td>
<td>18</td>
<td>63</td>
<td></td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th></th>
<th>% self-reporting moves abroad</th>
<th>Interest to move from current country of residence - Mean</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>60.4%</td>
<td>3.76</td>
<td>594</td>
</tr>
<tr>
<td>Male</td>
<td>59.6%</td>
<td>3.78</td>
<td>292</td>
</tr>
<tr>
<td>Female</td>
<td>60.9%</td>
<td>3.74</td>
<td>302</td>
</tr>
<tr>
<td>Highest education completed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>63.2%</td>
<td>3.16</td>
<td>19</td>
</tr>
<tr>
<td>Secondary school/high school</td>
<td>34.5%</td>
<td>3.78</td>
<td>58</td>
</tr>
<tr>
<td>Apprentice, technician, or higher training in life science (outside of university)</td>
<td>37.5%</td>
<td>4.5</td>
<td>8</td>
</tr>
<tr>
<td>Bachelor’s or equivalent</td>
<td>57.6%</td>
<td>3.95</td>
<td>99</td>
</tr>
<tr>
<td>Master’s or equivalent</td>
<td>57.8%</td>
<td>3.84</td>
<td>256</td>
</tr>
<tr>
<td>PhD</td>
<td>69.1%</td>
<td>3.6</td>
<td>81</td>
</tr>
<tr>
<td>Postdoc</td>
<td>84.9%</td>
<td>3.47</td>
<td>73</td>
</tr>
<tr>
<td>Graduate with honors (after high school)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>65.2%</td>
<td>3.9</td>
<td>290</td>
</tr>
<tr>
<td>No</td>
<td>57.5%</td>
<td>3.52</td>
<td>200</td>
</tr>
<tr>
<td>Not applicable</td>
<td>52.4%</td>
<td>3.85</td>
<td>103</td>
</tr>
<tr>
<td>Work Experience</td>
<td></td>
<td></td>
<td>418</td>
</tr>
<tr>
<td>12 months or less</td>
<td>57.7%</td>
<td>3.59</td>
<td>123</td>
</tr>
<tr>
<td>1-2 years</td>
<td>59.1%</td>
<td>4.24</td>
<td>66</td>
</tr>
<tr>
<td>2-3 years</td>
<td>66.1%</td>
<td>3.89</td>
<td>62</td>
</tr>
<tr>
<td>4-5 years</td>
<td>64.3%</td>
<td>3.83</td>
<td>70</td>
</tr>
<tr>
<td>6-7 years</td>
<td>69.7%</td>
<td>3.48</td>
<td>33</td>
</tr>
<tr>
<td>More than 7 years</td>
<td>78.1%</td>
<td>3.36</td>
<td>64</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single - not in a serious relationship</td>
<td>54.1%</td>
<td>3.94</td>
<td>244</td>
</tr>
<tr>
<td>Single - in a serious relationship</td>
<td>61.4%</td>
<td>3.9</td>
<td>132</td>
</tr>
<tr>
<td>Living with partner</td>
<td>68.0%</td>
<td>3.25</td>
<td>75</td>
</tr>
<tr>
<td>Married</td>
<td>67.8%</td>
<td>3.49</td>
<td>121</td>
</tr>
<tr>
<td>Other (widowed, separated, no answer)</td>
<td>54.5%</td>
<td>4.14</td>
<td>22</td>
</tr>
<tr>
<td>Long-distance relationship</td>
<td></td>
<td></td>
<td>328</td>
</tr>
<tr>
<td>No</td>
<td>58.4%</td>
<td>3.54</td>
<td>231</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Skill/Experience</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Having previous work experience in the field</td>
<td>4.21</td>
</tr>
<tr>
<td>Experience with interdisciplinary projects</td>
<td>3.97</td>
</tr>
<tr>
<td>The research area of the post-graduate degree</td>
<td>3.94</td>
</tr>
<tr>
<td><strong>Work experience abroad</strong></td>
<td><strong>3.9</strong></td>
</tr>
<tr>
<td>The research area of the graduate degree</td>
<td>3.68</td>
</tr>
<tr>
<td>Record of obtaining grants/funding in the past</td>
<td>3.59</td>
</tr>
<tr>
<td>Grades/Marks on graduate degree</td>
<td>3.28</td>
</tr>
<tr>
<td>Having previous experience in management</td>
<td>3.22</td>
</tr>
<tr>
<td>Knowledge of government regulations</td>
<td>3.07</td>
</tr>
<tr>
<td>Grades/Marks on Bachelor’s degree</td>
<td>2.98</td>
</tr>
</tbody>
</table>

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)

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

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

<table>
<thead>
<tr>
<th>Most recent move</th>
<th>Total/sum across past 5 moves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study as part of degree program</td>
<td>119</td>
</tr>
<tr>
<td>Short-term study abroad or exchange program</td>
<td>67</td>
</tr>
<tr>
<td>Postdoc</td>
<td>39</td>
</tr>
<tr>
<td>Internship</td>
<td>34</td>
</tr>
<tr>
<td>Work (Professional/office/research, related to life sciences)</td>
<td>32</td>
</tr>
<tr>
<td>Moved to be with family</td>
<td>15</td>
</tr>
<tr>
<td>Research (Not part of degree and not listed above)</td>
<td>14</td>
</tr>
<tr>
<td>Language courses</td>
<td>8</td>
</tr>
<tr>
<td>Work (other)</td>
<td>6</td>
</tr>
<tr>
<td>Work (Professional/office/research, not related to life sciences)</td>
<td>4</td>
</tr>
<tr>
<td>Moved to be with boyfriend/girlfriend</td>
<td>6</td>
</tr>
<tr>
<td>To leave a bad situation in the country I come from</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
</tr>
<tr>
<td>Total number of individuals/ moves*</td>
<td>358</td>
</tr>
</tbody>
</table>

*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\textsuperscript{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.

\textsuperscript{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.
CHAPTER 7: LIFE SCIENTISTS’ REASONS FOR INTERNATIONAL MOBILITY AND LOCATION CHOICE

“The key factor of the global economy is no longer goods, services, or flows of capital but the competition for people. The ability to attract people is a dynamic and sensitive process. New centers of the global creative economy can emerge quickly; established players can lose position. It’s a wide-open game, and the playing field is leveling every day.” (Florida, 2005, p. 16)

As discussed in Chapter 1, some research in the past ten years or so has aimed to further integrate reasons for immigration in a more comparative context, as partially reflected in the work of Florida (2002; 2005). Florida’s research discusses more broadly for the ‘creative class,’ living in large cities, but it is not clear if his findings apply to other contexts. Although his work brought attention to the importance of lifestyle factors for location choice, Florida focuses on ‘place’ as attracting the people and does not examine the career drivers linked with ‘productivity’ in my research framework. Yet, the premise is similar -- The complexity and patterns of international migration have changed with the expansion of destination choices beyond traditional immigration countries.

How much is really understood about scientists’ preferences globally for where to move during their career? The last chapter highlighted the importance of international mobility in current life science careers, showing that it features in a large percentage of careers and is seen as valuable particularly for academic careers. This chapter examines two interrelated research questions: Which factors are considered and influence life scientists’ intentions to move or moves abroad? Which countries are attractive to life scientists and why?

This chapter aims to integrate the findings of the CiLS study into an existing framework for assessing factors influencing decisions to move. While international movements cannot be said to be predictable, it is important to try to better understand what scientists say is influential to their decisions. This chapter first presents a framework on drivers of skilled mobility from Papademetriou, Somerville, & Tanaka (2008; 2009). Next, the following CiLS survey questions are analyzed:

- Q.97 Factors used in deciding where to move: How much would the following factors influence your choice of country to move to in the future? Please use a scale of 1-5 where a 1 means “not important at all” and a 5 means “extremely important”
- Q112/Q115 To what extent has each of the following influenced your decision(s) to move/ not to move (separate questions for movers and non-movers)
- Q.92 Which country would you be most interested in working in? (Drop-down menu of all countries)- First choice
- Q. 93 Why would this country be your first choice? (type in open-ended response)

Next, the framework presented earlier from Papademetriou et al. is modified with findings of the CiLS survey, to make it in line with the mobility of life scientists in particular. These changes also take into account the 4P analytical framework I explain in Chapter 3, integrating aspects related to people, place, productivity, and policy into
scientists’ migration location choice.

It should be noted that the framework by to Papademetriou et al. was only found after the CiLS results had been collected and did not guide the survey’s design. One point of departure for this analysis is that the starting point is the career in life sciences, and common factors among this career that impact destination choice are discussed. This is important, as many studies use the country of destination as a starting point. However, this may overstate the importance of factors that are found in that particular country. For instance, one assumption made is that skilled migrants gravitate to countries where English is the native language, such as the US, UK, and Australia, yet a large percentage of research on skilled migration has also been conducted in these countries. Second, countries differ in terms of their strengths in various fields of research or the extent of opportunities offered for different job roles. All of these aspects need to be integrated to better understand reasons for migration location choice.

ASSESSING DECISIONS RELATED TO SKILLED AND SCIENTIFIC MOBILITY

In Talent in the 21st-Century Economy, Papademetriou et al. (2008; 2009) first summarize the work on skilled migration and competitiveness and then create a framework for looking at skilled migrants’ decisions to move to various places. This research was found to be a good starting point for better understanding scientific mobility as well. Their framework is divided into a top row of drivers, which they consider to be “essential” when skilled migrants decide where to move (2009, p.243). The framework also has a bottom row of “facilitators,” which they say have an influence on the decision where to move, but “are not likely to determine the outcome.” (p.243). In between the two levels are the policies, or rules and conditions, that also influence migration destination choice.

Papademetriou et al.’s (2009, pp. 242-253) framework for individual skilled migration decision-making (see Figure 14) is explained in brief here. These authors note that the primary drivers of skilled migration are both “mutually dependent and intentionally overlapping” (p.245) and include: 1) “the opportunity”, defined as return on human capital investments already made 2) “capital infrastructure,” which they define as “facilities that allow highly skilled immigrants to realize personal and professional goals.” Their list of examples of capital infrastructure include research labs, strong universities for themselves or family members, clusters that allow entrepreneurs to bring innovations to market, and “such intangibles as dynamism—that is the crossroads where knowledge, creativity and transformation meet.” 3) “presence of critical mass of other talented professionals” in their own and related fields to facilitate networking, development of new ideas and products, and to attract further talent. Papademetriou et al. (2009, p. 245) also list secondary factors, for which the importance will vary some depending on individual career and family situations, including “generous and fair social models” (which they feel apply especially to those with families or those who are interested in staying long-term); “lifestyle and environmental factors” (refers mostly to quality of life in a given location) and living in “safe and tolerant societies, where the acceptance of, and even respect for, diversity of language, ethnicity, race and cultural and religious practices – and a welcoming environment toward immigration – are part of the national narrative can be a very strong element of attraction, particularly given the growing intolerance of many societies” (p.246). They state that in this regard, countries
with a longer history and more regard for immigration historically, such as the US and Canada, Australia and New Zealand, have an advantage (p.246-247).

FIGURE 14 FRAMEWORK ON SKILLED MOBILITY DESTINATION CHOICE FROM PAPADEMETRIOU ET AL. (2009)

The overall migration decision in their framework is also considered to be influenced by migration policies, including opportunities for family members and long-term settlement (p.247-253). These are placed in the middle of the framework to show that they are “important enough to exert strong influence in the decision of a destination choice but not necessarily a determinant of it” (p.247). They identify four key elements, two which are linked directly to immigration rules, and two that instead relate to chances of economic success for both the immigrant and his or her family members. These can be considered to be structural factors. Much of the focus in their discussion is on policies revolves around the importance of allowing permanent residency, whether or not the immigrant decides to pursue a long-term option, and also clear paths to citizenship. They even anticipate that “as interest in the most talented immigrants intensifies, we believe that more and more countries will find that offering permanent status up front will be what is expected by the most sought-after would-be immigrants” (p.249). The first element related to potential for economic success is the recognition of education and other credentials. They also discuss debates around having fluency of the native language as a prerequisite for immigration. They suggest a better approach is to have programs that facilitate language acquisition, as some immigrants may not need to know the national language for their job, and possibilities of learning a new language may be attractive to certain immigrants. The final element that can make a country more attractive is allowing family reunification and giving family members the right to work. They explain “while spouses are often allowed to accompany an immigrant employee, many countries do not
allow them to enter up front or have a long waiting periods before visas become available” (p. 253).

Papademetriou et al.’s framework was designed to address skilled migration on the whole, based on circumstances they thought would apply between the years 2005-2025. Furthermore, these authors analysis had an explicit focus to integrate the various perspectives needed to understand mobility, including the firms, governments and the individuals involved and for strategies for ‘talent’ for both developing and developed countries. Such a broad perspective has rarely been applied in skilled migration research and their work represents an excellent starting point for looking at various issues needed to understand recent changes and talent strategies. This framework is interesting as it can be applied across cities or countries and is therefore a good step in further understanding the global competition for talent; however, further modifications may be needed based on new empirical research, which takes an international perspective for specific economic sectors or with careers, rather than destination, as the key focus. Their framework was therefore found to be an excellent starting point and very applicable to scientific mobility, as it not only integrates aspects similar to technology, talent, and tolerance but also integrates the role of factors related to productivity, as well as immigration and social policies for skilled migration. The remainder of this chapter will use CiLS data on mobility decisions to discuss how Papademetriou et al. (2009) framework can be further modified to understand the mobility decision-making factors of life scientists, as a more specific form of skilled migration. It questions the extent to which the elements listed in their framework apply when looking at scientific jobs in particular. This modified framework can also help build understanding of skilled migration decision-making in the global, rather than national context.

Factors that influence life scientists’ location choice abroad in the CiLS study

Respondents in the CiLS study were asked to rate the importance of various factors in their decision to move. In line with the other research on scientific mobility, the CiLS results (see Table 19) show that “equipment and possibilities for good scientific work” is seen as the most important (mean=4.51), along with “possibilities for career advancement” (mean=4.39) “quality of education” (mean=4.14), and “openness to foreigners” (mean=4.05). This list is reflective of the findings discussed on scientific mobility – that excellence for a given field of research and similarly good facilities and career opportunities – lead scientists’ decisions on where to move. However, it is also interesting to note the relatively high importance given to openness to foreigners. This finding is in line with the research of Florida (2002, 2005), but to my knowledge has not been discussed within the context of scientific mobility. Papademetriou et al. (2009) list tolerance as a facilitator of mobility among the high-skilled, but the CiLS results suggest it is actually a core concern in decisions where to move.

Structural factors linked to the overall city or country and opportunities afforded by the country on the whole were given slightly lower levels of importance when ranked among total concerns, although most were still seen as being important (statements with median or mode of 4). It is important to keep in mind that an individual’s life stage and family situation influence both on whether or not to move and on destination choice. “Possibilities for my partner (husband/wife/boyfriend/girlfriend) to work there as well”
was among the highest rated structural/policy-related factor and is even higher when looking at those in a serious relationship or marriage. Individuals who listed themselves as single and not in a serious relationship had a mode of 4 on the importance of the partner being able to work abroad, whereas all other groups (single in a serious relationship, living with partner, and married) had a mode of 5. Among the individuals who have a partner with a career, only small difference are seen between career types (partner has life science career: mean=4.35; career not related to life sciences: mean=4.41; compared to currently does not have a career: mean=3.95). The cost of childcare, as expected is also more important when looking at those who have children (mean=3.98) versus those who do not (mean=3.13). Childcare is not one of the top rated items, even among those with children, which may be an indication that it is an issue that is solved after moving, rather than a consideration beforehand.

Factors related to social networks (having friends and family in the country or business contacts in the country) and possibilities for entrepreneurship were among the lowest rated concerns. The lack of relevance could be due to some scientists aiming for an academic, rather than industry (business-based), science career, as the statement listed focuses on business contacts. However, it also suggests that the location’s reputation, in terms of its excellence, is a bigger driver for people than having existing contacts in that location. A similar result was seen for ratings of possibilities to start one’s own business; it is relevant for only a small group of scientists. Most scientists surveyed were not aiming to start their own company, but rather to work in research, and further analysis of the open-ended answers shows often in prestigious institutions (academic or companies), and therefore ratings on the importance of these factors are also among the lowest of all the factors mentioned when looking at the total CiLS survey ratings for these statements. This is in line with other research:

But although biotechnology, genetic manipulation and bioinformatics have brought the life sciences to the forefront of industrial interests, empirical studies suggest that academic entrepreneurship and technology transfer, though immensely grown in status and achievement, are still a passion of the few, albeit a prestigious and influential few. (Morris & Rip, 2006, p. 260)

### TABLE 19 FACTORS FOR DECIDING WHERE TO MOVE IN THE FUTURE

<table>
<thead>
<tr>
<th></th>
<th>N Valid</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment and possibilities for good</td>
<td>586</td>
<td>8</td>
<td>4.51</td>
<td>5</td>
</tr>
<tr>
<td>scientific work (Q97equip)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possibilities for career advancement</td>
<td>589</td>
<td>5</td>
<td>4.39</td>
<td>5</td>
</tr>
<tr>
<td>(Q97career)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of education (Q97education)</td>
<td>586</td>
<td>8</td>
<td>4.14</td>
<td>4</td>
</tr>
<tr>
<td>Openness to foreigners (Q97open)</td>
<td>583</td>
<td>11</td>
<td>4.05</td>
<td>4</td>
</tr>
<tr>
<td>Stable political situation (Q97politic)</td>
<td>582</td>
<td>12</td>
<td>3.88</td>
<td>4</td>
</tr>
<tr>
<td>Possibilities for my partner</td>
<td>567</td>
<td>27</td>
<td>3.82</td>
<td>4</td>
</tr>
<tr>
<td>(husband/wife/boyfriend/girlfriend) to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>work there as well (Q97partner)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Better ratio between cost of living and</td>
<td>579</td>
<td>15</td>
<td>3.77</td>
<td>4</td>
</tr>
</tbody>
</table>
One factor was seen as unimportant to life scientists – “Place has same religion as mine/where I come from”. This factor was asked in part to better gauge feelings of openness. It is possible that religion itself is not seen as a relevant factor, or another interpretation would be that scientists are more concerned about how open and accepting others are to them and particularly their work, and not on ascribed religious or cultural differences.

Influence on decisions to move versus not to move

The CiLS respondents also asked separate questions for people who have moved versus those who have not, to assess how various elements influenced their decisions (Table 20). Statements were asked related to opportunities, relationships, and work permits. This list is not exhaustive, but gives some indication of how strongly people felt various aspects influence their decisions.

Both movers and non-movers stated that they were more influenced by whether or not they had a specific offer for work or study and the economic/work opportunities, rather than the other factors, which mostly had a median of 2. It is important to note that the country of citizenship does have an influence on the relative importance of work permits, with individuals from developing countries rating this as a more important factor than those from European countries. This will be discussed in more detail later in this study, when differences in the opportunity structure are addressed. There is a large difference seen in the importance of the relationship with partner, as it depends on the individual’s relationship status, but among those in long-term relationships it generally has a strong impact on mobility decisions. The same can be true of relationships with other family
member. However, while for some people family is an important consideration, many others feel it is not influential:

**TABLE 20 INFLUENCE ON DECISIONS TO MOVE/NOT TO MOVE**

Scores (5=strongly; 4=slightly; 3=somewhat; 2=not very much; 1=not at all)

<table>
<thead>
<tr>
<th></th>
<th>Movers</th>
<th></th>
<th></th>
<th>Non-movers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Mode</td>
<td>Mean</td>
<td>Median</td>
<td>Mode</td>
</tr>
<tr>
<td>Specific offer for job or study</td>
<td>4.28</td>
<td>5</td>
<td>5</td>
<td>3.56</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(movers)/ Have not had a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>specific, attractive job offer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or offer to study at specific</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>university/institute (non-movers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic/work opportunities</td>
<td>3.58</td>
<td>4</td>
<td>5</td>
<td>3.37</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Work permits</td>
<td>2.54</td>
<td>2</td>
<td>1</td>
<td>2.61</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Relationship with partner</td>
<td>2.39</td>
<td>2</td>
<td>5</td>
<td>2.67</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Brothers/sisters/parents</td>
<td>2.12</td>
<td>2</td>
<td>1</td>
<td>2.92</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Friends</td>
<td>2.34</td>
<td>2</td>
<td>1</td>
<td>2.64</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

I never had the money or a good opportunity yet to spend about one year abroad, but I think about doing my Master degree abroad. It's very important to me, that the partner could live in the same country, if you stay there longer. Family is not that important, because I consider it okay, seeing them twice a year and I think that would be possible. (Female, 20, Germany)

In the open-ended responses on why individuals had not moved, 5 main reasons were given.

- Family reasons, typically due to spouse’s career, child raising, or needing to care for other family members, such as parents:

  I got married early and I didn’t want to leave my husband for example 3-4 years to make a PhD abroad. My husband is also a scientist. And it is not easy to find a place for two people in one place/city. (Female, 28, Poland)

  It's simple; I have friends and family here. Especially my boyfriend has a very good job and a sure future... and jobs in life science are most often just for 2 years. (Female, 26, Germany)

  My father was rather ill and I felt that I could not move myself abroad until solving my family problems. (Male, 28, Spain)

- There is a lack of interest in moving/happy in current job, city, etc.

  I have an attractive job in a research institute. I love my city, Barcelona. (Male, 33, Spain)

  The most important issue are work opportunities - if there is nothing more attractive than in my country then there's no point in moving internationally. (Female, 21, Poland)
My primary decisions have been motivated by excellent opportunities in the community I grew up in. There has been active fostering of bioscience here that has allowed me to settle within minutes of the home I grew up in. This allows my children to have constant access to their grandparents, which enriches their lives greatly (both children and grandparents!). While I would have taken a postdoc abroad if I was single, my wife was not interested in such opportunities. (Male, 34, US)

- Assumed to be better/ plan to go abroad at a later stage

Working in the field of cancer research has been my childhood dream and definitely going abroad for me has also been one of my priorities. (Female, 35, India)

I preferred to finish my education till PhD degree and after have an international experience. (Female, 34, Switzerland)

- No response to efforts to apply for positions abroad

I would like to do my PhD studies abroad, but for the past 2 years I have not worked in the field related to life science due to my family situation since Science did not provide enough money to feed my family. I’m very much interested to do my Doctoral studies in abroad but since I do not have research experience, my application always gets rejected in United States and Canada. But my aspiration is to do PhD. If really given an opportunity surely I'll prove myself and become a great scientist. (Female, 24, India)

- Lack of resources, whether financial or related to information, was commonly cited in the open-ended answers. Lack of resources and information is most commonly mentioned as a barrier why one did not pursue studies abroad, but it also applies to job offers. The concerns about resources were found both among people from developed as well as developing countries:

My university section was shitty when it came to studying abroad. They were not helping at all. On the contrary, they were not qualified and/or willing to help. (Male, 24, Switzerland)

I am from a rural area of India. So advanced knowledge about opportunities are not reaching me in time. I had come to know about international opportunities only after my postgraduation. If I know it early, I could try for it effectively. (Male, 24, India)

CILS SURVEY RESULTS: WHICH COUNTRIES GLOBALLY WOULD LIFE SCIENTIST LIKE TO WORK IN?

Following this discussion about what influences scientific mobility in general, is discussion of where scientists would most like to work and what s influences the preference for one destination over another. The CILS survey asked for respondents to name their first choice country for work from a drop-down list of all countries and then state why that country would be their first choice. The CILS data presented needs to be interpreted with caution. As explained in the methodology chapter, not all countries are represented equally so there may be a bias in this regards. It should also be pointed out that the CILS survey was conducted in English, which again likely influences which countries have higher numbers of respondents. Instead of using the CILS data to decide a
strict rank order of places, it is instead used to assess more generally what is considered and possible strengths and weaknesses in the attractiveness of various countries for life science careers. Table 21 lists countries by number of respondents saying it is their first choice and shows the percentage of citizens within first choice as compared to the number from outside of Europe. The United States is most popular destination, but only marginally, named as first choice by 18% of all respondents. This shows that while the US is a leader in attracting life scientists, it is far from a situation where the majority of life scientists have a preference to work in the US. Germany, Switzerland, and the UK also are among the countries most often named as first choice in the CiLS survey.

The percentage of citizens in Table 21 is instructive as it point out where there is a skew to nationals, versus EU or international migration. The percentage born in developing countries also suggests whether or not the destination country has broad international appeal. The most popular destinations -- the US, UK, Switzerland and Germany -- received a significant proportion of endorsements from people of other nationalities; whereas the majority of respondents naming Spain are Spanish citizens, followed by other EU nationals. The results for Spain are in line with what is shown in the migration literature, which shows that Spain has lower rates of international migration.

**TABLE 21 TOP 5 ‘FIRST CHOICE’ DESTINATIONS FOR LIFE SCIENTISTS: BY CITIZENSHIP**

<table>
<thead>
<tr>
<th>Country</th>
<th>First Choice-Counts</th>
<th>% of total responses</th>
<th>% of first choice made up of citizens (to see if potential skew)</th>
<th>% with citizenship from other country in EU, EFTA or Switzerland</th>
<th>% citizens of developing countries and India</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>109</td>
<td>18%</td>
<td>6.4%</td>
<td>38.5%</td>
<td>47.7%</td>
</tr>
<tr>
<td>Germany</td>
<td>96</td>
<td>16%</td>
<td>32.0%</td>
<td>19.6%</td>
<td>47.4%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>78</td>
<td>13%</td>
<td>30.8%</td>
<td>47.4%</td>
<td>23.1%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>66</td>
<td>11%</td>
<td>10.6%</td>
<td>47.0%</td>
<td>36.3%</td>
</tr>
<tr>
<td>Spain</td>
<td>32</td>
<td>5%</td>
<td>57.6%</td>
<td>36.3%</td>
<td>6%</td>
</tr>
<tr>
<td>% of First choice responses captured in top 5 countries</td>
<td>64%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It is also important to acknowledge that there are fewer UK nationals and foreign individuals living in the UK in the CiLS sample than the respective numbers for Germany or Switzerland. This means that the ratings for the UK may be a bit lower than what would truly occur if sampling was based on the most competitive life science locations, as has been done in other research which shows the UK as one of the top destinations.

