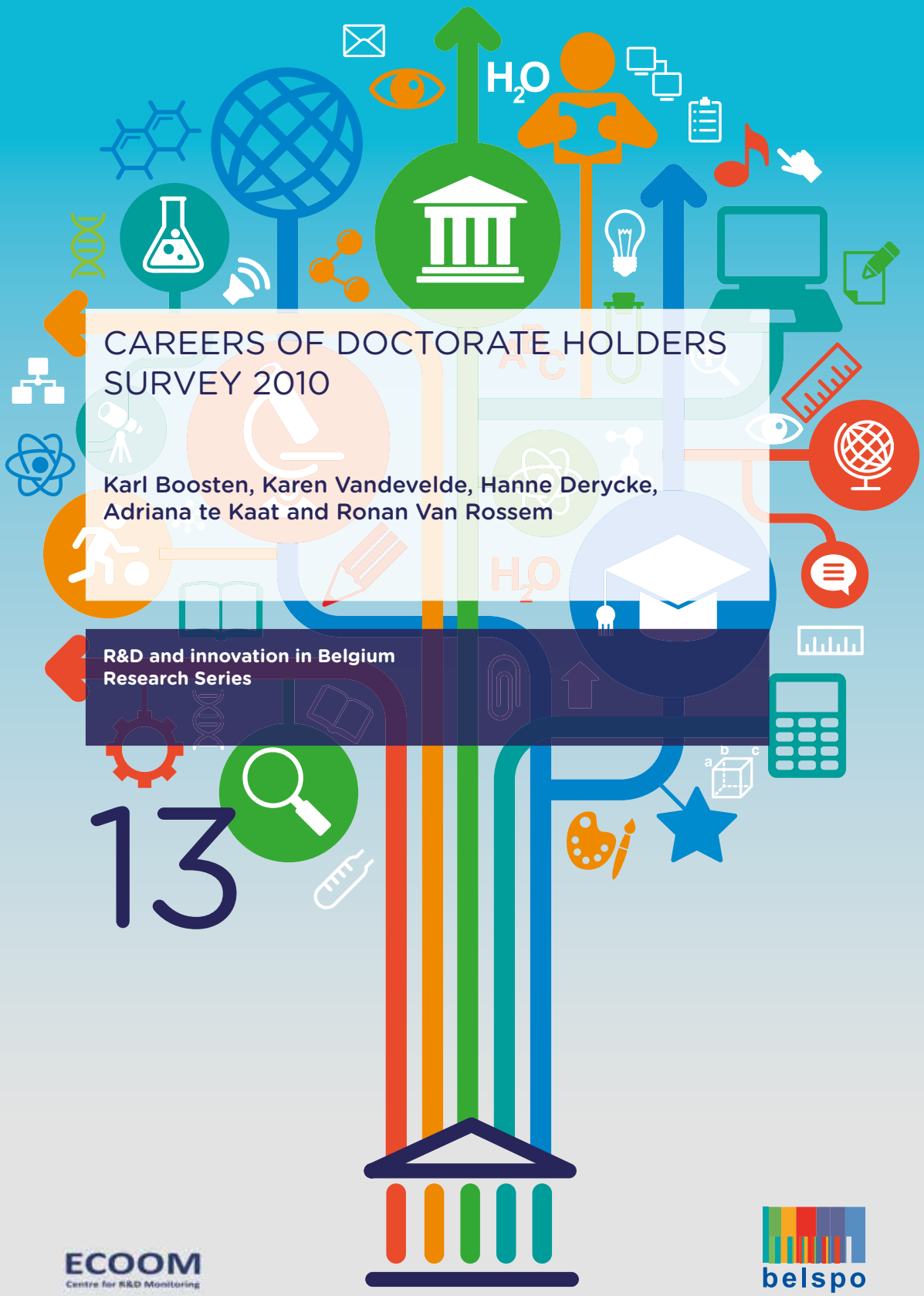

CAREERS OF DOCTORATE HOLDERS SURVEY 2010

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R&D and innovation in Belgium
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Foreword

Research is not just a matter of financial investments. Investing in research is investing in people. People who are trained to conduct research have undergone intensive training in the theoretical fundamentals and methodological requirements of a scientific discipline. An innovative society depends on the employability and creativity of researchers, which is why they have attracted the interest of policymakers.

Although not all researchers complete a doctorate, the focus in this book is on holders of a doctoral degree. This type of schooling is the highest level of formal scientific education offered by universities.