**Why would this country be your first choice?**

One other way to look at why life scientists move is to look at what attracts them to various destinations, the pull factors. It is conceivable that the list of factors presented to respondents in Q97 may not reflect all the aspects considered important by life scientists.
Furthermore, decisions about where to go need to be understood within the context, that is where does the individual hope to move? The analysis of the answer to an open-ended question, “Why would this country be your first choice?,” which follows after they select the destinations they would be most interested in moving to is therefore also instructive for understanding the factors considered when making mobility decisions. This section will add to the discussion given so far by showing reasons which are top-of-mind, or unprompted. This open-ended question (Q93) was asked before the list of factors (Q97), and therefore would not have influenced their responses. It was felt to be important to ask people to name what attracts them without providing a list of reasons, as a certain destination could have a unique factor drawing individuals to it, and to check if lists at other questions were complete, as this is exploratory research. The open-ends were coded through open coding, that is categories were made as the responses were read.

Table 22 summarizes the factors mentioned spontaneously by life scientists on why a certain destination would be their first choice, regardless the country was named. The groupings were done at a later stage, and placed within the categories defined in the modified framework (Figure 15). In line with the discussion by Papademetriou et al. (2009), there is often considerable overlap for the factors mentioned in their model, particularly in regards to those related to research excellence and those related to work opportunities. These were coded separately, but given the subjective nature, a net was made that combines the codes as well, listed as “career drivers,” and were mentioned by 343 respondents or 57.7% of the total. The non-career based factors, were defined as drivers related to quality of life issues and the ease of adjusting. High numbers of respondents also name these as important, with 305 CiLS respondents (51.3%) naming a reason within this broader category.

The reasons given for why a certain country is their first choice indicate that ‘productivity’ plays a key role. Most responses are centered on the excellent research departments or facilities, funding, career opportunities, and scientific environment, in line with other literature on scientific mobility. For instance, a 40 year old, female, German citizen living in Germany who has previously completed two post-docs in France, feels that the US ‘still (has) best conditions to do basic research and to move up the career ladder; Easier to obtain grant money; Better networks’ and a 27 year old female Chinese citizen living in the United Kingdom chose the United States as first choice because there are ‘a lot of biopharmaceutical companies, big investment in life science projects.’ In line with this career focus, countries in Europe with the largest life science sectors also emerge as places of interest for future work, particularly the UK, Switzerland, and Germany. However, new destinations are also appearing based on perceived opportunities. Although Spain is not considered one of the tope countries globally in the life sciences or biotechnology, some people are drawn to Spain given its growth, and the innovative environment that results. This is an important observation, that it is not only the strongest countries that are attractive, but also those that are seen as up-and-coming. For instance, Spain is attractive to some due to its ‘emerging’ scientific industry, which affords new opportunities, coupled with the other lifestyle elements it offers. A 26 year old male, Italian who has previously worked in US as research technician, named Spain as his top choice because ‘It's in Europe. It is growing, young and innovative under many different aspects. Lifestyle and climate are definitely things that fit me.’ Given the importance of research excellence in location choice, Appendix E provides additional
examples of reasons given for the top countries selected to be the scientist’s first choice: US, Germany, Switzerland, UK, and Spain.

One of the most mentioned lines of reasoning for choosing a certain country, other than career and productivity based reasons, was coded as the “ease of adjustment or familiarity.” A very small number of individuals seek out moves to places that are as dramatically different from their own country as possible either due to interest or feeling it would broaden their perspective: For example: *I am interested in living in China because the culture is totally different, but not for that long* (24 year old German male). The majority of people wish to move to a country where they expect to adjust more easily. One of the aspects that helps the ease of adjustment is the proximity and access to one’s home country. While, the United States is still the top destination globally, many Europeans state a preference to stay in Europe. Another important aspect is having previous experience in that country or knowing about the experience of others who have been there. Already having family and friends in the area is a facilitator for some individuals, although the closed-ended questions show it usually is not a primary driver among life scientists.

Language issues are one of the most named reasons that a country is selected, and can also be considered an aspect of the ease of adjustment. The interest in learning new languages was also found to be one of the most important reasons for intra-EU mobility in other research (EUROFOUND, 2006). Living and working in an environment where one’s native language or English is spoken is one of the key advantages for countries such as the United States and United Kingdom. Places where English is not the main language can also be attractive due to the opportunity to improve other language skills, combined with the draw of scientific opportunities. A 41 year old from and living in Turkey after obtaining his PhD in the US says he would be interested in moving to Spain because ‘*I would like to learn a second foreign language and Spanish is going to be a dominant language in coming years in Europe and the rest of the world. Also, life science research of Spain speeds up and very active science and technologies are developed in Spain.*’ A 28 year old Indian citizen living in South Korea names Germany as most attractive because ‘*There are many universities and research institutes doing highly advanced research in the field of Biotechnology. Secondly, I know well about culture of Germany and I did four months classes in India to learn German language...*’ These statements act as anecdotal evidence of the increasing pull of ‘new’ skilled migration destinations based on a combination of changing competitive advantages in the career field and language differences are not always seen as a barrier to moving, but sometimes as an opportunity to improve skills, including language skills. Nonetheless, enthusiasm for being in an environment with a foreign language can wane. A female scientist, 32 years old, from India and living in Germany says she would like to work in the US: *Since I am more or less an English native speaker, I prefer my working language to be English. In Germany the science is fantastic, but there are times I would have been happy, if I knew German like my mother tongue.*
<table>
<thead>
<tr>
<th>Q93 Why would this country be your first choice?</th>
<th># of people:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAREER DRIVERS</strong></td>
<td>343</td>
</tr>
<tr>
<td>Research or scientific excellence (net)</td>
<td>240</td>
</tr>
<tr>
<td>Research or scientific excellence</td>
<td>146</td>
</tr>
<tr>
<td>Funding</td>
<td>40</td>
</tr>
<tr>
<td>Leader / Strong in life sciences or biotech</td>
<td>58</td>
</tr>
<tr>
<td>Access to equipment and technology</td>
<td>21</td>
</tr>
<tr>
<td>Excellence for specific field of research/ particular institute</td>
<td>20</td>
</tr>
<tr>
<td>Good reputation (General)</td>
<td>11</td>
</tr>
<tr>
<td>Strong policies for life sciences/policy support</td>
<td>6</td>
</tr>
<tr>
<td>Good policies/place for international students</td>
<td>3</td>
</tr>
<tr>
<td><strong>Opportunities (net)</strong></td>
<td>116</td>
</tr>
<tr>
<td>Many opportunities (general)</td>
<td>33</td>
</tr>
<tr>
<td>Career opportunities</td>
<td>46</td>
</tr>
<tr>
<td>Salary/High pay in this country/Reward scientific work</td>
<td>36</td>
</tr>
<tr>
<td>Developing/Growing place/life science market/or specific field</td>
<td>16</td>
</tr>
<tr>
<td>Science skills development</td>
<td>6</td>
</tr>
<tr>
<td>Received scholarship</td>
<td>1</td>
</tr>
<tr>
<td><strong>Critical mass of talented professionals (net)</strong></td>
<td>62</td>
</tr>
<tr>
<td>Work culture/ethnic/work conditions</td>
<td>50</td>
</tr>
<tr>
<td>Good scientists/scientific community/networks</td>
<td>14</td>
</tr>
<tr>
<td><strong>QUALITY OF LIFE/ LIFESTYLE DRIVERS</strong></td>
<td>305</td>
</tr>
<tr>
<td><strong>Ease of adjusting/Familiarity (net)</strong></td>
<td>219</td>
</tr>
<tr>
<td>Language (subnet)</td>
<td>78</td>
</tr>
<tr>
<td>English as main language/ widely spoken here</td>
<td>39</td>
</tr>
<tr>
<td>Build or improve language skills</td>
<td>19</td>
</tr>
<tr>
<td>Family and friends</td>
<td>69</td>
</tr>
<tr>
<td>Like the country</td>
<td>39</td>
</tr>
<tr>
<td>Have experience with or work experience in the country</td>
<td>37</td>
</tr>
<tr>
<td>Proximity to home country/Family (other than home country)</td>
<td>30</td>
</tr>
<tr>
<td><strong>Living Standard/Quality of Life (net)</strong></td>
<td>82</td>
</tr>
<tr>
<td>Quality of life/Living standard</td>
<td>63</td>
</tr>
<tr>
<td>Political reasons/social political rights/equal opportunities</td>
<td>11</td>
</tr>
<tr>
<td>Social services and benefits including healthcare/childcare</td>
<td>10</td>
</tr>
<tr>
<td>Peaceful/ quiet place/Low Crime/Safe</td>
<td>11</td>
</tr>
<tr>
<td><strong>Lifestyle, cultural and environmental (net)</strong></td>
<td>76</td>
</tr>
<tr>
<td>Like culture/experience new culture</td>
<td>36</td>
</tr>
<tr>
<td>Like the people there</td>
<td>18</td>
</tr>
<tr>
<td>Landscape and weather</td>
<td>22</td>
</tr>
<tr>
<td>Lifestyle</td>
<td>10</td>
</tr>
<tr>
<td><strong>Tolerant Society (net)</strong></td>
<td>27</td>
</tr>
<tr>
<td>Diversity/International Environment</td>
<td>27</td>
</tr>
<tr>
<td><strong>Home country/already live here</strong></td>
<td>123</td>
</tr>
<tr>
<td>Make positive contribution to own country</td>
<td>11</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
</tr>
<tr>
<td>No real location preference/consider various countries</td>
<td>21</td>
</tr>
<tr>
<td>Prefer short trips instead of moving</td>
<td>4</td>
</tr>
<tr>
<td>Did not provide an answer</td>
<td>21</td>
</tr>
</tbody>
</table>
Very few individuals mention specific policies when choosing a destination; however, many base decisions on the competitiveness (status as a leader) in life sciences or biotechnology, or their specific field, which can be influenced in part by policy. For instance, a 27 year old, Belgian citizen named Germany as the top choice because, “Apparently very good science policy. Competent people are leading. (Germany is) the leading country in many aspects of society.” Immigration policy was not frequently known or noted by scientists, and science policy may have a more discernable effect, due to the visibility of cutting-edge research as well scientists seeking out information about available funding. Scientific funding is closely tied to the institutional context (Hackett, 1987; Laudel, 2006), and is one area where governments and universities have the potential to create a strategy that differs them from other places, whether the funding is for student degree programs or advanced research projects.

One other commonly named reason that features in the interest of where to move among some life scientists is the perceptions of being diverse, international, or multicultural societies, and this is often named in combination with career or productivity related reasons. In this regard, the Anglo-Saxon countries, traditional countries of immigration, have an advantage as was also described by Papademetriou et al (ibid). For instance a 24 year old female who is a citizen and living in Italy wants to go to the UK ‘because in the UK there is a multicultural environment that allows the comparison and exchange of knowledge.’ A 26 year old Italian female, states “In my opinion United Kingdom, and especially London, offers a wide range of opportunity in science/biotechnology field being an international and multi-cultural reality.” A 28 year old male from and living in India names the US as his first choice, ‘Because of its diversity, language, living standard, quality of research work, international recognition and good salary.’ Some other countries also have this advantage, for instance Singapore: A 31 year old Malaysian woman names Singapore due to its “good funding opportunity/career advancement opportunity multi-cultural research environment near to home country.” Diversity can also feature as a reason people want to stay in their home country, as a 28 year old Swiss citizen names Switzerland as his top choice due to "Quality of life, Political rights, Density of population, diversity."

Furthermore, broader reasons for place attractiveness also feature, including perceptions of the characteristics of the culture, weather or lifestyle. While research on the creative class (Florida, 2002; 2005) has assumed that ‘talent’ is most drawn to cities, it cannot be expected that all prefer a fast-paced, large urban atmosphere. A 28 year old German citizen who currently lives in Switzerland says the country remains her first choice because of ‘Nice landscape (hiking, swimming, close to sea), nice people, international, high living standard, and high salary’.

More analysis on differences between the opportunity structures in various countries for life scientists is provided in the next chapter.

**DISCUSSION OF FRAMEWORK: WHAT INFLUENCES SCIENTIFIC MOBILITY AMONG LIFE SCIENTISTS?**

The CiLS study aims to better understand factors that influence mobility decisions of life scientists. The framework setup by Papademetriou et al. (2008, 2009) was found to be an
excellent starting point for discussing the mobility decisions of global life scientists and the aspects named in their framework were confirmed as being important in the CiLS survey results. Yet, the model also seemed slightly incomplete and new modifications\(^{36}\), indicated in white boxes in Figure 15, arose by using the CiLS data to apply their research specifically to careers in life sciences. These results have been found based on the total survey sample and are expected not only to apply to life scientists, but to improve understanding of scientific mobility on the whole.

**FIGURE 15 MODIFIED FRAMEWORK FOR SCIENTIFIC FIELDS, BASED ON CILS RESEARCH**

As was also noted by Papademetriou et al. (ibid.), there is considerable overlap in concerns. The two levels of drivers were renamed from first order and second order to career drivers and quality of life and lifestyle drivers. This is to indicate that both levels are important in mobility decisions. In other words, the CiLS study brings about reason to question that it is the career drivers that most influence the choice of where to move abroad. The places that fare the best in the global competition for talent will need to combine as many of the elements found to be important as possible. They will also need to be sure their unique advantages within these categories are recognized.

\(^{36}\) These changes are made based on survey answers and qualitative analysis but have not been modeled and quantitatively tested.
The strongest influence among career drivers is then information and perceptions regarding the quality of science research and reputation of various institutions in one’s specific field, particularly universities and research institutes, as well as perceptions about places that have an appealing work culture and conditions. What an individual is looking for is subjective. Nonetheless, a few things that are mentioned are a lack of hierarchy, respect for scientists, and a hard-working attitude. The main changes that have been made to the career drivers include:

- The opportunity is assessed not only in terms of returns on human capital investments already made, but also the possibility for further skill development and career growth. The skills that are seen to be important range from science-specific skills, which often cannot be accessed on the same level in the home country, to ‘soft’ skills that increase one’s ability to work in international environments.
- Furthermore, the opportunity is defined to some degree by the offer, including but not limited to, salary or scholarship packages. The CiLS research confirms the findings of other research on scientific mobility -- while the salary should be sufficient, it is seen as less important than the factors that influence the quality of the work and research environment.
- Business and entrepreneurship opportunities can be influential in scientists’ location choices, but only for a small sub-group of scientists who have business-related aspirations. As shown earlier (see Chapter 5), most respondents in the CiLS survey aim for a research career. Although the competitiveness literature often purports the need to capitalize on findings to foster innovation and spin-off companies from university research are associated with the strength of biotechnology clusters, individual scientists do not necessarily hold the same value to entrepreneurship. Rather, they are focused more on research and publication, fitting the traditional model of the academic career.
- The main goal of scientific mobility, as shown both in other research and the CiLS analysis, is to be able to do high-quality research. In order to better reflect the concerns of life scientists, the category of capital infrastructure has been renamed “research and scientific excellence.” One of the most important elements of this new, broader category is a place’s reputation as a leader in the sciences, both in industry and academia. This means that it is not only the research and education quality that is assessed, but also the reputation of companies (in this study, particularly biotech and pharmaceuticals). The various elements within the capital infrastructure, such as the quality of research labs and education, are included as part of scientific excellence. The availability of research funding is also of high importance to research careers and quality in the life sciences.
- The presence of critical mass/talented professionals is undoubtedly important as well, but is closely coupled with the research excellence. One cannot exist without the other in the sciences. The CiLS research draws out another element that is important to scientists – the work ethic and work culture. Research is not conducted in the same way or with the same intensity in various countries.

The elements named as facilitators or second-order variables by Papademetriou et al were changed to quality of life and lifestyle drivers. The factors which Papademetriou et al.
call ‘facilitators’ are named spontaneously by a nearly equal number of respondents as those mentioning career drivers (see Table 22). Therefore, the term second-order variables may be misleading – they appear to work together in tandem, or figuratively as two sides of the same coin. Therefore, a modification to the framework was made, whereby the top row reflects career drivers and the bottom contains quality of life and lifestyle preferences. The importance of each will vary based on personal preferences, and life stage, including as related to family issues (spouse and children).

A caveat should be made in regards to interpreting which lifestyle and environmental factors are important for deciding where to move. Florida (2002, 2005) has focused on urban environments, as places where the ‘creative class’ gravitate. The lifestyle factors of importance that emerge are linked to both diversity in the population and the leisure activities available in cities. However, not all skilled migrants in demand are drawn to large cities. The factors provided by Papademetriou et al. (2009) generally reflect the opposite group, those who are interested in living in beautiful, clean, peaceful surroundings. Both ends of the spectrum are important, and different places will have their own unique values that make them attractive destinations for certain individuals.

Lifestyle, cultural and environmental aspects: Cultural factors were not part of the original framework, and those named in the CiLS study range from generally “liking the people there” to specific aspects related to the country’s history or heritage. Landscape is often mentioned, particularly as it has an effect on how one can spend their free time in the mountains or at the beach, for example.

Tolerant society should not be considered as just a facilitator as it was in the original framework, but instead as a primary driver. Living in a tolerant society appears to be a prerequisite for most global life scientists and is considered strongly along with career-related factors. It is also highly linked with the job opportunities that are afforded in an open atmosphere and whether or not the individual expects to have equal opportunities there. The aspect of safety was instead included in the lifestyle and environmental factors, as it seemed to be more linked to quality of life. However, this distinction is debatable and there is noticeable overlap.

The CiLS data suggested that a new category should be created, related to the ease of adjustment in the new location. The factors related to ease of adjustment were supported through the open-ended answers. This includes issues related to language. Past research often mentions the possibility of speaking English or their native language as a key driver of skilled migration location choice. While this is true, it may have been overstated in the past due to most of the skilled migration research having been conducted in English-speaking countries. Naturally, it is important that the individual does not have language barriers in their workplace. However, there are also many respondents who see time working abroad as a chance to build new language skills, whether in English or another language of interest. This is identified by Papademetriou et al. as well, but not necessarily frequently named in the skilled migration literature as a whole. In addition to language, a few other aspects help to aid in the ease of adjustment. These include liking the city/country where one will move to, having friends or family in the area, and having previous experience in that country, whether through travel, study, or work. Some
respondents also mention that the proximity to their home country is important, or for instance, wanting to stay within Europe.

Although Papademetriou et al. rightfully draw attention to policies that influence institutional differences between countries (middle layer of framework), further modifications and key points are suggested by the CiLS data and include:

- Recognizing interest in various durations of stay: Papademetriou et al. focus much of their discussion of immigration policies on possibilities to extend stays or become citizens. Yet, scientific mobility is often characterized by shorter-term moves. It is my perspective that having transparent and expedited visas for shorter stays, ranging from a few months to a few years, is very important, and may be enough to boost the attractiveness of the country if it is coupled with a strong scientific work environment. As will be discussed in the next chapter, most people intend to have stays for work or study lasting a maximum of a few years. Therefore, although not having clear paths to citizenship or longer stays may cause stress in a later stage, it will not likely influence their decision for life scientists on whether or not they move there initially, at least in the current phase of global mobility attitudes. On the other hand, if longer-term immigration paths are not available, it could affect the country’s image as being less ‘open’, which is an important driver of location choice and also an element discussed in the original framework. More research is needed on this topic and the relationships between immigration policies, perceived openness, and decisions to move and stay in any given country. Expedited visas for families to work are also important. It is important to keep in mind, as shown in the last chapter, that many life scientists have spouses with a different citizenship and also that there are many dual-life science career households. This means that visas that base decisions on citizenship can add extra complexity if there is not a more open visa giving spouses the right to work.

- A new box has been added related to the competitiveness of a destination and the policies that influence it. To better understand the global competition for talent, elements related to economic competitiveness and productivity should be seen as equally important as those related to immigration in skilled migration decision-making, particularly for knowledge-based sectors. The competitiveness is influenced by a myriad of policies, as listed in Part I.

**CONCLUSION**

In terms of preferred destinations for life scientists, the United States remains among the most popular destinations and can be seen as a ‘magnet’ country, attracting scientists based on its reputation for scientific research, but it has a very marginal lead. Additionally, the UK, Germany, and Switzerland are also seen as highly desirable locations, due to the size of the life science sector and quality of research and job opportunities there. It is important to realize many life scientists would consider moving to any of a range of different countries, provided the job, funding and/or research equipment available were good.

While the framework is useful to look at destinations for mobility, it should also be kept in mind that the interest in moving will vary by the individual, his or her current study
level or work status, and life stage. While the last chapter showed that most scientists express a desire to move, it is not universal. Furthermore, international mobility often is seen as most beneficial in a later stage, often as graduate or post-graduate research. There also can be various barriers to mobility. The main barriers in the CiLS study were linked to a lack of opportunities, including not having enough information or financial resources to access opportunities. One’s personal life also can have a strong influence for some individuals, particularly related to needing to care for family members, and whether or not moving abroad is interesting and seen as beneficial for one’s spouse or partner.

Finally, what is the role of structural differences in the individual’s decisions on where to move? It is my point of view that structural factors have the most impact on migration decision-making when personal experience is involved. This means that problems/advantages of places where one has already lived are likely to be the most influential, as push factors. Without experience, individuals have only partial information about structural factors at any given destination, and these will therefore have more influence on decisions only after moving to that place or having spent time there. In other words, it is the reputation, combined with specific opportunities given to that individual that most influences where scientists want to move, whereas the structural factors will have a greater influence on their satisfaction there and hence how long they want to stay.

The next chapter will address differences in competitiveness in various countries, and its impact on life scientists’ mobility decisions.
“The issue of ‘regional competitiveness’ is thus ripe with theoretical, empirical and policy debate. In an era of ‘performance indicators and rankings’, it is perhaps inevitable that regions and cities should be compared against each other in terms of their economic performance. Such comparisons can serve a useful purpose in that they point up the fact that, and call for explanations of why, regions and cities differ in economic prosperity. But, to adapt Krugman’s criticism of the idea of a national competitiveness, it is at best potentially misleading and at worst positively dangerous to view regions and cities as competing over market shares as if they are in some sort of global race in which there are only ‘winners’ and ‘losers’ [...] Crucially, it is important to distinguish between ‘competition’ and ‘competitiveness’.” (Kitson, Martin, & Tyler, 2004, p. 997)

‘Winners,’ ‘losers,’ ‘some sort of global race’ – These phrases used for discussing global economic context or competitiveness, as well as more recently for immigration in the global ‘race’ or ‘competition’ for talent. National competitiveness, framed within a changing and advancing global context, seems to have become the keyword for a wide range of policy decisions. Economic competitiveness, in global context, is also often the driving force for new adoption of skilled migration policies, where they were not there previously. It also applies to policies for internationalization of the sciences and universities. And, it is also the keyword used for supporting the knowledge economy and scientific research as a whole. Yet, competitiveness is often intangible, prone to lots of different definitions, assessments, and changing across time. Furthermore, while migration research has long assumed individuals seek out moves to the most competitive places, which are historically often seen in terms of higher wages, personal motivations may defy this assumption. Even for highly skilled individuals, international mobility is not motivated only by wages, and studying life scientists, illuminates this further.

As discussed in Chapter 1, there has been much debate within the academic literature and no consensus on whether or not countries can ‘compete,’ although there is recognition that there can be a competition for resources, including skilled individuals. Following from the analysis in the previous chapters, there are two critiques of the “obsession with competitiveness” that are applicable to also understanding whether the concept of competitiveness can also apply to immigration destinations:

1. Many commonly cited tools create a competitiveness index, which gives the impression that a strict rank order of countries is possible. While these indexes are useful, and in some cases there may be a clear ‘leader’ in a given measure, more attention needs to be placed on the contextual features that are not captured by the index. There are clearly shortcomings in having comparable, international data, for every measure that matters. Even if the data was perfect, determining the ‘winners’ and ‘losers’ in this context ignores the constant dynamism of competitiveness. The exit of a single, large company can have a dramatic impact on a city’s economic standing – just one company, one decision. In the same way, changing policies also can change industry or workforce dynamics.

2. Often, discussion intermingles and hence confuses the distinction between competition and competitiveness. A competition seems to imply that a concrete
event where there are identifiable ‘winners’ and ‘losers’. Competitiveness, on the other hand, is more of a way to measure of the most important aspects that drive performance relative to others.

Both of these critiques are highly relevant to advancing understanding of the global competition for talent and will be expanded upon through the data shown in this chapter.

The brain drain versus brain gain paradigm is perhaps one of the best examples of how the concepts of competition leading to countries ‘winning’ or ‘losing’ has been applied in immigration discussions. For instance, Gaillard and Gaillard (1998) debate the idea that it can be determined which countries ‘win’ and ‘lose’ in their scientific workforce when individuals move abroad. These authors argue that former ‘losers’ can move to ‘winners’ if and when living standards rise and viable scientific work opportunities exist. International moves then may be a way to form international networks, rather than a move indicating loss (p.106). Cañibano and Woolley (2015, p. 115) argue that debate on brain drain is intertwined with discussion on human capital, as these theories both developed in the 1960s. These authors argue that the lack of conceptual distinction has led to brain drain being applied in cases a problematic way. They review the development of literature on brain drain and conclude with a focus on the role of knowledge networks.

The study up to this point has argued for the importance of the concept of competitiveness to skilled migration, both which need to be considered in light of changing global context. Chapter 4 showed that competitiveness is often a key concern and argument used by governments when implementing new skilled migration or mobility policies. The last chapter highlighted one way in which competitiveness is useful to migration studies in particular. Competitiveness can frame the overall context for migration decisions when multiple countries, or cities, are being considered by a potential migrant. In other words, individuals may assess where the ‘top’ destinations either in one’s field, for quality of life, for having opportunities in general, or any other factor and combinations thereof determined as most important to that individual. Scientists are driven more by being able to conduct high quality research, and wages are usually less important. Table 21 showed that the CiLS respondents consider a number of countries to be first choice destinations for life science work, with the US, Germany, UK and Switzerland as the top choices.

The goal of this chapter is to further expand the discussion on competitiveness and immigration through insights from scientists participating in the CiLS research. The chapters up to this point in Part II have shown some of the dynamics of life science careers and scientific mobility, this chapter aims to bring these two aspects together and briefly examine variations in situations in different countries.

First, it analyzes:

- **Which cities and countries are seen as the most competitive for biotechnology globally?**

The first section begins by highlighting the main reports and indexes on competitiveness in the life sciences and biotechnology in various countries. This allows a brief snapshot to be given of how biotechnology competitiveness in international or global context has
been assessed by others. The goal is not to give a full analysis of competitiveness in biotech, but to introduce a few ideas better frame discussions on how competitiveness.

Following the statistical overview of biotechnology competitiveness, is analysis of CiLS data. First, is analysis of an open-end question where respondents name cities and countries that are competitive in biotechnology. This data looks at the cities and countries that are recognized as leaders in biotechnology by the CiLS respondents, to add additional context about which countries are seen as leaders and whether or not clusters play a central role in this recognition.

Second, assessments of the availability of opportunities in the life sciences are provided. This section will give a comparison of opportunities in the life sciences across various countries based on ratings for CiLS statements regarding opportunities where the individual comes from and in where they live now. This can be considered an additional measure of competitiveness. An assumption is often made that individuals are moving away from a lack of opportunities to go to highly competitive destinations in their field. As the CiLS study was designed and analyzed to focus primarily on cities and countries, this will be the main level of competitiveness discussed. Although it is essential to understand that competitiveness is dynamic, this study only assesses it at one given point in time. This means that the results may not be projectable to the current day. This is not the goal in this analysis. Instead, it aims to point out common career concerns as well as structural differences that influence impressions of competitiveness, and later point to its influence on migration, as seen through the viewpoint of life scientists.

The next section then looks at how individuals in various countries view international mobility, keeping in mind the paradigms of brain drain, brain gain and brain circulation. It examines the research questions:

- **Which duration of stay is most desired for moves for life science jobs in the US and in Europe?**
- **What effect do life scientists expect international mobility to have, in terms of staying abroad versus returning to their home country of work?**

This section will compare results among various countries. A general trend is found that most respondents expect international mobility to improve job opportunities in their home country and this often applies to both developing and developed countries. It first provides quotes that add context to better understand similarities across countries and regions. It then turns to briefly addressing structural differences among specific regions or countries, namely Italy and Central and Eastern Europe, which are seen as outliers in the data in that they show risk of brain drain. This section argues that the competitiveness of countries alone is not enough to understand the retention of life scientists, but that the opportunity structure, which is in part due to cultural norms and practices, including work culture, has a large influence.

This chapter argues that generally the dynamics of scientific mobility within the global competition for talent are more complex than that which can be defined as a relative gain or loss the country being studied. While movements from or between certain countries may be more prone to brain drain or brain gain, it is reflective of the broader opportunity
structure, and improving the institutional context should be the goal, rather than blaming
the individual who seeks work elsewhere.

LIFE SCIENCE AND BIOTECHNOLOGY COMPETITIVENESS

Benchmarks for biotechnology competitiveness

Similar to the discussions on difficulties in measuring national and regional
competitiveness, measuring the competitiveness of a certain field or industry, such as
biotechnology, is no easy task. There are a few main areas that drive biotechnology
competitiveness. Yet, given the high interest in biotechnology, government initiatives for
scorecards have been made, but notably many of these have been a one-time only
publication. One initiative that is important to note is the European Commission (2003)
Biotechnology Innovation Scoreboard. This study has not been updated since then,
although the EU now issues a scoreboard on innovation across all sectors. There are
questions as to the value of biotech scoreboards:

It is ‘almost impossible’ to rank individual countries, according to Bénédicte
Callan, administrator at the biotechnology unit of the Organization for Economic
Cooperation and Development (Paris, France). ‘The conclusions that can be
drawn from [a biotechnology competitiveness report] can only paint a very broad
brushstroke picture,’ she says. Also, focusing on indicators from individual
countries has limited value because innovation performance may depend on
international factors, too. ‘This industry draws on international expertise and
serves international markets,’ she adds. (Louët, 2003)

Canada also created a global biotech scoreboard (Santerre, 2006), but it also is no longer
being updated. A private initiative to annually rank countries for biotechnology
performance exists, the Scientific American’s WorldView.

Despite the missing information, the ‘brushstroke picture’ presented by biotechnology
competitiveness reports does suggest some sort of benchmark, at least to which countries
are active in biotechnology. In this regard, the reports are useful for framing the analysis
in the CiLS study. However, it should also be kept in mind that the life sciences and
particularly biotechnology are highly dynamic fields, and the competitive landscape is
hence ever-changing.

Despite the difficulties in measuring the nuances, almost every study finds that the US is
the most competitive country globally in biotechnology, given its long research history in
the field, including the high number of firms and the success of these companies, the
level of R&D investments and revenues, and high-quality universities. When comparing
total number of biotech firms in US versus the EU as a whole, the numbers of companies
are similar but the structural aspects related to its financing differ greatly, as well as to
the rates of success of turning research into marketable products. The companies in
Europe also tend to newer, with most of the biotech companies recognized as ‘elite’ in
the Critical I study in 2004, being founded in the late 1990s or early 2000s. One area
where EU’s numbers are better than in the US is in the number of science of doctoral
graduates (European Commission, 2004, pp. 68-72; Reiss et al., 2005, p. 57). However,
the EU has questioned whether their training can be capitalized on in Europe, that is whether it leads to job growth in the field of study (Hollanders & Es-Sadki, 2014). In other words, the EU is strong in life science research, but it is pooled more towards academic research, rather than applied for commercialization and biotech products in companies.

Policies to support biotechnology vary by country, and it has been difficult to find a link between policy and biotech competitiveness. The BioPolis study (Enzing et al., 2007) aimed to look at the policy routes taken between 2002-2005 and how it impacts biotech innovation performance in all countries of the European Union, as well as Switzerland and Norway. Although their analysis was very thorough and this study highlights many important comparisons in biotechnology policy and performance, the European Commission (2007a, p. 23) reports:

The BioPolis study has attempted to find a link between how Member States organise funding system and their performance, but there is no clear link, mainly because becoming successful in biotechnology depends on a combination of favourable measures. This includes creating a solid knowledge base, transferring knowledge between academia and business, encouraging innovation and product development, providing adequate access to finance, and coordinating activities at national and regional levels. One single measure is simply not enough to succeed.

What can be said about the performance of European regions, or clusters, for biotechnology? As noted in the first chapter, Porter (1990) has claimed that clusters are one of the competitive drivers of an innovative sector’s competitiveness. A report from the European Commission found:

In the USA, biotechnology is characterised by a high degree of concentration of firms in a restricted number of regions, where the beneficial effects of company clusters reinforce both cooperation and competition. A similar process of clustering has taken place across Europe, with examples such as the BioTech-Region München and the Medicon Valley between Sweden and Denmark. In comparison with the US company structure, Europe has a lack of critical mass, not only at the individual company level but also at the cluster level. The majority of European biotechnology clusters do not seem big enough to compete effectively with those in the US. (European Commission, 2007a, p. 25)

A few of the measures listed are shown below, which were felt to show some aspect linked to the workforce dimensions of competitiveness. The figures and tables are selected to show the status as a leader in biotechnology or the life sciences (depending on the data available) as defined on different scales and for different measures – national R&D, regional clusters, company performance, and institution’s publications. The tables and figures shown only partially portray life science and biotechnology competitiveness across the world and fully assessing its competitiveness is made of a multitude of measures (see Appendix D).

Figure 16 shows OECD data for R&D investments in the business sector compared to the public sector. In brief, this measure shows why it is difficult to determine rankings in biotechnology, other than that of the leading country. The US has a substantial lead in the
amount of business investment in R&D. Switzerland specializes in biotechnology as a top R&D sector, with it receiving more than 25% of total R&D, and specialization can also drive competitiveness. Germany has very high public R&D spends focused on biotechnology. While biotechnology R&D is present around the world, levels between many countries are often similar, although this cannot be equated with equal biotech competitiveness.

Table 23 first shows the *WorldView* innovation index score country rankings (top 10). What becomes clear is that most of the leading countries have a similar composite performance. Hence, understanding biotechnology competitiveness will involve better understanding the nuances of the industry, the differences in specialization, the variations in the opportunity structure, to name a few. The next columns show where regional strengths in biotech may be found. The competitiveness literature argues that clusters are crucial in driving innovation. Again, the majority of the top clusters are found in the US. Yet, it shows that regional specialty has emerged, with some small countries, such as Denmark and the Netherlands, having regions that are among the top globally for patents in biotechnology and nanotechnology. China also receives mention as having a top region, Beijing. The third column shows where biotechnology clusters are found in the US. It indicates that they are spread across the East and West coasts of the United States, and the list bears similarity to that reported by the OECD. The final column helps put the size of the European biotech industry in perspective. Critical I conducted a study of the strength of biotechnology in Europe. One of their measures was to look at the number of elite companies in various countries, which were defined as those which “outperform an appropriate benchmark by 100%. And the appropriate benchmark we have chosen is the Typical US company” (Critical I, 2006, p. 17). This method was adopted noting that while the European biotech sector is commonly said to be less competitive than that in the US, “the sector is not the competitive unit in biotechnology: the company is” (p.17). Their findings indicate that the number of European elite biotech companies is generally small and most of these companies had been founded in the past ten years or less, pointing to the dynamism of the biotech industry.

Table 24 looks at Scimago’s life science rankings through a different metric, that of the number of publications by various institutions, including academic, governmental agencies, and companies. The numbers shown in this table are for the number of publications, not their impact scores (which is also part of their rating), as well as the percent of publications that involve international collaboration. Interestingly, by the amount of output alone, Russia, China and Brazil all appear in the top 30. These are all large countries, but it also is a reflection of their research activity and that this research happens globally. Within the European Union, Germany, France, and Spain have institutions listed as top life science publishers. The amount of papers that involve international collaboration among these top institutes range from around 20% the Veteran’s Affair Medical Centers in the US to nearly 60% of that published by Max Planck in Germany between 2004-2008. What needs to be highlighted is that regardless of the country that the top institutions are in, at least 20% of the published life science work was found to involve international collaboration.
FIGURE 16 BIOTECHNOLOGY R&D EXPENDITURES IN THE BUSINESS SECTOR (TOP) COMPARED TO PUBLIC AND UNIVERSITY R&D EXPENDITURES (BOTTOM), 2012 OR LATEST AVAILABLE YEAR

Source: OECD, Key Biotech Indicators, 2014
<table>
<thead>
<tr>
<th>Rankings of Countries –</th>
<th>Global – Top Clusters</th>
<th>US- Top Clusters</th>
<th>European Elite Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotech Innovation, 2009, top 10 countries, index scores</td>
<td>OECD Sci and tech Scoreboard 2013: Top regions for patenting in biotechnology and nanotechnology*, share of country’s patents</td>
<td>Top 10 Biotech Regions in US, 2004, Composite Scores</td>
<td># of Elite biotech companies in Europe at end of 2004, # of companies/ range of yrs founded</td>
</tr>
<tr>
<td>US 3.8</td>
<td>Maryland (USA) 3.5</td>
<td>San Diego, CA 100</td>
<td>UK – 9/ 1991-2003</td>
</tr>
<tr>
<td>Singapore 3.5</td>
<td>Massachusetts (USA) 2.0</td>
<td>Boston, MA 95.1</td>
<td>Germany – 6/ 1997-2002</td>
</tr>
<tr>
<td>Denmark 3.2</td>
<td>Beijing (CHN) 1.9</td>
<td>Raleigh-Durham-Chapel Hill, NC 92.5</td>
<td>Switzerland – 5/ 1995-2002</td>
</tr>
<tr>
<td>Israel 3.1</td>
<td>West-Nederland (NLD) 1.6</td>
<td>San Jose, CA 87.8</td>
<td>France – 4/ 1995-2002</td>
</tr>
<tr>
<td>Sweden 3.1</td>
<td>Hovedstaden (DNK) 1.6</td>
<td>Seattle-Bellevue-Everett, WA 83.8</td>
<td>Austria – 3/ 1997-2003</td>
</tr>
<tr>
<td>Australia 3.0</td>
<td>Northern-Kanto, Koshin (JPN) 1.5</td>
<td>Washington, DC 79.4</td>
<td>Belgium – 2/ 2000-2001</td>
</tr>
<tr>
<td>Finland 3.0</td>
<td>North Carolina (USA) 1.2</td>
<td>Philadelphia, PA 76.5</td>
<td>NL – 2/ 2000</td>
</tr>
<tr>
<td>Iceland 3.0</td>
<td>Pennsylvania (USA) 1.2</td>
<td>San Francisco, CA 75.8</td>
<td>Sweden 1/ 1997</td>
</tr>
<tr>
<td>New Zealand 3.0</td>
<td>New York (USA) 1.1</td>
<td>Oakland, CA 74.3</td>
<td>Denmark 1/ 2001</td>
</tr>
<tr>
<td>Switzerland 3.0</td>
<td>California (USA) 1.0</td>
<td>Los Angeles- Long Beach, CA 66.5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>Publication Output</th>
<th>Internat’l Collaboration %</th>
<th>Country, Type of institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Centre National de la Recherche Scientifique</td>
<td>30,057</td>
<td>49.51</td>
<td>France, Govt. Agency</td>
</tr>
<tr>
<td>2 National Institutes of Health</td>
<td>27,845</td>
<td>37.20</td>
<td>USA, Health System</td>
</tr>
<tr>
<td>3 Chinese Academy of Sciences</td>
<td>22,769</td>
<td>26.29</td>
<td>China, Govt. Agency</td>
</tr>
<tr>
<td>4 Harvard University</td>
<td>21,500</td>
<td>36.69</td>
<td>USA, University</td>
</tr>
<tr>
<td>5 United States Department of Agriculture</td>
<td>20,668</td>
<td>22.90</td>
<td>USA, Govt. Agency</td>
</tr>
<tr>
<td>6 Russian Academy of Sciences</td>
<td>15,330</td>
<td>33.82</td>
<td>Russia, Govt. Agency</td>
</tr>
<tr>
<td>7 Consejo Superior de Investigaciones Científicas</td>
<td>14,839</td>
<td>42.17</td>
<td>Spain, Govt. Agency</td>
</tr>
<tr>
<td>8 University of Tokyo</td>
<td>12,957</td>
<td>25.84</td>
<td>Japan, University</td>
</tr>
<tr>
<td>9 Institut National de la Sante et de la Recherche Medicale</td>
<td>12,341</td>
<td>42.96</td>
<td>France, Health System</td>
</tr>
<tr>
<td>10 Max Planck Gesellschaft</td>
<td>12,173</td>
<td>59.31</td>
<td>Germany, Govt. Agency</td>
</tr>
<tr>
<td>11 Johns Hopkins University</td>
<td>12,069</td>
<td>31.64</td>
<td>USA, University</td>
</tr>
<tr>
<td>12 University of Toronto</td>
<td>11,791</td>
<td>44.72</td>
<td>Canada, University</td>
</tr>
<tr>
<td>13 University of Washington</td>
<td>11,730</td>
<td>29.19</td>
<td>USA, University</td>
</tr>
<tr>
<td>14 Universidade de Sao Paulo</td>
<td>11,417</td>
<td>26.41</td>
<td>Brazil, University</td>
</tr>
<tr>
<td>15 University College London</td>
<td>11,210</td>
<td>47.64</td>
<td>UK, University</td>
</tr>
<tr>
<td>16 University of Pennsylvania</td>
<td>10,503</td>
<td>26.91</td>
<td>USA, University</td>
</tr>
<tr>
<td>17 University of California, Davis</td>
<td>10,245</td>
<td>32.31</td>
<td>USA, University</td>
</tr>
<tr>
<td>18 Kyoto University</td>
<td>10,182</td>
<td>25.60</td>
<td>Japan, University</td>
</tr>
<tr>
<td>19 University of California, San Francisco</td>
<td>10,166</td>
<td>31.23</td>
<td>USA, University</td>
</tr>
<tr>
<td>20 University of California, Los Angeles</td>
<td>9,757</td>
<td>30.50</td>
<td>USA, University</td>
</tr>
<tr>
<td>21 University of California, San Diego</td>
<td>9,666</td>
<td>34.03</td>
<td>USA, University</td>
</tr>
<tr>
<td>22 University of Oxford</td>
<td>9,526</td>
<td>55.31</td>
<td>UK, University</td>
</tr>
<tr>
<td>23 University of Florida</td>
<td>9,507</td>
<td>27.18</td>
<td>USA, University</td>
</tr>
<tr>
<td>24 Veterans Affairs Medical Centers</td>
<td>9,385</td>
<td>19.57</td>
<td>USA, Health System</td>
</tr>
<tr>
<td>25 University of Minnesota, Twin Cities</td>
<td>9,157</td>
<td>25.89</td>
<td>USA, University</td>
</tr>
<tr>
<td>26 Cornell University</td>
<td>9,051</td>
<td>32.64</td>
<td>USA, University</td>
</tr>
<tr>
<td>27 Stanford University</td>
<td>8,860</td>
<td>31.49</td>
<td>USA, University</td>
</tr>
<tr>
<td>28 Yale University</td>
<td>8,844</td>
<td>31.84</td>
<td>USA, University</td>
</tr>
<tr>
<td>29 University of Wisconsin, Madison</td>
<td>8,844</td>
<td>25.25</td>
<td>USA, University</td>
</tr>
<tr>
<td>30 University of Michigan, Ann Arbor</td>
<td>8,690</td>
<td>25.16</td>
<td>USA, University</td>
</tr>
</tbody>
</table>

Source: ScImago SIR World Report – Life Sciences (2010) *Life Sciences includes: Agricultural and Biological Science; Biochemistry, Genetics, and Molecular Biology; Immunology and Microbiology; Neuroscience; Pharmacology, Toxicology, and Pharmaceutics
Competitive biotech countries and regions in the CiLS research

As also discussed in chapter 1, competitiveness in this project has been defined as “status as a leader,” particularly in the life sciences and biotechnology. In order to see which markets are viewed as competitive by the life scientists answering the CiLS survey, two open-ended questions where the respondents name cities, regions and countries that they think have “an especially strong life science and biotechnology industry.”

Table 25 shows the results of the places perceived as most competitive in the life sciences and biotechnology by the CiLS respondents. The country seen as the strongest in biotechnology is the US, named by 76%, or the majority, of respondents. Germany (mentioned by 55% of respondents) and the UK (41%) are also seen as top places for biotechnology. Switzerland was named as being strong in the life sciences and biotechnology by one-third of respondents. France, Sweden, Japan, the Netherlands and Canada are also recognized as competitive, but are named to a much lower extent than the top four, each being named by 10-15% of the respondents. These countries did not have high numbers of respondents in the CiLS data and hence may be even higher rated if that was controlled for.

Even though the first of these competitiveness questions asked individuals to name cities or regions that are competitive in the life sciences and biotechnology, many named countries instead. This may be an indicator that there is low awareness about many biotech clusters, or biotechnology on the regional level, but instead only understanding of which countries are active in biotechnology research.

Around 25 regions or cities globally were recognized as strong biotech clusters by at least 10 (around 2%) of respondents. A few countries had multiple regions recognized – notably, the US, Germany and Switzerland are strong in this regard, and to a lesser degree, the UK and France. The highest recognized regions were in the US (California and the area around Boston, Massachusetts), UK (London), Switzerland (Basel), and Germany (Munich) as the only regions named by at least 10% of respondents.

Other countries that be said to have recognizable clusters are France (Paris was mentioned by 9%) and Singapore (mentioned by 7%), notable given it is outside of the region where most CiLS respondents live, and the mentions for Singapore were found in a large geographic range, including developing countries, India, Spain, and Switzerland.

A few methodological points should be pointed out. First of all, it should be noted that the numbers in the table are counts, not subtotals. For example, if someone listed Boston, but did not specifically mention the US, they are only counted in the line for Boston. Originally, there were plans to combine the results of questions on cities and countries to

37 There is no consensus on how to define a biotech cluster, whether it is a larger region, several nearby cities, or just a single city. For example, should California be counted as a single cluster, even though it is larger than some countries in Europe? In some cases, biotech clusters are found across national borders as well, such as the BioValley, which is in Switzerland, France, and Germany. Also, some countries focus more on individual cities as clusters, whereas others group them. For instance, London-Cambridge-Oxford is often considered as a single cluster. Twenty-five is therefore an approximated number.
get a total count for each country. However, given that Cambridge is a strong biotech city both in the US, the location of top schools such as MIT, and in the UK (where area around Cambridge University is another top cluster), the corresponding country could not always be determined. A similar problem with language was found when “Washington,” as both Washington DC and Washington state are top biotech regions in the US, but are located on opposite coasts, and hence these two regions are now counted together, given total mentions for either was low.

A second caution needs to be made based on uneven numbers of respondents from various countries. It was expected that proximity would have an influence on the recognition of various clusters, or cities, that are strong in the life sciences, meaning that life scientists would be most aware of scientific opportunities in their field which are nearby. Places that are further away and are still recognized as strong in biotech are likely to be top global biotech clusters or internationally-recognized ‘hubs’ for life science research, which was the case for the highest named clusters which received responses from diverse locations globally.

A key finding of the CiLS study is that generally the life scientists did not have high awareness of regions that were strong in biotechnology. This may draw questions as to how important clusters currently are for biotechnology, since most people name countries that are seen as competitive. Some individuals named specific companies, universities or research institutes. The survey did not ask respondents about the leaders on the institutional level, but it is conceivable that scientists may be more aware of this scale than the regions, as applications for study and jobs are done on the company or university level.

There is also a discrepancy in the biotech competitiveness indexes and in the countries named by CiLS respondents, in particular in that Germany is said to be more competitive in the CiLS study than in the usual indexes. Yet, when looking at the data by country of citizenship, it is clear that Germany is recognized globally, not just by individuals already living nearby. My own assessment is that this Germany has a higher reputation in the life sciences, as compared to many other fields. Furthermore, Germany has been active in international collaborations and has built a positive impression globally of German research and researchers. Germany also has had an active policy to support the development of biotech regions, industry, and research (see Box 3).
<table>
<thead>
<tr>
<th>Country</th>
<th>Cities/Regions</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>Boston</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>California</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>San Francisco</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>New York/New York City</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>San Diego</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Massachusetts</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>315</td>
</tr>
<tr>
<td></td>
<td>Munich</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Heidelberg</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Berlin</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Frankfurt</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Dresden</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>United Kingdom</td>
<td>234</td>
</tr>
<tr>
<td></td>
<td>London</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>England</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Oxford</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Switzerland</td>
<td>198</td>
</tr>
<tr>
<td></td>
<td>Basel</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Zurich</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>France</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Paris</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>Strasbourg</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Sweden</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>The Netherlands</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Canada</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Singapore</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Cambridge (not clear if in Boston area/US or Oxford-London-Cambridge in UK)</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Spain</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Australia</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Denmark</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Canada</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Montreal</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Singapore</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Cambridge</td>
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</tr>
<tr>
<td></td>
<td>Spain</td>
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</tr>
<tr>
<td></td>
<td>Barcelona</td>
<td>36</td>
</tr>
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</tr>
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<td></td>
<td>Melbourne</td>
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</tr>
<tr>
<td></td>
<td>Copenhagen</td>
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<tr>
<td></td>
<td>India</td>
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</tr>
<tr>
<td></td>
<td>Trivandrum</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Bangalore</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Hyderabad</td>
<td>6</td>
</tr>
</tbody>
</table>

TABLE 25 COMPETITIVENESS IN CILS SURVEY: STRONG CITIES OR REGIONS (Q117)/COUNTRIES (Q118) IN THE LIFE SCIENCES AND BIOTECHNOLOGY INDUSTRY
As was shown in the last chapter, the US had the most mentions as the first choice destination for life science work, but only marginally, named by 18% of the sample, compared with 16% for Germany. Looking at the total mentions for destinations considered is also another way to assess which countries are seen as leaders, as shown in Table 26. Three countries were named by over 50% of CiLS respondents – The US, UK, and Germany. Switzerland was mentioned by around 36%. The patterns of destinations for work reflect similar trends to what is seen in the chart on competitiveness. This is further evidence that the perceived competitiveness of countries does make a difference in migration location decisions of life scientists.

### TABLE 26 COUNTRY OF CHOICE FOR FUTURE WORK BY CITIZENSHIP

<table>
<thead>
<tr>
<th>Citizenship</th>
<th>WB Developing, not in EU</th>
<th>India</th>
<th>China</th>
<th>EU-10</th>
<th>France</th>
<th>Germany</th>
<th>Italy</th>
<th>Poland</th>
<th>Spain</th>
<th>Switzerland</th>
<th>United Kingdom</th>
<th>United States</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country of choice:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
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<td>28</td>
<td>3</td>
<td>8</td>
<td>27</td>
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<tr>
<td>United Kingdom</td>
<td>63</td>
<td>54</td>
<td>5</td>
<td>10</td>
<td>8</td>
<td>31</td>
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<td>19</td>
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<td>8</td>
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### BOX 3 COMPETITIONS TO BUILD COMPETITIVE BIOTECH REGIONS IN GERMANY

In 1996, an innovation competition sponsored by the German government, the BioRegio contest, allotted 25.5 million Euros (per region) for innovative regions that could present the best plan for attracting biotechnology companies and start-ups.

Germany has since had the fastest growth in the biotechnology sector within Europe and by some counts (ways of classifying and counting biotech companies can vary), has the highest number of biotech companies in Europe (Mergent, 2004, p. 7). However, the newness of the industry and its growth also means growth may not always be sustainable. An article in *Nature Biotechnology* (Hodgson, 2006, p. 272) named the BioRegio contest
as one of biotechnology’s top ten ‘gaffes,’ as Germany experienced rapid biotech growth and then a rapid fall around 2001 in number of companies and funding available:

“The take-home message is that it is easy to dispense free money to scientific enterprises but creating sustainable businesses around a core technical idea requires investor persistence and careful management, preferably by people who have some relevant experience [...] many other European nations are now making the same mistakes.”

Yet, is this criticism fair, or was it a too quick judgment? In the CiLS research, it was found that Germany has built an image as being both strong in biotech and as an attractive location for biotech researchers, both in retaining its nationals and attracting researchers from around the globe.