The career paths researchers take today are no longer comparable to the careers of doctorate holders two or three decades ago. The higher education system is no longer the most important employment sector for people with a doctoral degree. An increasing number of doctorate holders have found their way to other sectors of the economy. The private sector, in particular, has managed to attract an important share of these talents. These new career opportunities for doctorate holders have also caused a shift in the skills that are required to become successful in the labour market. Although employers highly appreciate the scientific and technical knowledge of doctorate holders, new skills gradually became part of the task description of people involved in research activities. Nowadays more emphasis is placed on management skills, interdisciplinary teamwork, knowledge of intellectual property and other practical skills.

The authors of this study hope to inform policymakers, research institutes, universities, future doctorate holders and social researchers about the diversity of careers within the research system and to provide a guideline to decision makers about how this changing landscape influences the innovative strength of our future knowledge economy.

This study was realised within the scope of an international project launched by the statistical bureau of the European Commission and the Organisation for Economic Co-operation and Development. In Belgium this project was coordinated at the federal level by the Belgian Science Policy Office with input from the regions. In the Flemish Region we were able to make use of the HFFR database of the ECOOM centre at Ghent University. In the Walloon and Brussels-Capital Region we were able to rely on the data of the CREF. The researchers of the ECOOM centre have also contributed to this study with several chapters.

Dr. Philippe Mettens
President Belgian Science Policy Office

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1

Introduction

Karl Boosten, Karen Vandevelde

1.1 Historical background

In recent decades a growing interest in socio-economic theory investigates the processes and dynamics that underlie innovation and the creation of knowledge and their impact on the economic prosperity of a country. This line of inquiry has brought the matter of a knowledge-driven economy to the attention of policymakers and government. At the European level, this focus resulted in the Lisbon Strategy of the European Commission to make the European Union the most competitive and innovative economy of the world.

In a first attempt to grasp the essence of 'knowledge creation', the main focus was R&D activities of the private and public sector. More specifically, this research tried to provide an answer to questions related to R&D in terms of financial incentives and staff investments. Secondly, the concept of knowledge creation got a broader interpretation and was extended to activities that were not pure R&D. This time, changes in a firm's marketing strategy or human resources policy could also be considered as valuable accounts of knowledge creation. Thirdly, due to the fact that research is carried out by human beings, the focus shifted to the subjects who contribute to the creation of new knowledge in their daily professional activities. Here lies the emphasis of this publication.

1.2 International set-up of the research project

In 2003, the first initiative to conduct research on the careers and mobility patterns of doctorate holders, now called the "Careers of Doctorate Holders" (CDH) project, was taken during a series of workshops and conferences hosted by the OECD. The main goal of the events was to improve the quality of existing data sets with regard to human resources in science and technology. This effort led to a first data collection exercise in 2006 under the aegis of three international institutions, notably Eurostat, OECD and UNESCO. Fifteen countries participated in this initial round, including Belgium. Due to both the interest the subject aroused, and weaknesses and faults related to the first data collection round, the three initiators decided to organize a new data round, while attempting to enlarge the group of participating countries.

All data discussed in this publication were submitted to international standardisation procedures. These procedures were drawn up within the framework of a close cooperation between the three above-mentioned international institutions (Eurostat, OECD and UNESCO) and national experts of the participating member countries. Instead of imposing an existing statistical framework, each member country had a say in the implementation of the survey. Thanks to this broad consensus, every country could take into consideration the specific national data resources available for the set-up of the survey. An additional advantage relates to the international comparability of the resulting data. If all countries share a common methodology to carry out the survey and to report on their findings, this is considered a reliable guarantee for the comparability of the data across countries.

1.3 Previous data collections

The first CDH-data collection in 2006 in Belgium was coordinated by the Belgian Science Policy Office. Although several questions remained the same, the results have to be interpreted carefully because there were several differences in the sampling methods being used. The first difference affects the composition of the sample. In 2006, all doctorate holders were identified on the basis of the 2001 census data which allowed for addressing the entire group of doctorate holders, in which all age groups were represented. For the 2010 survey we adopted a different approach, using administrative databases from the universities. These databases comprise all individuals who obtained a doctoral degree at a Belgian university, but because these databases were created in the beginning of the 1990s, our age spectrum was more confined.

A second difference is related to the fact that in 2006 the sample also contained people who had obtained a doctoral degree at a foreign university. The 2010 databases only registered people who graduated with a doctoral degree from a Belgian university.