Despite this criticism, Germany continued to adopt a similar approach in the next decades. In May 2007, the German Federal Ministry of Education and Research (BMBF) announced five new winning regions in the BioIndustry 2021 competition. The German government has reported that 60 million Euros has been allocated to the full BioIndustry 2021 program over the next 5 years to help build Germany’s presences in the field of industrial (or ‘white’) biotechnology. Five clusters were selected in Hamburg, Dusseldorf, Stuttgart, Frankfurt and Munich. As this list reflects, the German regions specializing in biotech are spread throughout the country.

It is important to note that German biotech policy has not focused on building companies alone. One strength of the German system has also been support of strong research institutions, for example the Fraunhofer institutes.

“Germany’s Fraunhofer Gesellschaft is a network of institutes that offer some of the world’s most successful applied-research programs. Fraunhofer employs 4,000 Ph.D. and master’s students and has a $2.2 billion annual budget. It essentially is a contract research organization, but Germany’s federal government supplies a third of its budget.”


Several of the Fraunhofer institutes specialize in biotechnology. Furthermore, these institutes are found in multiple cities in Germany – for example, the Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB) is in Stuttgart (in the state of Baden-Württemberg), but other institutes with more specialized foci are found in Straubing (Bavaria), Würzburg (Bavaria) and Leuna (Saxony-Anhalt, former East Germany). A Fraunhofer Institute of molecular biotechnology was recently started in Delaware in the United States (Wessner & Wolff, 2012, p. 293), again showing the importance of international collaboration for advancing life science research.

Perceptions of availability of life science job opportunities in home countries and regions of residence: Results from CiLS study

The rest of this section takes up part of this topic in an exploratory manner, whereby the ‘status as a leader’ is assessed by looking at life scientists’ perceptions of job availability.

38https://www.biotechnologie.de/BIO/Navigation/EN/Funding/foerderbeispiele,did=71310.html?view=renderPrint
opportunities in one’s home country and region of residence. This is assessed through agreement with two statements:

- There are **not** many interesting life science jobs in the country I come from, analyzed by country of citizenship (Scale: 5 = strongly agree; 4=agree; 3= neither agree nor disagree, 2=slightly disagree, 1 = completely disagree). The data for this statement is shown in its inverse, to so that the high numbers represent places that are seen as having good opportunities.

- I am currently living in a region where there are many great opportunities for life scientists” analyzed by country currently live in (regardless of citizenship) (same scale as above).

The data is shown in Figure 17. Germany, Switzerland, the UK and the US all are seen as offering good opportunities. Particularly the US and Switzerland are rated very highly both by the CiLS respondents currently living in regions in that country and by its citizens. Germany and the UK are rated similarly, with a mean score between 3.5 and 4 for the two statements. This information on the leaders is in line with the perceptions shown regarding life science competitiveness in the last section.

**FIGURE 17 PERCEPTIONS OF LIFE SCIENCE OPPORTUNITIES IN VARIOUS COUNTRIES**

Caution: Low base size for some countries. Data should be interpreted as providing a rough indication of the leaders in biotech only.

France, India, and Spain are seen to offer a medium number of opportunities. These are economies that do not have the advantage of being a leader, but are either emerging and improving their position in biotech (likely the case for Spain, which has improved its position in biotechnology considerably in the past years, and India) or are said to have moderate biotech competitiveness (France).
Chinese respondents give a mixed impression of the level of opportunities available in China. The ratings for having opportunities “in the country I come from” are high, while impressions of the amount of jobs around the respondents who live in China now, are low. This could be related to migrants having higher expectations of opportunities on return than what actually exist, or it could reflect regional disparities in biotech development in China. Further research, and larger sample sizes would be needed.

Italy, Pakistan, and Poland are all considered by their citizens and residents as having fewer opportunities for life science employment. Italy, in particular, will be examined in more detail in the rest of this chapter to add further context to understand better the careers and mobility decisions of Italian life scientists.

EFFECT OF MOVING ABROAD ON A CAREER IN LIFE SCIENCES -- ASSESSING THE BRAIN DRAIN, BRAIN GAIN, BRAIN CIRCULATION PARADIGMS

Beyond competitiveness – The influence of the opportunity structure in life science employment

The CiLS research has shown patterns and reasons for increases in scientific mobility as the internationalization of life science research deepens. This argument supports framing scientific moves from perspective of scientific mobility, in that it must be acknowledged that international mobility is often part of the career structure and are not necessarily permanent moves of ‘brain gain’ versus ‘brain drain.’ Furthermore, scientists who move abroad may still collaborate and conduct research internationally, including with their home country. However, there are exceptions and brain drain is still a risk particularly when there are other strong, structural problems that affect employment possibilities, whether cultural hiring issues or larger structural concerns, like an absence of research jobs in one’s chosen specialization. While number of job opportunities is linked to the competitiveness of the life science sector, hiring practices and criteria are more reflective of the broader opportunity structure for the life sciences.

Sociological analysis has long pointed to differences in the opportunity structure as influencing outcomes. While the term, opportunity structure, is used in a wide range of contexts, it generally denotes “differential access to opportunities” (Merton, 1994, p. 7), which can be related to any number of goals, but initial ones typically used were economic success and/or social mobility (p.30). These differing outcomes must also be linked to the “structural context” “or structural constraint” (p.17). They also are influenced by social capital (p. 21). While Merton was looking primarily at the opportunity structure as a concept to understand deviant behavior, the same term has been applied widely to look at career outcomes (Roberts, 2009). The opportunity structure is a useful concept for study of career-related topics in an internationally comparative context, but it must be done with caution as to what aspects of the opportunity structure are most influential.

The opportunity structure also needs to be coupled with understanding of the individuals as actors, also defined as agency, as explained in the mixed embeddedness approach (Kloosterman, 2010; Kloosterman & Rath, 2001; Kloosterman, van der Leun, & Rath, 1999). Although the mixed embeddedness approach was designed to better examine immigrant entrepreneurship, it is applicable to assessing any other economic activity across varying national or local contexts. This means that meaningful, comparative
assessments must not see either individual characteristics or structure as deterministic, but rather take into account how structure and agency can interplay.

Desired length of stay in US vs EU

“Each year, more than 70% of Europeans who study in the US opt to stay on to pursue their careers. Many of the scientific elite prefer to pursue their careers in an environment that has more to offer their talent and ingenuity. Consequently, about 40% of scientists working in the US today are Europeans.” (Mergent, 2004, p. 11)

As already pointed out in previous chapters, there is generally an assumption the US is the top choice for scientists globally to come for studies, work, and to stay long-term, while research in the US often claims the country is losing its lead in attracting ‘talent.’ The CiLS data shown so far indicates that it is viewed as the most competitive country for biotechnology and is also among the most desired locations for future work in the life sciences (see Chapter 7). Does this competitiveness then translate into a desire for scientist in other countries to work in the US permanently? Many studies make the assumption that this would be the case, but the CiLS research aimed to address it more directly.

Questions were asked in the CiLS survey to better understand how long life scientists would like to work abroad. The CiLS survey first asked a question to sort their interest into groups:

- Are you interested in moving (whether short-term or long-term) to another country in the future for (check all that apply): Working in another country; studying abroad/ in another country; None of these
- Now please think about where you are willing to move. Would you consider moving for work: In the United States; In Europe; Both in the United States and Europe; None

As shown in Table 27, the US is rarely the only destination considered. In looking at the proportion of people who are still interested in working abroad, the highest percentage, regardless of the country of citizenship, is for both the US and Europe. Additionally, the number of people interested in just working in Europe (not in the US) is higher for every country/country group of citizenship except for the US itself. These results need to be interpreted in light of the data given in the past chapter regarding reasons for location choice. Proximity to the home country is likely influential for many people. Others may question whether the lifestyle or quality of life meets their personal preferences in the US. Box 4 briefly examines some of the institutional elements that may make the US a less attractive destination for scientific work, despite its highly rated competitiveness.

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As the survey was shown as being conducted by the Young European Biotechnology Network, there is a possibility that the interest in Europe is over-represented when compared to life scientists globally on the whole. Nonetheless, it provides important information to refute the assumption that life scientists with an interest to move abroad are aiming primarily at working in the United States.
TABLE 27 INTEREST IN MOVING TO US, IN EUROPE, OR BOTH AMONG THOSE WILLING TO MOVE FOR WORK IN LIFE SCIENCES, BY CITIZENSHIP

| Country of citizenship | World Bank Developing, not in EU | Japan | China | EU-10 | France | Italy | Poland | Spain | Switzerland | United Kingdom | United States | All others | Total |
|------------------------|---------------------------------|------|-------|-------|-------|-------|-------|-------|---------|----------------|---------------|--------------|---------|------|
|                        | Total 18                       | 138  | 297   | 6     |        |       |       |       |         |                |               |              | 459     |
| Q99. Destination interested to moving to | In the United States | In Europe | Both in the US and Europe | None of these |
| In the United States | 6 | 20 | 48 | 1 | 75 |
| In Europe | 3 | 14 | 51 | 1 | 69 |
| Both in the US and Europe | 0 | 0 | 6 | 2 | 8 |
| None of these | 0 | 10 | 9 | 0 | 19 |
| World Bank Developing, not in EU | 0 | 7 | 9 | 0 | 16 |
| India | 2 | 20 | 38 | 0 | 60 |
| China | 0 | 0 | 6 | 2 | 8 |
| EU-10 | 0 | 10 | 9 | 0 | 19 |
| France | 0 | 7 | 9 | 0 | 16 |
| Italy | 0 | 18 | 25 | 0 | 43 |
| Poland | 0 | 6 | 17 | 0 | 23 |
| Spain | 1 | 13 | 37 | 1 | 52 |
| Switzerland | 2 | 9 | 22 | 0 | 33 |
| United Kingdom | 0 | 5 | 3 | 0 | 8 |
| United States | 2 | 1 | 6 | 0 | 9 |
| All others | 2 | 15 | 26 | 1 | 44 |

This question was then followed up by a rating scale of various lengths of stays for industry and academia for the locations, US and/or Europe (Q100-105), for those who were personally interested in moving to that location. These results are shown in Figure 18. In order to make the chart easier to read, countries that are considered developing or emerging are shown with the fine dotted line. These categories include countries classified by the World Bank as developing (excluding India and countries in the EU); India; and EU-10. Italy is shown with a large dotted line, as it is an important country of analysis in the next section discussing the brain drain phenomenon. The countries with highest competitiveness in the life sciences, Germany and Switzerland, are shown by the thicker solid lines. A few very interesting trends emerge.

First of all, the interest in length of stay varies more based on the location (US or EU) than on the type of career (academic or in industry). This is finding is interesting in light of the CiLS data in Chapter 7 and particularly considering that international mobility is seen as more important for academic careers than for industry. Among the country groups shown in Figure 18, Europe is seen as a more attractive destination among the CiLS sample for longer-term moves than the US.

Second, the interest is generally highest for moves between 1-3 years among each country group. Indians and individuals from various developing countries are more likely to also express higher levels of interest in medium-length stays, of more than 3 years but
FIGURE 18 MEAN INTEREST IN VARIOUS LENGTHS OF STAY AMONG INDIVIDUALS INTERESTED IN WORKING IN EITHER US AND/OR EUROPE. SCALE 1 (NOT INTERESTED AT ALL) TO 5 (EXTREMELY INTERESTED), ACADEMIC VERSUS INDUSTRY, BY COUNTRY OF CITIZENSHIP*

*Caution: Low base size: World Bank Devel. (US=60/EU=74); India (54/65); EU-10 (26/42); Germany (40/58); Italy (25/43); Spain (38/50); Switzerland (24/31)
not permanently. However, this trend cannot be said to be linked directly to the
development of the country, as those individuals from Central and Eastern European
countries in the EU have the lowest interest in moving abroad for either industry or
academia among any of the country groups.

Third, the lowest level of interest is for permanent moves to the United States, whether
for academia or for industry, among most country groups except for Indians and those
from developing countries outside of the EU, who still show a drop in interest compared
to interest in shorter stays. This is interesting, as the United States is often expected to be
the top migration choice for scientists and is considered the most competitive
biotechnology location in the literature, but among the scientists participating in the CiLS
survey, while there is interest in getting experience in the US for a few years, most are
not hoping for permanent relocations. It is also interesting given that competitiveness
reports show that the biotechnology industry (companies) are generally much stronger in
the US than in Europe.

CiLS data on brain drain, return migration, and multiple moves

The CiLS study also tried to assess how individuals personally see the decision to move
abroad, and their personal expectations as to whether it would help them find a job on
return or lead to them having careers abroad (See Table 28).

- Q109: From your own impressions and personal experience, which statement
best describes the effect of moving abroad on a career in life sciences?40.
  - It provides experience that makes it easier to find work in the country I
come from
  - It is a stepping stone that leads to moving internationally again
  - It makes it more unlikely that I'd return to the country I come from to
work
  - Other (please specify)
- This question was followed by the open-ended question, “Why do you think so?”

The answer choices were not phrased in terms of brain drain, or brain circulation
specifically, but these ideas were instead implied. Individuals who say that they expect
international mobility will help them to find a job in their home country, show potential
for brain circulation and return migration. Whereas, countries where more individuals say
that international mobility would make them less likely to return are at risk of brain drain.
These countries likely show other structural problems, and this will be addressed by
looking at the open-ended answers. Those who feel it is a stepping stone are expressing
interest in a series of temporary moves, to multiple countries. While the question
encouraged respondents to choose one statement that best applied, they were allowed to
suggest multiples if they explained the reasons why. This change was made based on

40 Multiple choices were allowed, but the question also included the request “If you select more than one,
please explain why.” This means that the data adds up to more than 100%. There was also an option for
“other” and to type in the response, but due to space constraints, this data is not shown in the chart.
feedback from life scientists who completed the pilot study. In the survey results, some people felt that the result of moving just depended on circumstances, and can change across time, as life situation and impressions change. For instance:

- "Own experience. Once you have left it's easier to go on moving to other countries. But it is not less likely to not move to my home country again since while being abroad, one learns to know what is great in one's home country." (Female, 21, Germany)

- All 3 are true and I speak from personal experience. International working experience is always well recognized by employers, as they hope that such candidate would bring innovation and fresh ideas which he/she has seen abroad. Moreover his communication skills in foreign language are likely to be high. It is difficult to come back to the country I come from as there are far less jobs suitable for me, and my bonds with friends and family have weakened after such a long time abroad. (Male, 23, from Poland living in Germany, Biotechnology)

- "Moving abroad puts you in a situation where you no longer really belong to any place. So it’s leading you to move internationally again, it makes you understand that in some places other than your country things can work better, but it also makes you miss your country... IF you eventually decided to return, it would be easier for you to find a job because you had an experience abroad and thus have a much more open mind than before." (Female, 27, Italian living in Germany, Cell Biology)

There are some noticeable differences as to the expected effect when divided by country groups. Table 28 provides the counts for each of these statements, divided by country of birth for every country in the CiLS sample. Although the sample size is low for some countries, this table should be interpreted qualitatively and as an exploratory way to find which countries may have similar patterns in terms of expectations toward scientific mobility. This is largely a new topic, particularly when analyzed in global context.

The majority of life scientists feel that international mobility will help them to find work in their home country (60 % of total sample, compared to 45% who say it is a stepping stone to move again and 16% who say it makes them less likely to return to their home country). Looking at the data by citizenship, or country groups (where sufficient base sizes are not available for individual countries), further indicates that international mobility is not equally valued everywhere. The main trends are outlined below and then the reasons supporting these differences are illuminated afterwards through quotes of scientists around the world with each perspective.

First of all, international mobility is typically seen as valuable in one’s home country for many countries in continental Europe. In the CiLS data, France, Germany, Spain, and Switzerland all show this pattern. Similar levels of endorsements for the value of international experience were found for many, but not all, developing countries.

Second, very few life scientists express that moving abroad would make them less likely to return (16% of the total sample). While migration theory would typically lead to the assumption that individuals from developing countries would be likely to show this
pattern, and more likely to not want to return than those from OECD economies, the CiLS story suggests a different scenario.

- The data on the BRIC economies are also intriguing, again keeping in mind the very small sample sizes, which renders the results as qualitative suggestions. For both Brazil and China, none of the respondents said that international migration would make them less likely to return to their home country to work, and only one individual in Russia said international mobility may lead them not to return. For India, where the base size is higher, only 5% of individuals chose that moving abroad could lead them to not returning. These economies have emerged more recently as scientific research locations, and are seen as attractive work destinations by their citizens.

- Many other countries also had none of its life scientists in the CiLS survey saying that moving abroad. These countries are as diverse as Ireland, Iran, Pakistan, and Nigeria – to name a few examples of the countries where there are more than 5 respondents.

- The biggest risk of brain drain was found in Italy, where nearly half selected that working abroad would lead them not to return. Some of the Central and Eastern European countries (Slovenia and Latvia) also showed a tendency toward brain drain, but data is only available among a few individuals.

- 45% of all respondents select that they see intentional mobility as leading to additional international moves. Again, these individuals are divided between developed and developing countries. In many cases, it seems more linked to personal choice or career decisions, rather than the competitiveness of the destination where they are from or currently working.

Before looking in more detail at the CiLS quotes to illuminate what leads to the differences in data among countries seen above, it should be highlighted what types of expectations are shared across countries. In other words, why do so many individuals say that it will help them find work in their home country, a trend that can be seen in many developing as well as developed countries? These quotes are gathered from the full CiLS results, not focusing on specific countries. Five main lines of reasoning supporting the need for international mobility were identified and are critical to keep in mind for understanding any current or future trends in the global competition for talent among life scientists:

- International mobility is seen as necessary by some for successful life science research, as life scientists aim to tackle problems of global importance. This aspect is particularly called out by respondents from developing countries or those interested in working on issues particularly relevant for developing countries:
  - *Research (especially in life science) is not a regional one. This is a matter of improving the life quality of all mankind.* (Male, 24, India, Biotechnology)
  - *According to me, three things are very important in today's intense competitive environment - it is hard, it is necessary and more than anything we have significant reasons to address issues related to human health. To overcome gigantic competition, it is crucial for me to empower
myself by laying my hands on vibrant research skills. The current exacting situation calls for corroboration of scientific data from every nook and corner of the world; often advocated by alternate solutions from investigating natively available resources that can help us in evading deadliest of the diseases. A world-wide scientific network is especially vital in understanding the current problems in daily life and healthcare sector; in turn, monitoring the regulatory boards of pharmaceutical and life science industry and helps in building amiable relationship across continents/nations. (Male, 26, India, Bioinformatics)

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The life sciences are forming the strongest core of university research in the US. The National Science Foundation reports: “In 2009, the life sciences represented the largest share (60%) of expenditures in academic S&E R&D. Over the last 20 years, the life sciences were the only broad field to experience a sizable increase in share—6 percentage points—of total academic R&D. Over the same period, the physical sciences share of total academic R&D dropped 3 percentage points.”

Stephan (2012)\(^42\) states that the National Institutes of Health doubled their spends in the biomedical sciences between 1998-2003. This created a lot of new opportunities for research, as well as improved lab facilities.

In line with the increasing R&D for this field of study, it also now produces the highest number of scientists of any academic discipline. For example, in 2008, there were 234,000 doctorate graduates in the biological, agricultural, or environmental life sciences in the US, compared to 67,000 in the computer/mathematical science, 169,00 in the physical sciences, 158,00 in engineering, and 226,000 across all the social and economic sciences. Survey results from the National Institutes of Health show that in 1997, 70.5% of biological science doctorate holders said their job was closely related to their training. This had dropped to 59.3% in 2008\(^44\).

As a result, there is often discussion in the US about why life scientists are quitting this career path, despite long years of study, and sometimes despite a continuing passion for research. This is often due to the competitive nature of science research in the US, but in a context where competition strongly decreases career satisfaction. Let’s take two examples.

The first comes from an interview on National Public Radio in 2014, titled “When Scientists Give Up.” This interview notes that after the NIH funding surge, these


\(^{44}\) [https://www.insidehighered.com/news/2013/02/19/research-aaas-meeting-notes-difficult-job-market-academic-science](https://www.insidehighered.com/news/2013/02/19/research-aaas-meeting-notes-difficult-job-market-academic-science), Accessed 2 March 2015

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budgets have more recently declined 20%. University scientists are expected to bring in research grants, but it is estimated only 1 in 8 are actually funded. Not only does this create a situation where scientists in US universities must spend much of their time pursuing research paths that are never built, it also can be discouraging for scientists who are funded. In the interview, a successful scientist, Ian Glomski, discusses why he is quitting his well-funded lab at age 41 to form a distillery. He says to get funded now: “You have to actually be much more conservative these days than you used to. And being that conservative, I think, ultimately hurts the scientific enterprise because everybody’s basically trying to be so conservative – to do things that ought to work or things that are expected to work, that you’re losing out on the cutting-edge research that really is what pushes science forward.”

The second example comes from a blog (“A career in science will cost you your firstborn”, www.johnskylar.com), from an early career scientist. In this blog, there is a discussion centered around why a successful postdoc candidate, who the author clearly looks up to, has decided not to further pursue her scientific career. He analyzes a range of reasons, but most importantly, pursuing science leads to an insecure life situation. First of all, pursuing a postdoc often means a lower salary than what many peers with the same education receive for different career paths, whether in industry, or outside fields like consulting. Many top universities in the biological sciences are also in areas with expensive cost of living. And in the US, “Worse yet, a postdoc isn’t a real job. You’re considered a ‘trainee’ for the purposes of everything from social security to benefits. You’re often locked out of retirement accounts, not that you’ll have enough money to save any to begin with. And you often can’t collect unemployment if you’re fired.”

At the same time, it needs to be kept in mind that currently a majority of postdoc positions in the biological sciences are being filled by foreign nationals in the US. For example, in 2010 there were 10,283 US citizens and permanent residents doing postdocs in the biological sciences, compared to 11,443 temporary visa holders.

Should it be any surprise that so many foreign scientists return to their home country at some point after finishing their selected training in the US? It has all the elements shown in the CiLS study to matter – a chance to access top universities, prestige, excellent scientific equipment, in a culturally diverse environment…and a lack of attractive, long-term job opportunities.

Yes, the United States is one of the most important foci of the global competition for talent in the life sciences. It is still seen as the most competitive, the leader, both due to quality of the universities and research, and for the number of companies in the biotech industry. But it is occurring in an era where neither the domestic employment situation of life scientists in the US, nor the international mobility patterns of advanced research students point to predominantly permanent stays. This does not mean that the US is now ‘losing out’ in the global competition for talent. It means the game, the rules and players, have changed.

### TABLE 28 WHICH STATEMENT BEST DESCRIBES THE EFFECT OF MOVING ABROAD ON A CAREER IN THE LIFE SCIENCES?

Counts for country of birth; highest number of responses in gray (countries with 3 or more respondents)

<table>
<thead>
<tr>
<th>Country of birth</th>
<th>It provides experience that makes it easier to find work in the country I come from</th>
<th>It is a stepping stone to moving internationally again</th>
<th>It makes it more unlikely that I'd return to the country I come from to work</th>
<th>Total</th>
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<td>4</td>
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### TABLE 28 (Continued)

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<th>It provides experience that makes it easier to find work in the country I come from</th>
<th>It is a stepping stone to moving internationally again</th>
<th>It makes it more unlikely that I'd return to the country I come from to work</th>
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<tr>
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<td>8</td>
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<tr>
<td>Venezuela</td>
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<tr>
<td>Zimbabwe</td>
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<td>0</td>
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<tr>
<td><strong>Total</strong></td>
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<td>237</td>
<td>269</td>
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</table>
New research skills, including exposure to new ways of conducting research and access to equipment, can be gained by moving abroad. Other people move abroad to build their foreign language skills. The prospects of building new skills are important both to individuals from advanced countries and particularly for individuals from developing countries where there are fewer scientific resources.

- Besides, lack of technology in different life sciences is the most important point and even if I got experience, what will be the benefit if I don't have facilities!? Yes, it may provide good position (maybe) but days on days without practicing what knowledge I got, I will lose everything unless I am in touch with development in my field with new technologies and facilities. (Female, 37, Yemen, Microbiology)

International mobility is seen to build soft-skills that are important for individual development or for careers, particularly open-mindedness and adaptability, and in some cases to show help the ability to work in multicultural environments.

- “Provides experience different cultures, which is important in a country such as Canada as it is so multi-cultural.” (Female, 23, Canada, dual citizen of Canada and Trinidad and Tobago)
- Because it broadens your mind, it helps you get to know other cultures and ways of living that you wouldn't be able to experience without moving abroad. It challenges your ability of adaptation. It helps you improve languages if the language of the country is not your mother tongue. As far as careers are concerned, I don't know how good or bad it would be. (Female, 21, Spain)
- Working abroad opens your horizons. It makes you able to cross the cultural barriers. Science is basically the same everywhere but besides work someone must enjoy his life in the country where he/she works. A great workplace, gaining skills and knowing new people and cultures makes you a citizen of the world. Working in science makes you a part of the overall humankind advancement and what is more rewarding than the feeling that you really are a citizen of the world that actively tries to unveil the mysteries of life? (Male, 37, Romanian citizen living in US, Immunology)

- Some respondents state that international mobility is highly regarded or even a prerequisite for employment in their home country or chosen field. Even though the answers from some of these respondents express lower enthusiasm to move abroad, it is seen as a necessary step in the career path.
  - Working abroad is valorized in Brazil. (Male, 45, Brazil, Bioprocessing Engineering)
  - Because companies like Siemens always ask for that in job interviews and consider international experience more important than the number of years one needs to finish his study. Better one year abroad and your study takes one year longer, than otherwise. (Female, 20, Germany)
  - Most of the research and academic institutes demand a good post doctoral or a graduate study from abroad for building up a scientific career. In that
case it will provide me the necessary research experience and world class exposure for building a scientific career. The same things apply to industries as well. (Male, 25, India, Genetics)

- In Singapore, overseas experience is more valued than experience from local institutes. (Male, 35, Singapore, no field of study provided)

- International mobility can be a way to forge new scientific networks. However, in some countries respondents express that moving abroad could lead to a weakening of their existing scientific network in their home country. Due to both of these viewpoints, the assessment on the value of international mobility for advancing one’s career in the home country varies.
  - “It makes it easier to collaborate with the country I come from to develop life sciences careers. Because having a strong international network will help establishing cooperation” (Female, 27, Algerian citizen living in France, Cell Biology)
  - The most important is the feedback between researchers around the world, moving abroad on a career allows that encounter and feedbacks. (Male, 34, Columbia, Medical Sciences)
  - It is mainly a risk to quit my country not to keep the contacts that will allow going back later. But intelligently used the experience acquired abroad is a plus. I personally would take the challenge to follow my partner in a country but with preparation in advance to do the contacts there and to keep the contact here. On the other hand, any other country I will go (not for purpose of following partner) would be with keeping a foot in a Swiss company or with contact in my country to come back is I want to. (Female, 29 Switzerland, Cancer Research)
  - When you leave, you lose visibility in your own country, and people forget to let you know job opportunities simply because you are not around. Working internationally can become addictive and you may not want to go back to a single cultural work setting. ”There are more work opportunities in the USA as a whole than in Europe for life scientists (Female, 31, Belgian living in US, Molecular Biology)

Those who see international mobility as a stepping stone to move abroad again report either:

- Lifestyle reasons
  - Well, once you tried it you cannot get enough, at least for a while. If you manage to 'survive' in a new country once you get the impression you will survive everywhere. The downside is that sooner or later you feel like you do not belong anywhere anymore. You start your life over and over again! It is great fun, if you (at least I need it), find a network of people like you around, which can be your friends for the time you are in that country, but maybe even forever, who knows... Anyway moving abroad teaches more than you can ever imagine sitting your whole life in your own country... (Female, 31, Polish citizen living in the Netherlands, Molecular Biology)
  - My main reason for wanting to move abroad was as a lifestyle choice - to experience a new country, a new culture and be near to other countries as
well, living in Europe. The second influence was to experience what it would be like to be challenged in a new job.”  (Female, 32 Dual citizen New Zealand –UK, living in Switzerland, Immunology)

- "I grew up in Luxembourg, one parent from (one European country) and one from (another European country), hence I always thought of myself as European, never belonging to one country. I have always enjoyed traveling. I studied/study in the UK but my studies involve frequent travels to Africa and other developing countries. One of my motivations for choosing this field of studies was, and still is, to experience working in and with different cultures, different countries. I enjoy learning new languages and meeting new people. I hope very much that my work continues to bring me these opportunities since that way I will enjoy it even more.” (Female, 24, dual citizen Luxembourg-UK, living in UK, Infectious Diseases)

- Lack of opportunities in their home country
  - “The opportunities in my country on a career in life sciences is quite low, and I always think a person should see abroad to widen his/her perspective on life itself, so I would like to live and study or maybe work abroad. Also because I do not like the life standards in my country, and I can do nothing to improve it right now, all I can do is to use my energy and knowledge on the fields that I believe I can improve on this world.” (Female, 23, Turkish citizen)

This section has aimed to highlight individuals attitudes toward international mobility and the effect expected on the career. The quotes illuminate why concerns about brain drain in many countries may be overstated. International mobility has become integrated in the career structure of life scientists in many countries. It is valued by many individuals for their personal and scientific growth, and it is highly valued by many employers. Yet, international mobility is not equally valued everywhere, and the expected effect on the career varies as well.

Brain drain in Italy and Central and Eastern Europe

Italy is a country in the CiLS data, where concerns about the opportunity structure are expressed by life scientists. Italy cannot be considered as necessarily uncompetitive in the life sciences when international competitiveness indexes are assessed. For example, the Scientific American listing shows Italy as one of the world’s top countries in science, with it being rated as in the top 10 for number of research papers, patents, R&D expenditure, and number of science and education graduates (Editors, 2012, p. 36). While this is for science on the whole, it is still evidence that scientific work does have some competitive presence. Yet, Italy was rated the absolute lowest among any country in the CiLS research by its citizens, in terms of having good life science opportunities available and was the country showing the highest risk of brain drain. Italians express:

- “The scientific career in Italy is not worth trying. Once abroad generally Italians don’t want to go back mainly for the salary difference and for the opportunity to find a stable job. Even if not stable, abroad there are more opportunities than in Italy.”  (Male, 30, Italian Living in Switzerland, Developmental Biology)
• Italy is a very strange country, where you always need to keep connections and contacts and once that you go out from the "system" it is difficult to go back, especially in Academia. (Female, 30, working on PhD in Neuroscience in Italy)

• In Italy the good positions in life sciences are few, usually not in the best Italian areas, and the salaries/social charges are not good. (Female, 35, Italian citizen in Switzerland)

• I think that it's extremely important to gain experience abroad, as it opens your mind and gives unique possibilities. Once you begin to evolve you don't want to stop progressing ... Having already some links and no need for work permit in the country I intended to move helped my decision, but the main reason was the lack of possibility in my country and the opportunity I have abroad to work in the field I am proficient and to gain experience for my career progression” (Female, 35, Italian citizen with post-doc, working in academia in UK, no field of study provided)

These findings are in line with the ERAWATCH report for Italy, which finds that its R&D spends are below the Lisbon Agenda targets, and that there are problems with attraction and retention of researchers due to: “overall low attractive working conditions for researchers, low salaries, difficulties to gain permanent positions, scarce relevance of merit.” (Poti & Reale, 2011, p. 5)

Central and Eastern Europe also showed some risk of brain drain, which it is linked mainly to the position as a transition economy, within the European Union. There are still disparities not only in salary as compared to Western Europe, for example, but also in terms of the quality of the work environment, which was particularly noted for academia. There is also often a frustration about the quality of the systems in place, including as reflected in politics as well as in the social structure:

• Because studying and working (and meaning it!) in Slovenia really sucks and is but degradation to the student, the adviser, the research, etc. Complaints are either not taken seriously or downplayed. Politics seems to mess in. Servility and execution of tasks is how many PhD theses are completed (the candidate is thus a faithful copy of the instructor). Ideas take too long to mature and turn into products. Hierarchy and status are strong. Personal disqualifications are common in arguments. Again, what exactly is meant by analytical and critical thinking, research, motivation, etc., anyway? (Female, 25, Slovenia, Biochemistry)

• When you know how things should be done abroad and you know that there are no chances for any improvement in your country (in this matter) then the answer is simple. Moreover apart from the professional point of view, there is also this social square people are better for each other outside of my country, and politics can not change a lot from day to day in your life - like in Poland when you are not sure what will happened tomorrow, because of some political decisions that quite often does not make sense. (Female, 28, Polish citizen, living in Switzerland, Biotechnology)

As is seen in many countries of the world, many governments in these countries are aiming to improve their position in biotechnology (Enzing et al., 2007, pp. 129-151). As
is the case with rating biotechnology competitiveness in general among countries, it is
difficult to determine how each compares to each other and different reports will give
different answers. It is important to note that while there may be some commonalities in
terms of work conditions and societal concerns (low confidence in the government and
corruption are widespread concerns, for example) in the former Central and Eastern
European countries, there also will be a large number of differences that have an impact
on both career opportunities and quality of life. More research is needed on this topic.
Box 5 describes some impressions from my time living in Lithuania and researching the
biotechnology sector there.

BOX 5 BRAIN DRAIN, RETURN MIGRATION AND INNOVATION TRANSITIONS IN
LITHUANIA

Brain drain is among the top social and political issues in Lithuania. Yet, the Lithuanians
have a highly divided view of emigration, despite high out-migration rates. This is
expressed commonly even in day-to-day conversations, as well as in the media. For
instance, the online version of the daily newspaper, Lietuvos Rytas, had a section called
“Emigrantai” or “Emigrants” when I lived in Lithuania in 2008. It was a newspaper
section lined with articles, on the one hand, of successful Lithuanians abroad. On the
other hand, the section contained stories of social ills from moving abroad, such as
divorce and internationally divided families, with another favorite topic being Lithuanian
criminals arrested overseas.

These examples are also reflected in general opinions on ‘emigration’ in Lithuania: on
one hand, those who emigrate are looked upon skeptically, and on the other hand, most
Lithuanians know someone who has gone abroad and in many cases these stories are
lined with ideas that they had high personal achievements, and ones felt to be
unattainable at home. Adding to this image, the former and very popular President of
Lithuania from 1998 to 2003 and then from 2004 to 2009, President Valdas Adamkus,
was elected shortly after returning from his own migration, having spent most of his adult
life in the United States.

Return migration does not always come easily. As part of my research in 2008, I
interviewed life scientists in Lithuania who had returned after working in the United
States. The reasons for wanting to return were usually family-based reasons, wanting to
be closer to relatives or hoping for their children to better know their home country and
language. I was told that the process of finding a job upon return was more time
consuming, in some cases taking several years, than expected. The employment situation
in Lithuania needs to be seen in light of the country as a transition economy, still moving
from the legacy of communist systems into more market-oriented approaches. Academia
is currently split between those from the ‘old’ system, where seniority determines status,
and the new standards in academia, whereby status is determined by the ability to get
international funding for research and through publications. Those from the old mindset
do not necessarily want the younger, competitive mind-set working with them. It is not
valued and may even be seen as threatening.

The disparities between systems can also be seen in policy discussions. One of the
reasons I was drawn to study in Lithuania was because of the policy documents stating
their efforts and intentions to build the biotech sector. The Institute of Biotechnology in
Vilnius is considered to have a competitive atmosphere and quality research labs. Almost
all the scientists here are Lithuanians; many are scientists who have returned after working abroad. It was pointed out to me that researchers also visit this lab from abroad, although most of these are short-term visits. The building I visited was formerly one of the top research institutes of the Soviet Union, and now instead is part of Vilnius University, a symbol of the changing alliances in a transition economy. Successful biotech companies are also present in the area, notably Fermentas, which is very active in international markets and was acquired by the US company, Thermo Fisher Scientific in 2010.

When I asked scientists at various locations about policies to support biotechnology, I generally was told there is a lot of talk, often due to pressure from the EU to increase R&D, but little moves forward. As I was told in an interview with a scientist who was actively involved in policy-making, many politicians argue that employment in manufacturing and agriculture are still important in Lithuania, and prefer to put their efforts more on supporting initiatives in these more traditional areas of employment. Again, this creates a division between the side aiming to increase competitiveness and those who are focused more on trying to meet needs within the existing economy, and among a larger percentage of constituents.

CONCLUSION

Perceptions of high US competitiveness, and the often negative perspective taken on the performance of biotechnology in Europe as a whole, seem to pervade discussions about biotechnology careers in Europe, among students and in some policy reports. As was mentioned in chapter 2, the idea of brain drain originally started from discussions of loss of European scientists to the US.

The multiple definitions of biotechnology, the diverse applications it applies to, as well as different configurations of policies and institutions that support biotechnology growth make rating ‘competitiveness’ of countries in biotechnology nearly impossible. While various independent reports with competitiveness reports exist, international organizations such as the OECD have been reluctant to adopt an index of biotech competitiveness. As discussed in detail in the methodology section, internationally comparative studies on biotechnology seldom focus on the workforce or employment aspect, but rather on legislation or innovation (R&D spends, patenting and publishing) differences, where comparable data is available. Usually the best data indicator for the workforce is the number of life science PhD graduates, but this tells nothing or their employment trajectories or how the aspects that create fundamental structural differences in biotechnology across regions relate to the employment of biotechnologists. Albeit being incomplete and prone to both interpretation and error, examining competitiveness helps us to better understand how countries and cities are perceived to fare in global context. Perceptions of competitiveness are assumed to be important, for drawing in talented individuals, firms and investments.

Biotechnology competitiveness is difficult to assess, not only at a single point in time, but also in that it is dynamic. Growth and international recognition of strengths will also influence perceptions of competitiveness, as will the effects of recession or other reasons for retrenchment in employment. Hence the list of places seen as competitive when the CiLS study was conducted have likely changed, at least slightly.
In the most basic sense, it can be said that there is a common outcome (evidenced by the presence of the biotech industry). However, the presence of these various factors does not imply that they are achieved in a similar manner. For example, a cluster can be largely supported by government funding, as has been the case for Germany’s biotech sector, or it can be business or market-led, evolving from existing businesses and independent spin-offs. Comparative research is therefore necessary in order to understand the contexts, including the opportunity structures, that then influence the availability of workers in that region or country.

The CiLS survey adds to the existing research by looking at life science and biotech competitiveness from the viewpoint of the workforce. Very few regions are identified by the CiLS respondents as being strong in the life sciences and biotechnology. It is rarely the case that regions and biotech clusters are in and of themselves are beacons in the night that attract the best and brightest from around the world, since very few biotech cities have this type of status. Rather, individuals are aware of cities either based on proximity, or seem to be choosing locations based on a key institution, such as university or top company at which they are interested in working or studying. As discussed in chapter five, independent research is seen as the “ideal” occupation by most life scientists, and hence the individual’s focus is likely on identifying key institutions in their field, not necessarily regions.

Although there is not necessarily a strong focus on regions, individuals are aware of biotech competitiveness on the national level. Four countries emerged as leaders for the biotech workforce, that is that they are very attractive to scientists from outside the country, as well as for the nationals: The United States, UK, Germany and Switzerland. The US has the highest recognized competitive regions in biotechnology among the CiLS sample, which is consistent with its reputation as the global leader in biotechnology.

All the discussion in the chapters up to this point have focused on structural dynamics that effect the global competition for talent and the competitiveness of the biotechnology industry in various countries. These reflect the investments, size, and specializations of biotechnology, but cannot make any claims about the biotech workforce. What can be said about the role of the workforce and their career and lifestyle preferences and motivations in shaping the global competition for talent?

Figure 18 looked at the desired length of stay for moves for life science work in the US as compared to in Europe. What is unique about this perspective is that the data is specifically for those interested in moving for work in the life sciences (data on intended student mobility is not included) to that specific location. What is shown is that the intentions for moves often defy conceptions about migration. Permanent moves are typically not the most desirable, regardless of the country of origin. This is even in light of academic careers sometimes involving tenure, or permanent positions. Among citizens of European countries, there is higher interest in longer-term relocations for moves within Europe than to the US. The level of development of a country is not necessarily the most important reason for wanting longer-term stays in the US or Europe. Individuals from Central and Eastern European countries, which generally are said to have lower wage and development levels than countries in the US or Western Europe, express among the
lowest interest in moving abroad to work in the US (for either academia or industry), slightly lower levels for working in industry in Europe, and similar levels to other countries/country groups for working in academia in Europe.

The final part of the analysis looked at life scientists’ expectations as to whether moving abroad would lead to brain drain, return migration, or additional international moves. Most respondents felt that international mobility would make them more attractive in their home country. Scientists from very few countries expressed attitudes that lead to concerns about potential brain drain. Even among many developing countries, few scientists say that international migration makes them unlikely to return to their home country. Italy was an exception, in that many Italians felt they would not return, and cited uncompetitive hiring practices and a need to be within the ‘network’ to get a job as core reasons. This shows that it is not just the presence of the research infrastructure that matters, other aspects of the opportunity structure also influence brain drain. The Central and Eastern European countries also show some risk of brain drain, but the data is inconclusive, and likely due in part to the changes unique to each of these transition economies. The respondents from Poland, for example, were less likely to say they would not return.

Competitiveness and immigration are linked. The most competitive economies in one’s field of work do have an advantage of also attracting people from other countries. Although competitiveness matters, it must also align with one’s personal goals and preferences, and here other factors come into play and mean that the most competitive locations do not have a ‘monopoly’ on the scientific workforce. Most scientists wish to have international mobility as a stage of their career. Theory has suggested that brain drain is linked with human capital development, and that individuals from developing countries will move, with intentions to stay outside their home country permanently. The CiLS data presents a very different picture. It is one that recognizes that the sciences are increasingly internationalized and that new scientific as well as soft-skills and contacts are built by being abroad. It shows that most scientists view international mobility as a way to then better increase the contribution to science they can make in their home country. Brain drain seems to be a risk in very few countries, and where it does exist it is likely reflective of a highly underdeveloped biotech sector or other problems limiting equal opportunities for individuals to reach the desired job positions. The brain circulation discussion leads in the right direction but it does not go far enough. This is because it also needs to be recognized that the internationalization of the sciences, individual aspirations, including a desire to live in multiple countries, as well as to build skill-sets associated with international mobility. International moves are increasingly part of the life scientists’ study or work trajectory in many countries of the world. The discussion surrounding scientific mobility therefore sets a more appropriate framework, in most cases, than that of brain drain and brain gain. The analysis also shows the importance in looking at the global competition for talent from a lens of competitiveness, that is the underlying drivers, and not of a strict competition.
CONCLUSIONS
“Forget terrorism and weapons of mass destruction. The next global war will be fought over human capital.” (Heenan, 2005 p.1)

This study examined what the global competition currently means, by discussing theories for skilled migration and competitiveness, statistical changes in skilled migration and international mobility, policy changes related to international mobility in the EU, and through examining careers in a growing field, biotechnology and life sciences in various countries. While this study has begun to answer the question, “What is the global competition for talent,” perhaps a bigger question is “What will the global competition for talent become?” While the answers can only be speculative, current trends and past experiences offer some insights, while a review of the existing research illuminates some theoretical and empirical gaps.

The 1990s to early 2000s was clearly an important turning point in skilled migration policies in many countries and in media and policy discussions across the world and a basis was built for discussing a “global competition for talent”. Although skilled migration was common in earlier decades, the movements were less influenced by specific national policies, but were largely seen as occurring as internal mobility in companies and particularly of managers in multinational corporations. Such movements were seen as unproblematic by governments in advanced countries and did not receive much policy attention. However, the IT boom in the US and in the case of Europe, the desire to emulate this success (as indicated by the goals of the Lisbon Agenda), triggered discussions of ‘competitiveness’ and in growing the knowledge economy. By the mid-1990s, discussions of ‘competitiveness’ had become part of the immigration discourse in Europe as more countries aimed to move from restrictive systems to selective systems of migration, favoring (temporary) skilled migration and also trying to further advance the attractiveness of the university system and higher education for foreign students. Although policies and trends will continue to change due to the current financial crisis and changing economic needs in general, the past forms an important backdrop for assessing the attitudes, beliefs, and experiences that have influenced policy decisions and mobility to date.

Given the economic trends seen in both developing and developed countries, interest in the global competition for talent will likely grow. Within this broad grouping, biotechnology whispers of potential solutions for the most pressing global problems – improving food production, alternative energy sources, pollution and waste treatment, and more affordable and efficient procedures and treatments in health care with fewer side effects. It therefore is a sector that fits the model of the “knowledge economy” and is expected to be part of economic cornerstone of advanced economies’ competitiveness as well as important to emerging and even developing markets. According to the OECD, biotechnology is “the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services.” Biotechnology has become the
cornerstone of current life science research. The most developed area of biotechnology in Europe is for healthcare technologies. Although the biotechnology sector does not always have large numbers of employees, it is a research-intensive field and makes a strong contribution to innovation (whether assessed by publications or patents). Therefore, supporting biotechnology is often part of the economic competitiveness strategy in both developing and developed countries. Regulatory climates for the biotech industry vary from place to place, as seen for example by varying support for stem cell research or bans on genetically modified food. The development of the biotechnology sector and the shape of it, in terms of specializations and its relative strength in industry versus academia, is influenced by a wide array of policies, research budgets, and any range of local to international partnerships.

One aspect that remains constant is the knowledge-intensive nature of the industry, which crucially points to the importance of aspects related to the availability of qualified personnel. There is a strong acceptance by policy makers that countries are increasingly becoming, ‘knowledge’ economies and that R&D intense activities, such as those found in biotech, are crucial for preserving national competitiveness in light of possibilities for lower cost manufacturing in other countries. Furthermore, there is a sense that there is not only competition to keep businesses located within their territories, but also that there is intense global competition for the best employees. However, the so-called “race for global talent,” or “battle of the brains,” overstates the openness of national labor markets. Despite the explicit focus on ‘knowledge’ little research has been done to understand how policies support or confine the availability of personnel, and related to this point, the recruitment practices, barriers, and skills shortages faced by businesses, or the impact of individual preferences regarding working in various countries or biotech regions.

**RESEARCH QUESTIONS**

This study set out with a primary goal to examine: **What structures the global competition for talent?** This is a question that arises from the observation that concern about the global competition for talent is increasing – in academic research, in policy reports and in media – and globally. Yet, it is not always clear what is meant by this phrase.

The research in this study is exploratory, in that its primary aims are to add new details to understand an emerging phenomenon, and one that still requires more theoretical development. In order to advance understanding of this topic, this study set a number of sub-questions to better examine the context in which the global competition for talent occurs. Part I of this study addressed conceptual and structural aspects:

- How can concepts and data (policies, statistics detailing changes) related to skilled migration and competitiveness be linked to better understand the global competition for talent?
- How have skilled migration policies and other policies facilitating international mobility of students and scientists developed in Europe? What are the main features of these policies within the European Union?
Part II then analyzes: **Which patterns have influenced the development of the global competition for talent as observed in the life sciences/biotechnology in particular?**

The main focus is to address the research question primarily from the viewpoint of the scientists, rather than from the employer or policies:

- How important/prominent is international mobility in life science careers?
- Which factors are considered and influence life scientists’ intentions to move or moves abroad?
- Which countries are attractive to life scientists and why?
- Which duration of stay is most desired for moves for life science jobs in the US and in Europe?
- What effect do life scientists expect international mobility to have, in terms of staying abroad or returning to their home country to work?

This part also briefly examines a few structural aspects that are important for understanding the context in which international mobility occurs for the life sciences in particular:

- What are the features of the labor market within which life scientists work?
- Which cities and countries are seen as the most competitive for biotechnology globally?

These questions have been addressed one by one in the preceding chapters. The goal here will not be to summarize each but instead to point to how they act together, by better integrating the findings into the analytical framework created for this study and described again below.

**THEORETICAL LENS: MERGING RESEARCH ON COMPETITIVENESS AND IMMIGRATION**

The main goals of this study relate to better understanding the global competition for talent, both as a concept and through better understanding new career dynamics. Various theoretical foundations are implicit in discussions of the global competition for talent.

One of the most important theoretical perspectives is the work on the drivers of *competitiveness among countries*. Competitiveness is not a simple competition, but rather made up of assessing strengths and weaknesses. The concept of competitiveness has been advanced through the work of Porter (1990; 1998; 2003). Porter argues that the share of exports was often used to measure the competitiveness of countries, as it showed the products that were in demand internationally, but the advance of the knowledge economy has made this inadequate. It is not just tangible products and trade that are now linked with productivity and the relative performance of countries, but increasingly technology to improve or even create new products or processes and the knowledge held by individuals as well. He argues that the competitiveness of countries is best measured through *productivity*, defined as “value of the output produced by a unit of labor or capital” (Porter, 1990, p.6), and with attention turned to individual industries to see the underlying drivers of productivity. Porter argues that high productivity allows both for higher wage levels and higher living standards. In addition, in order to build
competitiveness, countries need to build specializations, to focus on the industries where their productivity is highest. He argues that this can be accomplished in part through creating and promoting industry or research clusters, consisting of regions where universities, companies and other institutions create a synergistic environment where ideas can be exchanged and developed. Porter (1990) hence argues that examining macro-economic competitiveness, paradoxically, is best done through looking at the issue from a different scale, that of industries and regions.

Drucker (1986; 1999) began discussions on the importance of the knowledge worker to economic success. Drucker’s work was also a response to the rising challenges and changes of the knowledge economy. However, his focus on the knowledge worker pointed out that the individual level is also important to productivity. Individuals successfully working in the knowledge economy need to have the motivation to update their skills and also to produce quality work, not just quantity. In the knowledge economy, it is these personal characteristics of the individual knowledge workers that most influence the productivity of the organizations in which they work.

The literature on the knowledge economy has expanded considerably, but what is still difficult to measure is what I refer to as the workforce dimensions of competitiveness, which has become of central importance. In part, this is related to human capital, or the skills and knowledge that individuals embody. This aspect is measured to some degree in competitiveness reports, often through the number of graduates in a given field or the number of researchers. However, data for the scientific workforce as a whole is often not available and not comparable across countries. Knowledge can be measured through statistics on patents and publications, but what is missing is how this fits together in regards to differences in employment or career contexts.

In Chapter 2, it was argued that in the 2000s there was an increasing recognition of immigration as a contributor to national or regional competitiveness. Skilled migration policies were implemented in more countries, where they had not existed before, and new attention was also turned to student migration. Skilled migration has generally been studied from the same theoretical perspectives used for other forms of labor migration, including push-pull models, examination of global systems, and network theories.

More recently, skilled migration has been linked to the concept of ‘talent.’ This perspective has been built in part from the influential work of Florida (2002; 2005). Florida argues that regional growth can be better understood through technology, talent, and tolerance, the 3Ts. Florida (2002, p.249) argues, “To attract creative people, generate innovation and stimulate economic growth, a place must have all three.” His research focuses on the creative class, which he defines as various creative occupations, researchers, and other skilled work. His research originally used data on urban areas in the US. Florida’s work has been very influential and has been important in the expanding interest of ‘talent’ as well as in increasing the (political) acceptance that immigration can be an important contributor to economic competitiveness. One of his central arguments is that tolerant and diverse environments are a necessary condition to attract creative individuals, who are the drivers of creating innovation, which then creates regional growth. Yet, the degree to which it applies to contexts other than the US has been
questioned. A new framework for understanding the global competition for talent is needed, which can better apply to other countries and contexts.

Advancing competitiveness has become a top policy priority and is used not only for economic policies, but also to argue in favor of skilled migration, for instance, and as further internationalization of education systems, research and science on the whole occurs. ‘Talent’ has become an essential economic concern—“Talent – what it is, how to grow it, how to keep it, where it exists and how to attract it – has become a preoccupation for developed and emerging economies, as well as many developing ones, because it lies at the heart of economic growth and competitiveness” (Papademetriou et al., 2009, p. 215).

Yet, as pointed out in the quote above about talent, there is no consensus yet as to what ‘talent’ means. Like competitiveness, it is not always clear what scale it should be measured on, and the concept of ‘talent’ has taken root both in the management literature, that is how companies can develop, attract and retain ‘talent’, as well as in discussions on national skilled migration policies. Even when limiting the discussion to its application to immigration policy, it can be defined broadly as individuals with specific skills and abilities, or from educational fields where there is an assumed demand or those seen as strategic for supporting national competitiveness. It can also be analyzed more narrowly, whereby talent is used to attract only the top individuals in a given field, which can range from top athletes, to artists, to star scientists, to name a few.

In Chapter 2, I presented the main theoretical lenses that I see emerging in discussions of skilled migration in Europe. These are reiterated here, as they influence the theoretical lens adopted in this study:

1. Skilled migration is presented as a ‘race’ or ‘competition’ for global talent or a ‘battle for the brains’ – Goal of ‘attracting’ skilled migrants, particularly for the knowledge economy
2. Skilled migration as a contributor to economic and human capital development – Promoting circular migration to mitigate the brain drain in developing (sending) countries, especially in healthcare and education sectors; knowledge transfer to the home country is a benefit of skilled migration for scientific and technological sectors.

Both of these perspectives are implied in research that aims to address the “global competition for talent, the central topic of my study. However, while this phrase has permeated media and policy discussions, it has not yet been fully developed theoretically or empirically. In other words, there have been many assumptions made that lead to conclusions of certain countries ‘winning’ and other ‘losing, without deciding clearly who or what is on the playing field.

The theoretical perspective taken in this study therefore acknowledges that building a strong knowledge economy, in any form, invites questions on workforce availability. These can be filled either externally, by opening labor markets further to foreigners, or internally, by improving awareness of core issues, educational programs, and facilities in growing fields, such as biotechnology. Yet, it also recognizes that past research and theoretical perspectives have been either tainted by incomplete data, such as the lack of
that on the scientific workforce, or by lack of attention to the changing global context. This study aims to remedy these problems by introducing a new analytical framework, consisting of people, place, productivity, and policy (4P framework), which applies to research on the global competition for talent in any country or sector of employment within the knowledge economy. The 4P framework is influenced by the work of Richard Florida, but it expands it further to capture more diverse contexts, whether for different industries within the knowledge economy, or for countries with various degrees of economic development.

To reiterate, the building blocks of the 4P analytical framework include topics where discussion of the global competition for talent is relevant:

- **Productivity** in this framework is linked specifically to competitiveness, which has been defined in this study as status as a leader. This is a simplified definition, but allows for an examination of productivity as it applies to individuals, institutions, sectors of employment as well as countries on the whole. The goal of understanding productivity in this framework is not necessarily to measure it, but rather to better understand how it is related with the other aspects of the framework.

- The category of ‘People’ can be based on a number of analytic points:
  - demand for high-skilled labor in general or in a certain occupation/industry;
  - assessing individual merit and excellence, an instance where talent is defined more narrowly
  - the individual determinants of migration, that is what influences individuals to move and which destinations they select

- **(Perceptions of) Place**
  - Country and city image
  - Quality of life and lifestyle
  - The influence of the opportunity structure on working conditions and professional opportunities

- **Policy** can also influence the global competition for talent. Immigration policy is only one of the various areas that create differences among various countries. For instance, as discussed in Chapter 2, Eggers and Hagel (2012) suggest a need to understand ‘talent competitiveness’ which builds from policies for not only immigration policy, but also skills and education; innovation, research and development policies; and competitiveness in international markets, including foreign direct investment and intellectual property law. Furthermore, as discussed by Reiner (2010) it is recognized that policies can occur on various scales, including the global level (for instance the WTO), supranational level (as seen in the European Union), national level, and regional level. I would like to add that even the policies or common practices of specific institutions, including universities and companies, can have an influence.

The 4P framework adds a number of new aspects that previous work on the global competition for talent could not address – it is relevant for both developing and developed countries. It also works to better combine theories on both immigration and competitiveness, to understand new and emerging dynamics, while still allowing for
examination of the influence of past migration, for instance, or industry path dependencies.

METHODS

Part I is designed to better understand skilled migration in global context more generally, answering the question on what structures the global competition for talent. With this goal in mind, it is built primarily from desk research, including reviews of academic literature on skilled and student migration, statistical data on international mobility, and a review of policy documents, particularly those focused on comparing migration and mobility in Europe.

Part II turns to the topic of scientific mobility, through the specific example of life scientists. It looks at more detail at the dynamics of the global competition for talent as observed in the life sciences and biotechnology. In addition to desk research, the analysis in Part II is constructed particularly from the CiLS survey. I designed the CiLS study, working together with a few individuals from the Young European Biotech Network (YEBN). YEBN is an umbrella organization, made up of various other organizations, largely biotech student associations, in various countries in Europe. The largest groups of members are found in Germany, Switzerland, Poland, Spain and Italy, as these are countries where national student biotech organizations are part of YEBN as institutional members. The survey was conducted online in late 2008-early 2009. It was announced in various ways: among YEBN members and in different associated newsletters, in emails that could be forwarded to individual YEBN members’ contacts, by articles in academic biotechnology journals, and through a link to the survey on one of the largest international life science job websites, Naturejobs.com, which is related to Nature, one of the most prestigious life science publications. The number of responses from each of these collectors is found in Appendix A.

The CiLS study was presented as a survey about science careers, and international mobility was not a screening criterion, or in other words, was not required. Instead, respondents were screened on either currently studying or already having a degree in the life sciences or having already worked in a life science job or internship. As the survey was designed as an exploratory study to look at new patterns in life science careers and international mobility, it was very detailed, containing 121 questions, some of which involved multiple statements and rating scales. The goal was to get international data on life scientists from understudied countries and new information on current dynamics of international mobility, rather than a high number of responses. It was also designed to be a springboard for further research on life scientists’ careers and their international mobility. The survey was completed by 594 individuals, including both students and those working in the life sciences or related fields. The responses came from 69 countries, with the largest number of responses from the countries where YEBN is strongest as well as from India, the country that had the most responses to the Naturejobs survey link (34% of responses from this source were from India).

Participant observation also allowed the data and analysis to develop. Notably, I was actively involved in the Young European Biotech Network, attending in-person team meetings for the Careers in Life Science project, the YEBN annual meetings, and either
personally presenting the results of the CiLS survey, or helping to prepare presentations for others, at both internal YEBN meetings and organized life science career conferences. This allowed me to have greater understanding of life scientists and their concerns and provided feedback on the preliminary results of the CiLS study. A second aspect of participant observation occurred as I lived as an internationally mobile individual, as an American citizen living in four different European countries while working on this study. While this did not strongly influence the primary data collection, it exposed me to contextual differences that likely had a broader influence on my analysis of factors influencing international mobility and the aspects that need to be developed to better understand the global competition for talent.

PRODUCTIVITY, PEOPLE, PLACE, AND POLICY FRAMEWORK AS APPLIED TO LIFE SCIENCE CAREERS

The following sections will look at each of the aspects of the analytical framework – people, place, productivity, and policy – as revealed through this study focusing on international mobility of life scientists. Each section contains a reflection on some key findings on each of these aspects, to better understand how they can apply to careers of life scientists and their international mobility decisions. This is not to say that immigration or scientific mobility is the only way to improve the amount or quality of ‘talent,’ but rather it gives a more in-depth look at the influence of this one route to address issues related to ‘talent’. While many contextual features will vary across countries, the ‘most competitive’ economies will likely have managed to successfully intertwine all the aspects of the analytical framework – productivity, people, place, and policy. The strategy taken and the results of how each is performed will clearly vary across countries. However, it is also my perspective that ‘success’ can only be measured as a single point in time, as global dynamics continue to change, as regulation shifts, as new companies emerge or old ones fail, as innovative technology replaces older processes or topics of scientific research, and as countries develop, to name a few.

Productivity

The economic importance of the knowledge economy in the past decade has been demonstrated in statistics. Under this larger umbrella of a ‘knowledge economy,’ the life sciences and biotechnology have been growing in their relative size and importance. Indications include:

- Rising R&D and life science strength in developing economies, offering both a further source of competition and international collaboration for advanced economies
- Relative importance of sectors such as pharmaceuticals and chemicals, fields which also can be tied with goals and tools of biotechnology, in Europe.

Given these changes, competitiveness has become a crucial concept in understanding and supporting the knowledge economy, but measuring competitiveness is forged with many difficulties. One of the major problems is the lack of comparable data to measure various aspects of competitiveness that are linked with the workforce dimension. There are also problems to properly account for effects of internationalization. The effects of
international markets are hard to define, measure, and assess and taking a view of ‘national’ competition may analytically counteract the assessment of these synergies. Life science research involves a large degree of internationalization and through a range of forms, including international mobility of scientists in various career stages and for various durations, and international research projects with teams in diverse countries.

As was shown in the theoretical framework, productivity is important not only on a macro-level and among countries, but also among individuals. The presence of individual, ‘star’ scientists (see e.g. Tripl, 2013; Zucker & Darby, 2006; Zucker & Darby, 2007) have been found in other research to have an important role on the scientific productivity of the region where they reside. This is a result of both their own innovation contributions, including in the form of publications or patents, and because their presence can attract other talented scientists. This points out to the importance of the individual in the global competition for talent, and again shows that understanding ‘talent’ as defined narrowly by personal characteristics is important as well as understanding employment areas and skills in demand on a broader scale.

After better understanding the general context in which interest in the global competition for talent is emerging, the study turned to examine structural aspects specific to life scientists in particular. It was argued that life science careers now take a very different form than before, and one that the life scientists’ may not be anticipating. First of all, with the growth of the knowledge economy, there is an increasing role of research done by companies, or within industry, rather than academic research. Academic research has been seen as the ideal path among scientists, and their training has traditionally been geared toward conducting research for publication. The work in companies usually is driven more by products, and patenting, although some companies allow their employees to publish, in part because they realize it is important to the individual. At the same time, academic research in many advanced countries like the US and UK are increasingly involving short-term, insecure work, such as through post-doctoral positions. Few tenured positions are available. This means that although life science researchers may have high human capital, a PhD degree or more, they are not necessarily benefiting from higher pay or better positions. Of course, the structure of employment and the conditions vary by country, but the main trend is that the type of jobs available has changed.

Demand for scientists is also difficult to predict, as the relative importance of different research specializations change based on new technology and findings, and new biotech companies seem to rapidly open, as well as close. Given the insecurity, usually scientists who want to work in industry are most interested in the large, prestigious international organizations and companies. This is likely due both to stability as well as the type of opportunities and work these organizations offer. SMEs have low appeal, among the scientists in the CiLS survey.

Another aspect of productivity in the theoretical framework is related to the development and presence of clusters, strong regions in one economic sector. From the example of biotech, it seems that very few clusters are recognized by individuals in this field; in the CiLS study, the most recognized biotech clusters were only named by around 15% of the sample. These include the area around Boston and clusters in California in the US, London in the UK, and Basel, Switzerland. The US and Germany had several
recognizable biotech clusters, which is one form of evidence of their strength in biotechnology.

People

The main goal of the topic of ‘people’ is to better understand the workforce dimensions of competitiveness in the selected area of employment, the life sciences and biotechnology. On one hand, this involves understanding the human capital and demographic characteristics of the global workforce, and particularly how these have changed. On the other hand it involves understanding the workforce’ motivations, as this is crucial to facilitating the productivity of the individual.

What can be said of the changing trends in human capital and demographic characteristics, as related to employment within the global competition for talent? While in the past, international transferees were associated with a few countries, such as the US, Japan, or parts of Europe, and primarily found in managerial positions or those needing high levels of expertise, the ‘new’ landscape will include people from a much wider range of countries moving in all stages of the career ladder and in various professions. These moves are also occurring on one hand to places recognized as leaders in the given field, and on the other hand to anywhere where the business or organizational linkages exist. There is also evidence that international moves are more often initiated by the individual and their preferences, rather than the employer ‘sending’ them on international assignments (Al Ariss, 2010; Andresen, Al Ariss, & Walther, 2012; Doherty, Richardson, Thorn, Al Ariss, & Crowley-Henry, 2013; Vaiman & Haslberger, 2013).

Not only are patterns of employment changing, but international education is also growing in two ways. First of all, the number of people with a Bachelor’s degree or higher is also increasing, and particularly within ‘emerging’ economies (Eastern Europe, India, China, Brazil). Second, there are also increasing numbers of international students and this has implications for both developing and developed countries. The trend of studying abroad can be seen as changing one’s individual human capital, since skills and credentials acquired abroad can be different from those available in their home country. International student mobility can also be a route to access labor markets abroad, whereby more international students equates to a more international workforce in those countries. Given that many countries in Europe have implemented a skilled migration policy relatively recently (since the 2000s or later), the changes in student mobility are part of the shift that reflects more openness to allow more mobility of skilled individuals, even when it is only in the form of shorter-term student mobility and not for employment.

These changes have led the topic of the global competition for talent to have relevance for both developed and developing economies, as well as for both established and emerging sectors of employment within those economies.

Important demographic changes are also seen in the life sciences, through data on students and the workforce. These changes are not marginal – there are several important changes regarding the ‘new’ characteristics of the scientific workforce. First, it has been found that scientific careers tend to have a low appeal in many advanced economies (Sjoberg & Schreiner, 2010), while they are held in high regard by those in ‘emerging’ or developing economies. This trend points to a likelihood that scientists from so-called
‘periphery’ countries (in global systems theory) may make up the ‘core’ of the knowledge economy and productivity aspects listed above, particularly if future trends follow the current course. Second, although science has long been seen as a man’s world, statistics and this research show nearly equal numbers of males and females studying life scientists in many countries, including in Europe, and in some countries, females outnumber male doctorate candidates (for instance, in Sweden). Although the senior positions, to date, are still held mostly by men, in time it looks as though this gender imbalance may change. There is a need to better understand relationships between gender and life science careers and to recognize and address concerns of female scientists. Third, as science becomes more internationalized, having experience abroad is seen as part of the career path, whether the individual is from a country or university that is highly competitive in the life sciences or whether they are from a developing or developed country. This trend was revealed for life scientists who partook in this study. Among the total sample, the rates of having already lived abroad for three months or longer was 58% of individuals with a Bachelor’s or Master’s degree, 69% of individuals with a PhD, and 85% of those with a post-doctorate degree.

International mobility is seen as a way to advance one’s research skills and credentials, often for both scientists in developing as well as in developed countries. It is also seen as important for building ‘soft’ skills and for personal development, particularly open-mindedness that indirectly allows for new research perspectives and is highly valued, or even required, by many employers. International mobility is also a way to build networks for further research projects. It is often a way to access better research labs and equipment, whether for individuals from developing countries, or for people with niche specializations to go to the ‘hubs’ for their research field. Furthermore, some scientists note that as science tackles problems of global importance, being able to take a global perspective is necessary.

However, it cannot be assumed that life scientists are aiming for long stays in the countries they move to. The CiLS research showed that 1-3 years was the most desirable length of stay for life science work, whether in academia or industry, in either the US or a European country. In this context, the previous paradigms of brain drain versus brain gain are problematic, as multiple moves are likely after an initial period of international mobility, whether back to the home country or to a new destination.

(Perceptions of) Place

In the CiLS study, the reasons for choosing a destination provide evidence on how the perceptions of places may influence migration destination choice. This was done first through a rating scale of various statements about what is considered when choosing a destination to move to. Further info was added through an open-ended question, where the life scientists explained why the given country would be his/her first choice country to move for work in the life sciences. This means that the broader concept of place attractiveness can be examined, regardless of the country chosen.

First of all, the results show that productivity or competitiveness is a clear driver of location choice. The research infrastructure, in terms of equipment and strong research in one’s field, attract many individuals, as does a strong scientific work culture. Unsurprisingly, people are drawn to places where they feel they will have opportunities.
Salary is generally not the main driver for life scientists, who instead are driven by being able to produce strong research and improve their skills and qualifications as a researcher. Second, diversity and openness clearly matter strongly in professional work decisions. In other words, general discourse around openness and the reception to foreigners will be important on how ‘attractive’ countries can be and how likely people will be willing to stay to work there after finishing their studies. Diversity and openness matter not only because they create atmospheres that many individuals find attractive, but also because they are more likely to afford equal opportunities and hence better chances of career advancement.

Third, it is not only the career aspects that matter but also the perceived quality of life at that location, the perceived lifestyle there, and the individual’s assessment of how easy it will be for them to adjust there. For some individuals, having family or friends close by is an important part of this adjustment, but many others feel it is less important since new friendships will form after moving. The proximity to the home country is an important driver for many people, and means that other European countries are often the most attractive destinations for European scientists. Language also matters, but some individuals want to move to places where they are already fluent in the language, while others wish to build language skills.

What was found in terms of the actual destination choices? The US, Germany, the UK and Switzerland all emerge in the CiLS study as leading destinations, and have global pull, meaning they are attractive to individuals from outside of the general region. This is linked in part to the size of the life science sector and the performance of its universities and companies in this regard. The US is typically considered the most competitive country in biotechnology and this was also reflected in the CiLS survey results. The US is the top destination of interest for the CiLS respondents, but it did not have a strong lead (as it was only named by 18% of CiLS respondents as first choice). Although the highest levels of interest among life scientists surveyed were for working in the US, most intend to move there temporarily. Interestingly, among the CiLS sample, usually there was more interest in longer stays for work in European countries. The US is seen as an important destination for building skills, learning new ways of researching, and often as a good credential on one’s CV/resume.

Germany was shown to be a leader in attracting life scientists. Germany has a very strong scientific reputation, has been seen as open to international students (which was evident in its high levels of attractiveness to Indian citizens), has had active policy support to build new biotech clusters, and also has been involved in international collaborations, which has given life scientists a personal, and positive view of scientists in Germany.

Policy
The findings regarding the structural aspects of the global competition for talent are examined in Part I. As the policy aspect overlaps a great deal with the other aspects of the framework, a few of the main trends will be only briefly highlighted. First of all, new policies for student migration have led to new trends, of movements among and between developing and developed countries. The increases in student migration policies are not necessarily reflective of national changes, but also of institutional changes. For instance, universities in many countries now use higher fees for foreign students as a way to
increase the money in their education systems. Second, as described in Chapter 4, following the increasing interest in competitiveness, more countries began skilled migration policies by the 2000s. Skilled labor migration has previously been relatively small in most of Europe. In Chapter 4, I argued that a reluctant convergence is occurring in regards to skilled mobility in Europe. Many European countries come from a background of wanting to restrict immigration in recent decades, to now trying to facilitate migration in specific forms, which are thought to be beneficial. This has led to a start of new skilled migration policies in many European countries in the 2000s.

While there is an increase in the amount of national skilled migration programs, there is also increasing mobility due to EU directives that are not explicitly part of migration policy. Importantly, there has been a standardization of European education through the Bologna Process, which facilitates international student mobility. Another Directive that is central to this study is the Researchers’ Directive, allowing easier mobility of international researchers to come to and work within the EU. These Directives, which are not part of immigration policy per se, are among the most important policy changes having an impact on the mobility of researchers, and have been made on the supranational level, which then is applied by individual countries in the EU. Globally, these policy changes are of interest, as it aims to make Europe as a whole more competitive for research, rather than having a myriad of different entry criteria in the different member states.

Governments have a central role in the ‘global competition for talent’, as they are largely responsible both for resources related to education and to possibilities (versus restrictions) on immigration. The protectionist attitudes that guard industries may also carry over to ‘protecting’ the local worker and boost a call for restrictions on immigration in all forms, including for the highly skilled. When governments choose to enter the global competition for talent, by actively seeking out skilled labor in general or for specific sectors, the policies must be made with the ‘people’ aspects in mind – an understanding of personal and career goals and patterns in high-growth sectors is important. One issue that is considered to be of central importance is the possibility for the spouse to work there as well. It is important to keep in mind that there are many dual-life science research career households, as well as households where the spouse works in a different career.

ADVANCING THEORY ON THE GLOBAL COMPETITION FOR TALENT

What has become clear in this research project is that the global competition for talent should be seen as more than a buzzword, as it is reflective of new, changing, and increasing, mobility dynamics and global economic paths and concerns. Yet, as a concept, the global competition for talent borrows from other theoretical work, rather than already having its own widely accepted framework.

The theoretical lens taken for this study has involved integrating theories on competitiveness and immigration, particularly as related to the current discussion about ‘talent.’ This perspective was found to be a good starting point, but only a starting point. In other words, weaknesses in applying these theoretical lenses to research on the global competition for talent emerged through empirical study.
The main three theories used relate to the three main themes that frame the interest in the global competition for talent – increasing importance of knowledge workers (Drucker, 1986; 1999), changing assessments of national competitiveness (Porter, 1990; Porter, 1998), and ‘technology, tolerance and talent’ as contributors to this competitiveness (Florida, 2002; 2005). All three of these theories were all found to still be highly relevant, although an eye needs to be turned to new dynamics and diversity in contexts.

Drucker’s observations about the rise of the knowledge worker are very important, although there is still difficulty in fully measuring its effects. Knowledge workers are one of the economic cores of the modern economy, and part of the interest in ‘talent’ is a new development of how businesses and human resources departments aim to address these concerns. A single individual can have a large impact on competitiveness, and there is a need to be sure organizations are in touch with their aspirations, so that they do not move on elsewhere. While this is a micro-economic example, the same would apply to policies for skilled migration. Governments need to take into consideration the needs of the modern knowledge worker, and take into account that the immigration programs address their core needs and that of their families (when relevant).

Porter’s theories on competitiveness are very complex, laid out in several books. His core idea that productivity is the appropriate measure of competitiveness in the modern economy and this idea fits well within new studies related to the global competition for talent. Porter argued that productivity is a good measure because it relates not only to economic output, but also to quality of life. In other words, countries with high productivity also can have higher wages or social benefits and still be competitive. This line of reasoning is also important for understanding the global competition for talent, as scientists’ (and likely other skilled and creative individuals) were found to consider both aspects related to the competitiveness, such as in the form of high-quality scientific research and career opportunities there, but also in terms of the perception of quality of life in that country. When productivity is being applied to study the global competition for talent, it needs to be understood that it is not just about the output—the publications, the patents, the number of research graduates, or R&D employees – all of these contribute, but they lack the ability to address the impact of individual preferences and the effect of differences in the opportunity structure in different countries. As also show above, although the workforce is seen as a driver of competitiveness, measuring this influence has not been possible. Instead, competitiveness indexes typically rely on broader counts – the number of individuals working in R&D and the number of graduates (which often is for PhD students as a whole, or for science and engineering and not for specializations). Therefore there are clearly difficulties in measuring this competitiveness, despite the popularity of national competitiveness indexes.

Florida’s theory on the creative class likely drew attention to this topic of the global competition for talent. However, his framework of ‘technology, talent, and tolerance’ does not fully account for the measures of productivity so crucial to understand competitiveness. Analyzing the contributions of ‘technology’ suggests the concept of innovation, and indirectly point to one aspect of productivity, but it is an overly narrow description of it that could lead to misinterpretations. The same can be argued for his portrayal of the importance of ‘tolerance’ as his work, The Rise of the Creative Class, in part focuses on the acceptance of gays in an area, its index as a “melting pot” and the
amount of ‘bohemians’ (creative individuals). While this is reflective of a type of
tolerance or lifestyle choices, it is only one conceptualization of it, and one particular to
the US context. Perhaps Florida too recognizes this, as his follow-up work, The Flight of
the Creative Class, instead measures tolerance based on a values index, that is whether
the values are more traditional or secular, and a self-expression index, completely
different measures than what he used to examine the United States alone. The CiLS
research also showed that diversity and openness matter for location choice, yet it should
be questioned whether Florida’s measures are the best to assess tolerance, as it can
involve a complex relationship between multiple aspects. Many people are drawn to
places that openly accept diversity, in a wide range of ethnic, religious and cultural
forms, but they also seek diverse places in the hope that they will have equal
opportunities there -- whether due to gender or any other characteristic. This form of
tolerance happens in part because of diversity, but it also rests in societal attitudes toward
the foreigners that are present (as a place can have diverse population, yet not appreciate
this aspect) and whether or how institutions try to build inclusiveness among its
workforce. A place may have a large foreign population, yet generally look down upon
foreigners present. Or, it could have few foreigners residing there, yet treat the ones
present as highly valued additions to their society, whether the individual is there for the
short or long term.

Florida’s framework is also aimed at urban environments. Yet, top research institutes can
also be found in smaller cities that do not meet the type of diverse, tolerant, urban
environment that Florida describes. Not all people have a desire to live in an urban
environment, and countries that lack cosmopolitan cities but instead pride themselves on
their beautiful, natural environments, or high-quality of life, for example, can still be
highly competitive. Some individuals even seek out places dramatically different from
their own country, due to personal interests and the expectation that it will lead to
personal growth. Furthermore, fields like biotech research are relevant to both developing
and developed countries. A new framework was suggested that is expected to apply to
more contexts – the 4P framework. The key will be to mix people, place, productivity and
policy in a way that makes them attractive to individuals who would be interested in that
destination.

How can theoretical understanding of the relationships between immigration and
competitiveness be further advanced? To summarize, a primary barrier is that although
elements such as ‘knowledge’ and ‘human capital’ are seen to be crucial to modern-day
competitiveness as well as to skilled migration, they are not easily measured in a way that
keeps the human dimension alive, that is to say to recognize that individuals have their
own aspirations and personal as well as career motivations. Human capital is built on an
assumption that the values of skills are measurable, but is it really the same for all
individuals in any context?

Using specific career contexts as the starting point for examining mobility also may bring
about different conclusions as to the value of various skills versus education. One
argument that is commonly used against skilled migration in the US, for instance, is that
often the recipients are not among the highest in the educational ranks (Matloff, 2008),
but rather only hold a Bachelor’s degree and moderate salary. Yet, this critique does not
take into account whether the individual is in an early or late career stage, and the
education and skills appropriate for the job being filled. For example, post-doctorate positions in the US require very high education, but are considered to be relatively low-paid and insecure jobs. Collett and Zuleeg (2009) argue for the increasing importance of “soft, scarce and super skills” in skilled migration, which require possibilities for more a personal selection of migrants rather than broad lists of qualifications, as is found in most point systems or skilled migration visa programs.

There are a few precautions that should be made while advancing theory related to the global competition for talent. One is that the relevance and importance of competitiveness and competition should be separated within conceptual or theoretical frameworks. There may be a competition for resources, in this case for appropriate employees, occurring. However, there cannot be said to be a competition between countries, in the sense of a type of sports match. Competitiveness instead suggests underlying dynamics and advantages.

Another problem, which is closely tied to the idea of competition, is a tendency to want to name the countries that are ‘winners’ versus ‘losers’ in the global competition for talent. In terms of skilled migration, human capital theory and brain drain theory are closely intertwined in research (for a good overview of past research, see Cañibano & Woolley, 2015), even developing around the same time in the 1960s. This intermingling can be problematic, because using the term ‘brain drain’ can lead to an assumption that a skilled individual, or scientist, who leaves his or her own country, has done something harmful. This critique has been noted in the brain circulation perspective, where it is stated that many skilled individuals return, and with new or better skills or knowledge than before, hence enhancing their country of origin. But what of how international mobility fits into career dynamics? This is where new research on the global competition for talent becomes very interesting and relevant. International mobility has become integrated in the career structure of life scientists in many countries. It therefore cannot just be said that a place aims to ‘attract’ scientists, but also that scientists aim to make themselves more ‘attractive’ through international mobility. International mobility therefore is a career ‘stepping stone’, to use the words applied in the CiLS survey, and the individual is stepping toward a research career, and often one they could foresee taking place in any of a number of countries. Life science research often aims to tackle problems of global importance – improved healthcare, environmental sustainability, improving food supply. Many scientists are influenced by altruistic motives as well as a strong sense of curiosity. They recognize that solving global problems will require a broad, open-mind, and international mobility is seen as building these perspectives. In many countries, international mobility is seen as critical for life science careers, to build new skills and/or for international collaboration and networks. Many individuals, who are not necessarily personally highly attracted to the idea of moving internationally, see it is as essential to their career. Life scientist, particularly in continental Europe (given that the CiLS data suggests that the US and UK are exceptions) and many developing countries, say it is often a requirement for academic jobs in their home country, and also valued by companies.

Expressing the increasing integration of international mobility within life science career paths does not imply that the brain drain perspective is necessarily wrong—We can expect that brain drain can be occurring in some contexts, particularly where the sector of
study is too underdeveloped to have viable employment options or when there are barriers within the opportunity structure, including non-competitive hiring practices or discrimination, for example, to access these jobs. But in the context where the sector is present, assuming ‘brain drain’ ignores the importance of international mobility for building both skills and contacts. It also ignores that science is increasingly international, both as the topics address issues of global concern and as research is conducted in multiple countries. The discussions of scientific mobility instead points out that brain drain discussion is problematic from its basic premise that moves are in a model of going to one place and staying, or at some point returning home. It is further problematic in that the outcome is already decided before the processes or motivations involved are assessed. It is sometimes assumed that developing countries have to be in either a pattern of brain drain or brain circulation to thrive, but has this been proven or is it based on historical patterns that have since changed? The perspective of scientific mobility is therefore more appropriate as it looks at stays of any duration and to and from any country, regardless of the level of development.

A second analytical problem is that the ‘talent’ perspective is still developing and not yet fully defined. In its present stage it allows analysis to focus both on skills as a whole as well as the importance of contributions of individuals, such as ‘star’ scientists. It should be kept in mind that interest in ‘talent’ is occurring both in management literature, as well as in topics that take a more macro-economic focus and related to competitiveness. Migration research on the global competition for talent often fits into this second category.

Advancing research and understanding on the global competition for talent would be helpful to remedy this situation, particularly by researching a large range of countries for a more narrow focus on specific sectors of employment or study. The 4P framework of productivity, people, place and policy was found to be relevant and revealed a wide range of new information helpful to better understanding the global competition for talent among life scientists. This approach is need to better fit within the competitiveness perspective, whereby it is argued that specific sectors must be used for discussions of international competitiveness to make sense. This approach also allows both for assessments of various scales, be it a company or a country’s ability to ‘attract’ individuals. And, importantly, it frames this within global context. It already assumes that the dynamics of international mobility are changing, and that both developing and developed countries have a crucial position in this change, and that neither its processes nor its effects are completely understood yet. It is not a matter of who ‘sends’ and who ‘receives’ the individual necessarily, but rather of how fields such as those in the sciences have both international importance and can be connected by large, international teams or networks. These networks may be made up in part of individuals who ‘return,’ but also form as science and the issues addressed are global concerns, and a combination of shorter-term visits and conferences, exchange programs, student migration, working abroad, and joint research done in different locations all feed into the network.

The changing dynamics of the so-called ‘global competition for talent’ also provides challenges for further theoretical developments. Building on the work done in this research, a few challenges have been identified:
1. Challenges related to migration theory, as international mobility becomes more and more fluid, with fewer border restrictions and an active aim to ‘attract’ certain categories, either those that are needed in local labor markets (shortages of certain professions) or are said to be in top demand globally (wanting to attract the best in these fields). One theoretical idea that will likely become more relevant is that of place attractiveness on the global, regional, and national levels. Empirically, there will be a need to see how and why new patterns of skilled migration or scientific mobility have emerged, where past migration streams would lead to a prediction of different patterns. The talent perspective also embodies discussions of place attractiveness, why one place, whether a country or city, is more attractive to individuals than another. This discussion is closely tied to geographic research, and in this context to economic geography.

2. The challenge of further linking theoretical understandings related to the impact of individual characteristics, qualities, and decision-making with theoretical and empirical frameworks for economic competitiveness.

3. Understandings of the global competition for talent as influenced by employment and welfare trajectories of various countries: Generally the statistical trends show that the global competition for talent is too new and statistics too thin in many European countries to discuss firmly decided ‘strategies,’ particularly linked to welfare states that set its course in the global competition for talent. Democracy will mean finding a place among potential public resistance, in counteraction with likely support from some businesses.

Competitiveness and immigration, in terms of destination selection, are mutually reinforcing. In other words, the competitiveness of a place has some influence on the destination chosen, and attracting ‘talent’ through immigration can also boost the attractiveness of these destinations further. There are a range of other studies and findings that relate to this assumption – for instance, the idea of being able to build critical mass of professionals in core clusters and the ideas of Florida which were also confirmed by the CiLS research, that diversity and tolerance increase the attractiveness of a location. Hence, understanding the global competition for talent in the knowledge economy involves both analysis of how competitiveness influences immigration patterns as well as how immigration can influence the competitiveness of the locations where individuals choose to move.
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This study argues that skilled human mobility and specifically that for occupations linked to innovation, such as for science and technology, has undergone a rapid and continuing internationalization. This change has theoretical implications and requires a greater merging of theories in diverse disciplines. The main premise of the study is that the ‘global competition for talent’ has come into play in media, policy, and migration research, but more as a catchword rather than as an intricately defined concept or theory that pays attention to both the more ‘global’ changes as well as the particularities of career and country or regional contexts. This study’s aim is to begin closing this gap by discussing the theoretical frameworks and changes surrounding international skilled labor mobility, developing a more integrated framework for assessing the now only speculative global competition for talent, and looking at variations through a case study, focusing on life scientists.

Part I examines skilled migration in global context more generally, answering the question, what structures the global competition for talent? It is built primarily from desk research, including reviews of academic literature on skilled and student migration, statistical data on international mobility, and a review of policy documents, particularly those focused on comparing migration and mobility in Europe. The analysis addresses how concepts and data (policies, statistics detailing changes) related to both skilled migration and competitiveness be linked to better understand the development of the global competition for talent. The main argument is that implicit in the paradigm of a ‘global competition for talent’ are theoretical debates on the foundations for (national) economic competitiveness arising from processes of globalization, which need to be discussed in a more nuanced way in light of the relative positioning of states in terms of their economic structures, openness to labor migration in general as well as the characteristics of the national labor force, and while considering both global and local dynamics.

Chapter 1 focuses on the concept or theories of international competitiveness and particularly in light of changes related to the knowledge economy and how they relate to the workforce. It draws on three main concepts: Porter’s (1990; 1998; 2003) analysis of the importance of productivity for competitiveness, Drucker’s (1986; 1999) concept of the knowledge worker, and Florida’s (2002; 2005) 3T framework for economic development. In brief, Porter argues that competitiveness must be measured by productivity in order to be meaningful and is best assessed by looking at industries. Drucker found that individuals, who he called knowledge workers, are central to productivity in the knowledge economy and that organizations will need to be able to meet their needs in order to be competitive. Florida argues that technology, talent and tolerance (3Ts) are the core of modern economic development. Florida’s work also expanded recognition that immigration can be linked with the competitiveness of cities or regions, as diversity both fosters creativity and innovation and attracts more of these innovative individuals. Taken together, these theories also point to the reasons for the growing importance of the concept of talent for competitiveness, both in companies’ strategies, as reflected in the human resources literature, and also in immigration studies.
Chapter 2 discusses the concept of the “global competition for talent” linking it with the theoretical literature related to skilled migration. It showed that in the 2000s skilled migration policies were implemented in more countries, where they had not existed before, and new attention was also turned to student migration. It argues that this migration is coming from and going to a wider range of countries, including both developed and developing countries.

Chapter 3 provides an overview of the research questions and the research methodology adopted. It is then followed by an analytic 4P framework for assessing the global competition for talent, consisting of productivity, people, place and policy. The framework better combines theories on both immigration and competitiveness, to understand new dynamics. It is unique in that it is relevant for both developing and developed countries, whereas Florida’s 3T framework was mostly based on the urban, US context.

*Productivity* is the overarching support of the 4P framework and incorporates competitiveness. Following the research of Porter, productivity is best assessed on the level of industries or fields of employment. The aspect of people examines the workforce dimensions of competitiveness. On one hand, this involves understanding the human capital and demographic characteristics of the workforce, and particularly how these have changed in fields where workers are in high demand. On the other hand it involves the workforce’s motivations, as this is crucial to facilitating the productivity of the individual. Location choice for work is also influenced by individual preferences, and in the 4P framework, is included in the third aspect, place. Perceptions are central to understanding the role of place in the global competition for talent – the country and city image, expectations about the opportunity structure and professional opportunities, and the quality of life in a country or city. Finally, drawing from the work of Eggers and Hagel (2012), policy is relevant to the global competition for talent and includes that which influences competitiveness in international markets (including innovation and R&D policies, foreign direct investment, and intellectual property law) as well as those which foster development of the workforce (including both education and immigration policies). These policies can be implemented on any level, from the local to the supranational (see Reiner, 2010).

Chapter 4 examines skilled migration and mobility policies and patterns, focusing on Europe. This chapter argues that homogenizing EU-level policies have broadened student and scientific mobility, and many of these policies have often occurred outside the domain of ‘immigration’ policy. Although immigration still largely remains an issue considered to be central to national sovereignty, the EU is increasing its role in setting and harmonizing policies across its member states that relate to international mobility. Some important initiatives include the Bologna Process to harmonize degree recognition and internationalize European education, the Blue Card visa for skilled migration, and the start of the European Research Area. While the ‘competition for talent’ has gained some attention, national policy responses have been fragmented and at times resistant to implementing more migration programs or supporting labor mobility.

**Part II then analyzes: which patterns have influenced the development of the global competition for talent as observed in the life sciences/biotechnology in particular?**
This analysis is constructed largely from the CiLS survey on skills and international scientific mobility, which I designed, working together with a team from the Young European Biotech Network (YEBN). YEBN is an umbrella organization, made up of various other organizations, largely biotech student associations, in various countries in Europe. The survey was conducted online in late 2008-early 2009 and was completed by 594 individuals, including both students and those working in the life sciences or related fields. The responses came from 69 countries. The data is mostly analyzed either by for the total, or by citizens of countries, particularly for countries with highest number of respondents -- Germany, Italy, India, Spain, Switzerland, the EU-10 countries, and a grouping of other developing countries. Scientific mobility in this study is defined as individuals with a higher education in the life sciences who have moved internationally for stays of two months or longer, not including holidays/vacations.

Chapter 5 addresses the research question: what are the features of the labor market within which life scientists work? It shows that large-scale changes are occurring both in the career trajectories and demographic characteristics of life scientists. Life scientists and their education have traditionally been geared towards academia and publishing of results. One of the main findings is that the sample has the highest interest 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. Second, demographic characteristics of life scientists have changed. More than half of advanced life science students are female, in countries where data is available. There is also high interest in science careers among people from developing countries. In combination with the increasing global mobility, the internationalization of the sciences is increasing, as evident through looking at published journal articles. These partnerships further reflect international networks among institutions, networks that may lead to future exchange of students and faculty. Finally, postdoc positions have become a more common part of the career trajectory, but this is usually based on aims for academic tenure, and it is not clear whether having a postdoc is an advantage for working in industry. With so many changes, there are also multiple configurations for competitiveness, whether it is viewed in terms of personal career strategies or institutional structures.

Chapter 6 examines the question: how important/prominent is international mobility among life scientists? International 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 in the CiLS data, including past mobility (around 60% of respondents), interest in future international mobility (few individuals express low levels of interest to move abroad), and the rating of the importance of international mobility in life science careers (which varies by country). Respondents from most 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, international mobility is seen not just as a personal experience, but as a qualification that is helpful, or even essential, in the life science job market. Furthermore, 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 as well as dual science-career households. 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.

Chapter 7 first analyzes: which factors are considered and influence life scientists’ intentions to move or moves abroad? This chapter builds from a framework for assessing skilled migration reasons for destination choice created by Papademetriou, Somerville, and Tanaka (2009, pp. 242-253), and then modifies it for life scientists in particular through the CiLS data, including rating scales and reasons for country choice as an open-ended question. It was found that career-based factors, including research excellence, opportunities, and presence of other talented scientists and good work culture, act in combination with quality of life and lifestyle factors for location choice. Scientists have also been found to generally be driven to move due to their desire to conduct high-quality research, rather than salary. Next, the question, which countries are attractive to life scientists and why, is addressed. For the survey respondents, the United States remains among the most popular destinations and can be seen as a ‘magnet’ country, attracting scientists based on its reputation for scientific research, but it has a very marginal lead and is mentioned as first choice by 18% of CiLS respondents. Additionally, the UK, Germany, and Switzerland are also seen as highly desirable locations, due to the size of the life science sector and quality of research and job opportunities there. It also is important to realize many life scientists would consider moving to any of a range of different countries where they believe they can have productive careers.

Chapter 8 addresses differences in competitiveness in various countries, and its impact on life scientists’ mobility decisions. It shows international statistics that indicate the US is the global leader in biotechnology, but with many countries active in this field. It then presents CiLS data, whereby respondent were asked to name regions and countries that are competitive in the life sciences and biotechnology industry. The highest recognized regions by the CiLS sample were in the US (California and the area around Boston, Massachusetts), UK (London), Switzerland (Basel), and Germany (Munich) as the only regions named by at least 10% of respondents. Next, the chapter examines which duration of stay is most desired for moves for life science jobs in the US and in Europe? Most respondents expect international mobility to improve job opportunities in their home country, and this often applies to individuals from both developing and developed countries. What is also shown is that the intentions for moves often defy conceptions about migration. Permanent moves are typically not the most desirable, regardless of the country of origin. This is even in light of academic careers sometimes involving tenure, or permanent positions. Among citizens of European countries, there is higher interest in longer-term relocations for moves within Europe than to the US. Most individuals view international mobility as improving their job prospects in their home country or as leading to additional international moves. This chapter argues that the competitiveness of countries alone is not enough to understand the retention of life scientists, but that the opportunity structure, which is in part due to cultural norms and practices, including work culture, has a large influence. Generally the dynamics of scientific mobility within the global competition for talent are more complex than that which can be defined as a relative gain or loss the country being studied.
In conclusion, with both changing demands of the knowledge economy and from globalization processes, advancing understanding of the global competition for talent, the focus of this research, is essential. This shifting interest to immigration as global is new, as immigration studies to date have mostly taken the view of the nation-state as the main context and ties between two specific countries, rather than of dynamic globalized systems. Although the situations of nation-states will continue to frame much of the skilled migration discussion, there will be a need to also compare the attractiveness across countries, which can also be viewed as competitiveness on an international scale, as well as to understand how and why new international skilled mobility patterns are appearing. It also involves understanding the local contexts which support or hinder their development, or variations in the broader opportunity structure, and includes shifts when policies change and organizations adapt. Although elements such as ‘knowledge’ and ‘human capital’ are seen to be crucial to modern-day competitiveness as well as to skilled migration, they are not easily measured in a way that keeps the human dimension alive, that is by including career aspirations and personal motivations.

Competitiveness and immigration, in terms of destination selection, are mutually reinforcing. In other words, economic competitiveness has some influence on the destination chosen, and attracting ‘talent’ through immigration can also boost the attractiveness of these destinations further. There are a range of other studies and findings that relate to this assumption – for instance, the idea of being able to build critical mass of professionals in core clusters and the ideas of Florida that diversity and tolerance increase the attractiveness of a location. The 4P framework of productivity, people, place and policy can reveal a wide range of information to better understanding the global competition for talent. This approach allows a better fit within the competitiveness perspective, including with a focus on specific industries, and, importantly, it frames this within changing global and local contexts.
SAMENVATTING


Het uitgangspunt van dit onderzoek is dat de mobiliteit van kenniswerkers, met name van degenen die werkzaam zijn in de sfeer van innovatie, zoals wetenschap en technologie, in een snel tempo steeds internationaler wordt. De duiding van deze ontwikkeling vereist een combinatie van theoretische inzichten uit verschillende disciplines. De mondiale strijd om talent manifesteert zich in de media, het beleid en migratie onderzoek, maar dan toch vooral als een vlotte term en niet als een zorgvuldig gedefinieerd concept of theorie die algemene mondiale veranderingen en de specificiteit van landelijke of regionale contexten apperecreert. Het doel van dit onderzoek is het dichten van deze kloof. Dit gebeurt door theoretische en empirische verkenning van de internationale migratie van hoogopgeleide kenniswerkers, en door de ontwikkeling van een meer omvattend theoretisch raamwerk, met de mobiliteit van life scientists als speciale casus.

Deel 1 beschrijft hoogopgeleide migratie op mondiaal niveau door met name aandacht te besteden aan de strijd om talent. Dit deel is vooral op literatuuronderzoek gebaseerd, waaronder academische literatuur over de migratie van studenten en kenniswerkers, statische data over internationale mobiliteit, alsmede beleidsdocumenten over migratie en mobiliteit in Europa. Op welke manier kunnen concepten en data van hooggeschoolde migratie en concurrentievermogen worden gekoppeld? Het voornaamste argument is dat het paradigma van een ‘mondiale strijd om talent’ impliciete theoretische aannames bevat over het (nationale) concurrentievermogen en globalisering, zonder die adequaat te relateren aan de herpositionering van staten in termen van economische structuur, de mate van openheid voor migratie, en kenmerken van de nationale beroepsbevolking.


Hoofdstuk 2 verbindt de discussie over de mondiale strijd om talent met theoretische literatuur over migratie van kenniswerkers. Het laat zien dat meer en meer landen
recentelijk beleid hebben ontwikkeld gericht op het aantrekken van kenniswerkers en van studenten. Het argument is dat steeds meer landen bij die migratie betrokken raken, zowel zendende als ontvangende landen, en zowel economisch geavanceerde landen als ontwikkelingslanden.

Hoofdstuk 3 bevat een overzicht van de onderzoeksvragen en onderzoeksmethodologie. Hierin wordt ook het 4P raamwerk gepresenteerd waarmee de mondiaal strijd om talent onderzocht kan worden; de 4Ps staan voor Productivity, People, Place en Policy. Dit raamwerk stelt ons beter in staat om de dynamiek van immigratie en concurrentievermogen theoretisch en empirisch te duiden. Terwijl Florida’s 3T raamwerk hoofdzakelijk betrekking had op een stedelijke context (en dan vooral in de Verenigde Staten), is het onderhavige raamwerk relevant voor zowel ontwikkelde landen als ontwikkelingslanden. Productivity verwijst naar concurrentievermogen. In navolging van Porter wordt productiviteit onderzocht op het niveau van sectoren of velden van werkgelegenheid. People verwijst naar de arbeidskrachten die in die sectoren of velden werkzaam zijn. Het gaat dan over opleidings- en ervaringskenmerken (human capital) en demografische kenmerken van de arbeidskrachten. Maar het gaat ook over de motivaties van de arbeidskrachten aangezien dit cruciaal zijn voor hun productiviteit. Place gaat vooral over de keuze voor bepaalde locaties om te werken, iets dat eveneens samenhangt met individuele preferenties. Het gaat dan ook om percepties, zoals het imago van de stad of het land van bestemming, verwachtingen van de kansenstructuur en carrièrekansen, en de kwaliteit van leven in die stad of dat land. Policy, tenslotte, is relevant voor de mondiaal strijd om talent, zoals Eggers en Hagel (2012) reeds hebben betoogd. Dit omvat alles wat concurrentievermogen in internationale markten beroert (waaronder ook beleid met betrekking tot innovatie en R&D, foreign direct investments, en intellectueel eigendom), en ook alles wat de ontwikkeling van de arbeidskrachten aangaat (waaronder onderwijs- en immigratiebeleid). Dit beleid kan op elk niveau worden ontwikkeld en geïmplementeerd, van lokaal tot supranationaal (zie Reiner, 2010).

Hoofdstuk 4 gaat over migratie van kenniswerkers en het migratiebeleid, met speciale aandacht voor Europa. Er wordt betoogd dat beleid op EU niveau de mobiliteit van studenten en kenniswerkers heeft vergroot, maar ook dat veel van dit beleid werd ontwikkeld buiten het beleidsterrein van ‘immigratie’. Hoewel immigratie voor de nationale soevereiniteit nog steeds een essentieel onderwerp is, regelt de EU steeds nadrukkelijker de internationale mobiliteit. Tot de belangrijke initiatieven horen het Bologna Process, dat beoogt het onderwijs te harmoniseren en te internationaliseren, de Blue Card visa voor kenniswerkers, en de start van de European Research Area. Terwijl de strijd om talent wat aandacht heeft gekregen, hebben nationale overheden wisselend en soms zelfs negatief gereageerd toen het ging om het implementeren van maatregelen die migratie en mobiliteit zouden bevorderen of ondersteunen.

Deel II analyseert de ontwikkeling van de mondiale strijd om talent in het algemeen en in de life sciences/biotechnology in het bijzonder. Deze analyse is grotendeels gebaseerd op de CiLS survey naar vaardigheden en internationale wetenschappelijke mobiliteit die ik speciaal hiervoor heb ontworpen samen met een team van het Young European Biotech Network (YEBN). YEBN is een koepelorganisatie die verschillende
andere organisaties samenbrengt, waaronder verenigingen van biotech studenten in uiteenlopende Europese landen. De survey werd online uitgevoerd vanaf het najaar van 2008 tot het voorjaar van 2009 en werd uiteindelijk ingevuld door 594 respondenten uit 69 landen, zowel studenten als professionals in het veld. In deze survey werd wetenschappelijke mobiliteit opgevat als de mobiliteit over grenzen van individuen die een hoge opleiding in de life sciences hebben gevolgd, en die naar een ander land trokken voor een periode van twee maanden of meer (vakanties niet inbegrepen). Hoofdstuk 5 beschrijft de kenmerken van de arbeidsmarkt waarin deze life scientists werken en laat ingrijpende veranderingen zien in hun loopbanen en demografische kenmerken. Life scientists en hun opleidingen waren traditioneel gericht op de academische wetenschap en op het publiceren van resultaten in academische tijdschriften. Life scientists blijken nog steeds grote belangstelling voor onderzoek te hebben, maar zij oriënteren zich niet uitsluitend meer op de universiteiten, maar in toenemende mate op de industrie. Verder blijkt meer dan de helft van de life science studenten vrouw te zijn, althans in de landen waarover data beschikbaar zijn, en steeds vaker komen zij uit ontwikkelingslanden. Tenslotte bleken postdoc posities een steeds normaler onderdeel van loopbanen te zijn. Voor degenen die een academische loopbaan ambiëren is dat essentieel; in hoeverre dat ook het geval is voor een loopbaan in de private sector is niet duidelijk. Al deze veranderingen in persoonlijke loopbaan strategieën en institutionele omgeving hebben vanzelfsprekend uiteenlopende effecten op het concurrentievermogen. Hoofdstuk 6 betreft de vraag hoe belangrijk internationale mobiliteit is voor life scientists. Het is inderdaad zo dat de meeste respondenten internationale mobiliteit zien als een essentieel onderdeel van hun loopbaan, vooral degenen die voor een academische loopbaan kiezen. Met name in Europa (met uitzondering van het Verenigd Koninkrijk) wordt internationale mobiliteit niet alleen gezien als een persoonlijke ervaring, maar als een handige extra of zelfs essentiële kwalificatie op de arbeidsmarkt voor life scientists. Het toegenomen belang van mobiliteit en ook de toegenomen mobiliteit zelf hebben gevolgen voor de familie structuur: we vonden vooral veel internationale tweepersoonshuishoudens als huishoudens waarvan beide partners in de life sciences werken. Uit ander onderzoek bleek al wel dat vrouwelijke life scientists het krijgen van kinderen uitstellen (Dean & Fleckenstein, 2007, p. 33), en in ons survey vonden we inderdaad opmerkelijk weinig gezinnen met kinderen. Meer onderzoek is nodig naar het verband tussen het hoge niveau van mobiliteit in de life sciences en de ontwikkeling van families.

Hoofdstuk 7 analyseert de factoren die van invloed zijn op de intenties van life scientists om naar het buitenland te vertrekken. Het bouwt voort op het model van Papademetriou, Somerville en Tanaka (2009, p. 242-253), zij het aangepast voor gebruik voor life scientists in de CLS survey. De analyse laat zien dat de intenties om te migreren worden beïnvloed door factoren die op de loopbaan betrekking hebben, zoals onderzoeksexcellentie, carrièrekansen, de onderzoeksomgeving (getalenteerde collega’s, werkcultuur), in combinatie met factoren die betrekking hebben op de kwaliteit van het leven en lifestyle. Verder kwam naar voren dat life scientists zich meer laten leiden door de wens om hoogwaardig onderzoek te doen dan de wens om veel te verdienen. De Verenigde Staten blijft een van de populairste bestemmingen (18 procent van de respondenten), maar het verschil met andere populaire bestemmingen zoals het Verenigd Koninkrijk, Duitsland en Zwitserland, is marginaal. De omvang van de life science
sector, de kwaliteit van het onderzoek en kansen op de arbeidsmarkt daar worden als gunstig beoordeeld. Het is evenwel belangrijk om te weten dat veel life scientists bereid zijn naar welk land dan ook te gaan als ze menen dat dit hun loopbaan kan bevorderen.

Hoofdstuk 8 gaat in op verschillen in concurrentievormgen in verschillende landen en hun invloed op de beslissing van life scientists om te migreren. Internationale statistieken laten zien dat de VS de ‘global leader’ in biotechnology is, maar veel landen zijn in deze sector actief. In de CiLS survey noemden tenminste 10 procent van de respondenten California en het gebied rond Boston, Massachusetts (VS), Londen (VK), Basel (Zwitserland), en München (Duitsland) als de meest hoogwaardige regio’s. De meeste respondenten kiezen voor internationale mobiliteit om hun kansen op de arbeidsmarkt thuis te kunnen verbeteren. Om die reden wensen zij niet permanent te migreren, zelfs niet als er sprake is van een vaste baan. Europese respondenten zijn wat meer dan anderen bereid om voor wat langere tijd te migreren, mits binnen Europa. Al met al blijkt dat het concurrentievormgen van landen op zichzelf niet voldoende is om de retentie van life scientists te begrijpen. De kansenstructuur, die deels is gevormd door culturele normen, is van grote invloed.

Migratiestudies hadden tot dusver vooral als uitgangspunt dat migratie plaats vindt tussen twee natie-stataten en dat de banden tussen die twee staten van groter belang is dan een dynamisch mondiaal systeem. Hoewel natie-stataten voorlopig bepalend blijven in discussies over de immigratie van kenniswerkers, is er ook de noodzaak om meerdere landen te vergelijken: welke kunnen het grootste concurrentievormgen aan de dag leggen, welke zijn voor kenniswerkers het meest aantrekkelijk, en welke migratiepatronen tekenen zich af? Daarbij blijft de lokale context met hun eigen beleidsposities en organisaties van belang. Kennis en ervaring (human capital) worden gezien als cruciaal voor moderne concurrentiekraft en dus ook voor de migratie van kenniswerkers, maar zoals uit deze studie blijkt spelen loopbaan aspiraties en persoonlijke motieven eveneens een grote rol.

Concurrentievormgen en de bestemming van kenniswerkers versterken elkaar wederzijds. Anders geformuleerd, concurrentievormgen heeft enige invloed op de keuze van een bestemming, en het aantrekken van talent door middel van immigratie versterkt de aantrekkelijkheid van die bestemming weer. Het 4P raamwerk van Productivity, People, Place en Policy helpt om beter begrip te krijgen voor de mondiaal strijd om talent. Deze benadering heeft immers meer oog voor de kenmerken van specifieke sectoren en de lokale en mondiaal dynamiek ervan.
APPENDICES

APPENDIX A: CILS SURVEY COLLECTORS AND INTERVIEWS

Table A.1: List of CILS survey collectors and number of responses

<table>
<thead>
<tr>
<th>Collector</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>YEBN newsletter</td>
<td>86</td>
<td>14.5</td>
<td>14.5</td>
</tr>
<tr>
<td>YEBN website</td>
<td>90</td>
<td>15.2</td>
<td>29.6</td>
</tr>
<tr>
<td>Naturejobs</td>
<td>194</td>
<td>32.7</td>
<td>62.3</td>
</tr>
<tr>
<td>European Fed. of Biotechnology newsletter</td>
<td>29</td>
<td>4.9</td>
<td>67.2</td>
</tr>
<tr>
<td>Email to YEBN members</td>
<td>13</td>
<td>2.2</td>
<td>69.4</td>
</tr>
<tr>
<td>MDC Grad School, Germany</td>
<td>25</td>
<td>4.2</td>
<td>73.6</td>
</tr>
<tr>
<td>UniBern, Switzerland</td>
<td>14</td>
<td>2.4</td>
<td>75.9</td>
</tr>
<tr>
<td>YEBN members' link to friends and contacts</td>
<td>23</td>
<td>3.9</td>
<td>79.8</td>
</tr>
<tr>
<td>Email to YEBN's contacts (non-members)</td>
<td>23</td>
<td>3.9</td>
<td>83.7</td>
</tr>
<tr>
<td>EPFL, Switzerland</td>
<td>70</td>
<td>11.8</td>
<td>95.5</td>
</tr>
<tr>
<td>BTmag. eu Careers blog</td>
<td>18</td>
<td>3.0</td>
<td>98.5</td>
</tr>
<tr>
<td>ETH, Switzerland</td>
<td>9</td>
<td>1.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>594</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table A.2 List of interviews in Lithuania

Chairman of Lithuanian Science Council, member of Lithuanian Academy of Sciences and Professor of Chemistry, Vilnius University

Member of organization of returning migrants from US

Returning scientist and top manager at Institute of Biotechnology, Vilnius

Returning scientist working at Institute of Chemistry, Vilnius

Expert on migration and brain drain, Vilnius University

Expert on migration and brain drain, Public Policy and Management Institute
## Table B.1 Levels of Education

Which of these best describes the highest level of education that you have ALREADY completed:

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary school/high school</td>
<td>9.8%</td>
<td>58</td>
</tr>
<tr>
<td>Apprentice, technician, or higher training in life science</td>
<td>1.3%</td>
<td>8</td>
</tr>
<tr>
<td>Bachelor’s or equivalent</td>
<td>16.7%</td>
<td>99</td>
</tr>
<tr>
<td>Master’s or equivalent</td>
<td>43.1%</td>
<td>256</td>
</tr>
<tr>
<td>PhD</td>
<td>13.6%</td>
<td>81</td>
</tr>
<tr>
<td>Post-doc</td>
<td>12.3%</td>
<td>73</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>3.2%</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>594</strong></td>
<td></td>
</tr>
</tbody>
</table>

## Table B.2 Twenty fields of graduate study of CiLS respondents, for highest level of education completed and current studies (Counts)

<table>
<thead>
<tr>
<th>Highest level of education completed</th>
<th>Current studies</th>
<th>Post-doc</th>
<th>PhD/MA</th>
<th>Post-doc</th>
<th>PhD/MA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnology</td>
<td>Molecular Biology</td>
<td>0</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molecular Biology</td>
<td>Biotechnology</td>
<td>0</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biochemistry</td>
<td>Cancer Research</td>
<td>1</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microbiology</td>
<td>Cell Biology</td>
<td>0</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genetics</td>
<td>Neurosciences</td>
<td>1</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cancer Research</td>
<td>Biochemistry</td>
<td>0</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immunology</td>
<td>Immunology</td>
<td>0</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bioinformatics</td>
<td>Genetics</td>
<td>0</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell Biology</td>
<td>Infectious Diseases</td>
<td>1</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant Sciences</td>
<td>Microbiology</td>
<td>0</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurosciences</td>
<td>Biomedical &amp; Tissue Engineering</td>
<td>1</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infectious Diseases</td>
<td>Pharmaceutical Sciences</td>
<td>0</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmaceutical Sciences</td>
<td>Plant Sciences</td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal Sciences</td>
<td>Developmental Biology</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developmental Biology</td>
<td>Bioinformatics</td>
<td>0</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table B.3 Cross-tabulation of citizenship by country of residence (at time of survey)

<table>
<thead>
<tr>
<th>Citizenship</th>
<th>WB Developing</th>
<th>India</th>
<th>EU 10</th>
<th>Germany</th>
<th>Italy</th>
<th>Spain</th>
<th>Switzerland</th>
<th>All other countries</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently live</td>
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</tr>
<tr>
<td>Count %</td>
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<td></td>
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</tr>
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<td>Germany</td>
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<td>63.7</td>
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<td>3.3</td>
<td>0</td>
<td>5.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Italy</td>
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<td>1</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>36</td>
<td>2.8</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
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<td>0.0</td>
<td>91.7</td>
<td>0.0</td>
<td>2.8</td>
<td>1.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Spain</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>57</td>
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<td>Switzerland</td>
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<td>6</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>40</td>
<td>21</td>
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<td>7.6</td>
<td>7.6</td>
<td>1.9</td>
<td>38.1</td>
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<tr>
<td>France</td>
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<td>1</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>11</td>
<td>9.1</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>9.1</td>
<td>9.1</td>
<td>27.3</td>
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<td>0.0</td>
<td>36.4</td>
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</tr>
<tr>
<td>The Netherlands</td>
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<td>2</td>
<td>2</td>
<td>0</td>
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<td>5</td>
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<tr>
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<td>0.0</td>
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<td>14.3</td>
<td>14.3</td>
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<td>0.0</td>
<td>7.1</td>
<td>0.0</td>
<td>35.7</td>
</tr>
<tr>
<td>Poland</td>
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<td>0</td>
<td>16</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0.0</td>
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</tr>
<tr>
<td></td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Sweden</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>0.0</td>
<td>37.5</td>
<td>12.5</td>
<td>12.5</td>
<td>0.0</td>
<td>12.5</td>
<td>0.0</td>
<td>12.5</td>
<td>100.0</td>
</tr>
<tr>
<td>UK</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>10</td>
<td>18</td>
<td>16.7</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>16.7</td>
<td>5.6</td>
<td>11.1</td>
<td>0.0</td>
<td>11.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>55.6</td>
</tr>
<tr>
<td>US</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>14</td>
<td>25</td>
<td>12.0</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>12.0</td>
<td>8.0</td>
<td>8.0</td>
<td>0.0</td>
<td>8.0</td>
<td>0.0</td>
<td>6.0</td>
<td>0.0</td>
<td>56.0</td>
</tr>
</tbody>
</table>
Table B.4 Residence of EU and Swiss citizens in CiLS survey

<table>
<thead>
<tr>
<th>EU or CH Citizenship</th>
<th>Live in same country</th>
<th>Moved to other EU or Switzerland</th>
</tr>
</thead>
<tbody>
<tr>
<td>349</td>
<td>246 (70%)</td>
<td>4</td>
</tr>
<tr>
<td>Central and Eastern Europe (EU-10) = 48</td>
<td>26 (54%)</td>
<td>10</td>
</tr>
<tr>
<td>Poland</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Latvia</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Lithuania</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Hungary</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Slovakia</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Slovenia</td>
<td>1</td>
<td>1 (US)</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>1</td>
<td>1 (US)</td>
</tr>
<tr>
<td>Romania</td>
<td>3</td>
<td>1 (Japan)</td>
</tr>
<tr>
<td>Germany</td>
<td>76</td>
<td>58 (76%)</td>
</tr>
<tr>
<td>Italy</td>
<td>49</td>
<td>33 (67%)</td>
</tr>
<tr>
<td>Spain</td>
<td>67</td>
<td>57 (85%)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>42</td>
<td>39 (93%)</td>
</tr>
<tr>
<td>Other EU</td>
<td>67</td>
<td>33 (49%)</td>
</tr>
<tr>
<td>France</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>UK</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Netherlands</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Belgium</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Austria</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Portugal</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Ireland</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Denmark</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Sweden</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Luxembourg, Finland, Greek 1 each</td>
<td>1 (Finland)</td>
<td>1 (Finland)</td>
</tr>
</tbody>
</table>
Table B.5 Countries included in Citizens of World Bank Developing Countries in the CiLS survey

<table>
<thead>
<tr>
<th>Countries in CiLS sample included in World Bank Developing*</th>
<th>Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>1</td>
</tr>
<tr>
<td>Argentina</td>
<td>6</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>3</td>
</tr>
<tr>
<td>Belize</td>
<td>1</td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>1</td>
</tr>
<tr>
<td>Brazil</td>
<td>3</td>
</tr>
<tr>
<td>Cameroon</td>
<td>1</td>
</tr>
<tr>
<td>Chile</td>
<td>3</td>
</tr>
<tr>
<td>Colombia</td>
<td>5</td>
</tr>
<tr>
<td>Croatia</td>
<td>4</td>
</tr>
<tr>
<td>Egypt</td>
<td>6</td>
</tr>
<tr>
<td>El Salvador</td>
<td>1</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>1</td>
</tr>
<tr>
<td>Guatemala</td>
<td>1</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1</td>
</tr>
<tr>
<td>Iran</td>
<td>7</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>1</td>
</tr>
<tr>
<td>Kenya</td>
<td>3</td>
</tr>
<tr>
<td>Malaysia</td>
<td>4</td>
</tr>
<tr>
<td>Mexico</td>
<td>8</td>
</tr>
<tr>
<td>Nigeria</td>
<td>7</td>
</tr>
<tr>
<td>Pakistan</td>
<td>12</td>
</tr>
<tr>
<td>Russia</td>
<td>8</td>
</tr>
<tr>
<td>Serbia</td>
<td>3</td>
</tr>
<tr>
<td>South Africa</td>
<td>1</td>
</tr>
<tr>
<td>Syria</td>
<td>1</td>
</tr>
<tr>
<td>Tunisia</td>
<td>1</td>
</tr>
<tr>
<td>Turkey</td>
<td>9</td>
</tr>
<tr>
<td>Ukraine</td>
<td>1</td>
</tr>
<tr>
<td>Venezuela</td>
<td>1</td>
</tr>
<tr>
<td>Yemen</td>
<td>1</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>107</strong></td>
</tr>
</tbody>
</table>

*China, due to differing patterns, and countries in EU are excluded. Croatia was not yet an EU member at the time the CiLS survey was conducted.
APPENDIX C: CILS CONFERENCE PRESENTATIONS AND PUBLICATIONS

The following are activities related to the CiLS data at YEBN that I was actively involved in preparing:


Biotechnology statistics

First, collecting internationally comparative biotechnology statistics and information on the global scientific workforce is a relatively recent endeavor. I began thinking of this project while still a Master’s degree student in 2005, a time when the OECD had completed an inventory of biotechnology statistics in different countries (van Beuzekom, 2004), but before the standardized statistics for Europe were available. Biotechnology has become a crucial part of life science research. The OECD first implemented a standard international definition of biotechnology in 2004: “Biotechnology is the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods or services.” The first main OECD report using this definition was: Biotechnology Statistics 2009, reporting on data from 2008. The reports issued prior to 2009 were based instead on various national statistics, drawing from various R&D surveys, which were not harmonized internationally in terms of types of information collected or in the definition of biotechnology.

The OECD’s most recent full report using standardized statistics was Biotechnology Statistics 2009, reporting on data from 2008. The reports issued prior to 2009 were based instead on various national statistics, drawing from various R&D surveys, which were not harmonized internationally. A list of the current key biotech indicators is listed below.

### OECD Biotechnology Statistical Indicators (list last updated in October 2013)

#### 1. Biotechnology firms
- KBI 1 Number of firms active in biotechnology, 2011 or latest available year
- KBI 2 Percentage of small biotechnology firms, 2011 or latest available year

#### 2. Biotechnology R&D
- KBI 3 Biotechnology R&D expenditures in the business sector, 2011 or latest available year
- KBI 4 Biotechnology R&D intensity in the business sector, 2011 or latest available year
- KBI 5 Percentage of biotechnology R&D expenditure by dedicated biotechnology R&D firms in the services sector, 2011 or latest available year
- KBI 6 Percentage of biotechnology R&D expenditure performed by small biotechnology/R&D firms, 2011 or latest available year

#### 3. Public-sector biotechnology R&D

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46 At the time of writing, October 2013
A key challenge for conducting comparative research on the biotech workforce is that counts on the types of companies involved varies, as it occurs in a range of different industries (healthcare, equipment, chemicals, etc.), with different functions, and frequently in companies that are not working solely in biotechnology. Comparative statistics of the biotechnology industry is assessed through data on number of companies, patents, and R&D spends, or data on publications. What is important to point out now is that while each of these measures points to various aspects to compare the size of the biotechnology industry and related innovation across various countries, what is missing is comparable data on the workforce.

In other words, various comparative reports present sometimes radically different statistical data even for basic information such as number of firms or employees. Therefore, while the EU had expresses explicit interest in biotechnology at that time the studies on the industry’s structure tended to focus on regulation, patents, or funding, and not the workforce. Third, the biotechnology industry itself may be changing. Again, at the time of thinking of this study, biotechnology was relatively unknown by the masses, so to speak, and in Europe often negatively associated with genetically modified foods or cloning, and now developments related to biotech have received a more positive view, such as alternative fuels and ‘green’ and ‘clean’ tech. As demand for these new fields emerge, the dynamics of both skills needed from the workforce and employment structures (types of firms and where they are located) are likely also evolving and with it, the definition and classification of biotechnology may evolve too.

**The life science workforce and their international mobility**

Understandings of the life science workforce are also limited due to lack of internationally comparative statistical data. Internationally comparative statistics and the competitiveness of the biotechnology industry are assessed through data on number of companies, patents, and R&D spends, or data on publications. What is important to point out now is that while each of these measures points to various aspects to compare the
biotechnology industry and related innovation across different places, what is missing is comparable data on the workforce.

Although data on skilled migration tends not to be internationally comparable (given that they are often based on very specific qualifications for work or residence permits, as discussed in Chapter 2), there has been improved international data collection on international students in many countries, including some data by field of study. Internationally comparative statistics are more recent (Institute of International Education, 2008; OECD, 2007). International education statistics have been compiled through a partnership among the OECD, Eurostat, and UNESCO47. Understanding recent trends in international student mobility is therefore important for several reasons. First, as shown in Chapter 2, there have been substantial changes in student mobility in the past two decades, from 1.3 million students in 1990 to 4.1 million in 2010 (OECD, 2012, p. 362). Second, data for international students is more complete than comparable data on the international workforce. According to Inzelt (n.d., p. 3):

> A detailed analysis of the impact of such efforts to enhance (international) mobility of HRST (human resources in science and technology) is burdened by the lack of data and statistical information on researchers not only in an internationally comparable way, but national sources are scattered and contain limited information too – even if the importance of this kind of information is well known. Availability of data is much better on cross-border mobility of doctoral students, than on researchers.

Therefore, although student migration is statistically lower than many other forms of migration, it is important for understanding new trends and employment in scientific sectors. The following sections aims to combine the best available data sources to highlight trends related to the mobility of scientists, and where possible life scientists, and focuses particularly at identifying new trends through data from the late 1990s onward, the period identified earlier as the time the global competition for talent emerged as a concept and concern.

Data collection on the scientific workforce is therefore very uneven across countries. The US has long had an interest in mobility of students as well as the science and engineering workforce, given its long-standing position as the leading destination for international students, and had been collecting data on international students since 1948, and conducting the Survey of Earned Doctorates (SED) since 1962. It also created the

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47 There are two main definitions utilized. Some countries collect data on international students, which “refers to students who have crossed borders with the express intention to study. International students are those who are not residents of their country of study or those who received their prior education in another country” (Inzelt p. 9). The second statistical definition is based on foreign students, which instead looks at anyone who is foreign-born in the education system, rather than those who moved for education in particular. This is used by the OECD when data on international students is not available. This measure is less instructive to observing trends related to the expansion of international education and may contain immigrants who have been previously living in the country. The UNESCO Institute of Statistics’ World Education Indicators Program also has a survey, funded by the World Bank, among developing countries, where national statistical data on students is not always available.
Science and Engineering Statistical Data System (SESTAT) in 1993, a database that provides detailed demographic and workforce characteristics by combining surveys from various science and engineering graduates in the US. The SESTAT database combines data from three surveys: Survey of Doctorate Recipients, National Survey of College Graduates, and the National Survey of Recent College Graduates and is funded by the US Census Bureau (See https://sestat.nsf.gov/) and are conducted every other year. The OECD recently started a new statistical project called Careers of Doctorate Holders, which includes mobility as a key element, but at the moment the data is limited to survey data collected in 2007. Furthermore, the preliminary report concluded that there has been changes in international mobility in the past decades and particularly among younger cohorts, and therefore revised its standards for future data collection to individuals receiving their doctorate in the past 15 years (Auriol, 2010, p. 7). Therefore, the tool is still being developed and trends across time cannot be assessed yet. The European Commission has also aimed to increase the knowledge on research mobility within the EU member states, through two Mobility patterns and career paths of Researchers (MORE) studies to build both the statistical basis and understanding of motivations for researcher mobility across countries and sectors. The first was launched in late 2008 and the second in 2011.

In all of the surveys discussed in the previous paragraph, data for field of study are reported only in very wide categories. The data for the MORE2 study is available online, but life scientists fall under the wide category of “natural sciences and engineering and technology.” The OECD’s Careers of Doctorate Holders study groups the natural sciences together. This means that comparison between various fields in the natural sciences is not possible with publicly available data. Therefore, significant gaps still exist, both in comparing the workforce across countries and in being able to match it with findings of other studies, such as the importance of regional specialization in attracting top researchers. Nonetheless, some information on the prominence of international mobility is reflected by these data sets.

50 From data of graduates in mathematics; computer and information sciences (excluding hardware development and social aspects); physical sciences; chemical sciences; earth and environmental sciences; biological sciences (excluding medical and agricultural sciences); and other natural sciences (Auriol, Schaaper, & Felix, 2012, p. 69)
### APPENDIX E: ATTRACTIVENESS OF TOP 5 COUNTRIES LISTED AS FIRST CHOICE IN CILS STUDY BY CATEGORIES

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>DE</th>
<th>CH</th>
<th>UK</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Productivity: Research or scientific excellence</strong></td>
<td>It's the country where the research is the most interesting. Nobody can deny the quality research carried out in this part of world. So there is no question of its specific attraction. Because the United States are the Biotech's native country, and because it's easiest find a fund for biotech research. Finally because it's the land of the opportunity. Because US is developed so many policies and projects for research with modernized equipment in science and technology. I will be able to learn more especially in writing research grant, experiment planning, technique and skills. There are many different kinds of research seminar, conferences held in US from time to time. It is a good exposure to different types of research works.</td>
<td>As Germany is technologically very advanced in scientific research. Scientific heritage, excellent research background, world class research institutes. Germany is one of the countries with most advanced level in biotechnology research and highest number of biotech companies. They are one of the epicenters of cutting-edge research in the field of life science. Because it has many universities with developed departments that I think they are best in my field of study and my interest.</td>
<td>I love the level of research in Switzerland. Scientists are good and interactive. Good funding of research, close relationship between industry and research. Very good research institutes with good funding Booming Biotech / Medical engineering start-ups everywhere Because Biotech industry is highly developed here moreover all main biotech companies from all around the world have HQ here. It counts several good universities/institutes and biotech companies, as well as big pharmaceutical industries.</td>
<td>Very good balance between academic and industrial level of development and funding. Because of the trends in adopting new technologies with the traditional methods. In my opinion United Kingdom, and especially London, offers a wide range of opportunity in science/biotechnology field. UK is now one of the leader countries in Biotechnology. US companies (who still invest far more in biotech than any other country) are more likely to build sister companies first in the UK to enter the European market. I desire to study on microarray technology to develop my projects. The UK has improved technology in this subject. There are many renowned universities in United Kingdom like Edinburgh University, University of College London, King's College, Imperial London College and so on. These Universities are well-known for their research.</td>
<td>Growing research, new institutes At the time when Molecular Biology became important in the last century and seminal discoveries have been made, life science research has not been supported in Spain. After the repressive Regime of Franco, Spanish researchers managed to catch up with Europe and are now among leading scientists again. The vivid atmosphere and good funding provides a perfect research environment. There is an emerging market in life sciences.</td>
</tr>
<tr>
<td>US</td>
<td>DE</td>
<td>CH</td>
<td>UK</td>
<td>Spain</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This country considers your degree and research experience and offers good job opportunities like research assistants, professors, lecturer, Big pharmaceutical companies, Good universities etc.</td>
<td>Because my interest area of work has a lot of possibilities in Germany. There are several companies and academic institutions that allow to get more opportunities to get work.</td>
<td>Variety of work possibilities Because Switzerland has always been a country with a lot of opportunities for a graduate in life sciences.</td>
<td>Moving there in a few months, great opportunity in academia and industry.</td>
<td>In the field of biology, biotech and pharmaceutics it is an emerging country. I am convinced to go ahead with a career the environment has to be dynamic and give you opportunities. Switzerland is this field is already saturated and as young and dynamic you don't always get your chance. On the other hand the emergence of Spain gives you a young environment open mind to new ideas which I believe is quite exciting.</td>
<td></td>
</tr>
<tr>
<td>I think that there is the chance for everyone, especially who operate in scientific area.</td>
<td>It seems to me that job market for scientists is broader than in other countries.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The biggest amount of jobs offers and not so strange requirements as in (my home country).</td>
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<td><strong>Work ethic / Work culture</strong></td>
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<td>The work culture is in top notch.</td>
<td>I would like to work in this county because the way the work and experiments carried out in this country. The people are very disciplined. They are very precise and quality of the work is really better than any other part of the world.</td>
<td>Because my previous experience showed me that people in this country work seriously and with high degree of quality.</td>
<td>I like England or Scotland, and I know some people that have been working, studying or researching there and have had a very good experience.</td>
<td>…produce good science and research. It was very simple for me to communicate with the whole research group,</td>
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<td>Manner of working and communicating</td>
<td>It’s said to have a completely different way of focusing research.</td>
<td>I had the experience in working in academic field in Switzerland and I found it very well, and clever, organized.</td>
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<td></td>
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<td>Because my previous experience showed me that people in this country work seriously and with high degree of quality.</td>
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<td>US</td>
<td>DE</td>
<td>CH</td>
<td>UK</td>
<td>Spain</td>
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<tr>
<td><strong>Lifestyle, culture &amp; environmental reasons</strong></td>
<td>I love it.</td>
<td>Familiarity with the local language and culture</td>
<td>No culture shock and understanding of the way things work both generally, and within specific areas such as academia.</td>
<td>Like the culture and the &quot;life level!&quot;</td>
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<td></td>
<td>Good range of leisure and cultural activities</td>
<td>I believe that it’s the best place &amp; environment to live in Europe</td>
<td>Attitude of scientists and British people in general</td>
<td>I feel that Spanish people are very friendly and social.</td>
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<td>Lifestyle and climate are definitely things that fit me.</td>
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<td><strong>Diversity / International environment</strong></td>
<td>Because of its diversity.</td>
<td></td>
<td>UK has a big name in life science research with multinational culture.</td>
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<td></td>
<td>Diverse community, diverse people, diverse food</td>
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<td>Because in a UK there is a multicultural environment that allows the comparison and exchange of knowledge.</td>
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