A third difference concerns the fact that the 2006 sample contained people who considered themselves a doctor but who did not classify under the strict definition of a doctorate, for example 'doctors in law' or 'doctors in medicine'. The strict definition of a doctor implies an intensive training in the application of scientific methods to carry out research in a specific scientific discipline. This type of erroneous sampling was avoided in 2010 by making use of administrative databases.

1.4 Composition of the sample

For the collection of the data we used two data sources. Firstly, a database collected by the Ghent University branch of the Flemish Centre for R&D Monitoring, and secondly a database of the CREF (Conseil des Recteurs). Both administrative databases register every person who has obtained a doctoral degree at a Dutch-speaking or a French-speaking university in Belgium respectively, starting from 1990 onwards. In the period 1990-1991 until 2008-2009, more than 24,500 researchers received a doctorate degree from a Belgian University (14,404 in the Flemish Community and 10,137 in the French Community; see also table 2.1). At the time of composing the survey sample, the data for new doctorate holders of the academic year 2008-2009 (674 doctorate holders) were incomplete in the French Community and were removed from the sample.

In order to approach the respondents and to obtain their most recent addresses, the resources of the National Register were used. The National Register is a public service authorized to collect and store data with respect to the identity of Belgian citizens. A substantial number of the 23,867 potential respondents could not be traced in the National Register, either because the national registration number was missing or the potential respondents had moved out of the country. As a result, survey invitations were sent out by the

National Register to only 16,911 potential respondents or 70.9% of the survey population, but the characteristics of respondents included or excluded from the sample (discipline, gender, nationality) could not be provided. The National Register acted as a trusted third party in this process: respondents were able to take part in the on-line survey fully anonymously. Finally, 5,422 of these 16,911 potential respondents returned this survey (32.1%). For analytical purposes broad filters were used to eliminate returned questionnaires that were useless, resulting in a response rate of 28.3% (4,778 respondents) in the majority of the questionnaire modules. For other questions or modules, finer filters were applied taking into account 3,856 respondents or 22.8% of the survey sample.

When comparing the distribution of disciplines and nationality between the population data and the CDH survey data, some remarkable differences must be taken into account. The following two are the most striking:

- international researchers receiving their doctorate from a Belgian university take up 27.9% of the total doctorate holders population, while their representation in the CDH survey data is only 4.2%. As many of them never received a national registration number, or may no longer be living in Belgium; they could not be traced in order to be sent a survey invitation.
- disciplinary fields are more or less equally represented in the doctorate holders' population as in the CDH dataset, with the exception of agricultural sciences & natural sciences in the French Community. This may be due to great differences in response rate, although a more likely explanation might be a different categorisation of subfields.

The full overview of doctorates awarded in Belgium during this period is included in Annex 3.

1.5 Content of the questionnaire

The survey is composed of 5 modules that measure aspects with regard to the careers and mobility of doctorate holders. The module EDU addresses the experiences of doctorate holders during the preparation of their doctoral dissertation. The module EMP draws a picture of the way doctorate holders develop their careers. The module MOB assesses to what extent people with a doctoral degree are mobile on the international labor market. The module CAR examines whether or not doctorate holders continue to work as researchers following their doctoral attainment, and what the potential reasons could be for a career change. Finally, the module SKL explores the knowledge and skills doctoral researchers claim to have acquired and to what extent these are needed for their current professional activities.

1.6 Privacy and legal matters

The data were collected in cooperation with the Belgian commission for the protection of privacy. This official body supervised the organizational set-up of the survey to guarantee that the privacy of the respondents was respected during every stage of the survey.

1.7 Overview of themes discussed in the publication

The first chapter describes in more detail the population of doctorate holders in Belgium and the CDH survey dataset. The central theme of this publication is based on the fact that more often than in the past, PhD graduates are working in sectors outside the university. The underlying causes and consequences will be discussed in the second chapter of this publication.

The third chapter is devoted to the way in which doctorate holders experience the transition from the university to the labour market. More in particular the following questions will be handled: how do PhD graduates find their first job? How do they value the relevance of their degree in relation to the job market?

In the fourth chapter we focus on the careers of doctorate holders to find out what the professional situation is for doctorate holders once they have defended their PhD. In this chapter, we address the sector of employment and its evolution over time, common doctoral occupations, type of contract, the minimum required level of education for doctorate holders and the relation between the subject of the doctoral degree and the content of the current job.

Being competent in a wide range of skills and aptitudes is crucial for doctorate holders when bridging the gap between their PhD research on the one hand and their professional career on the other, both within and outside academia. Chapter 5 therefore addresses the extent to which doctorate holders perceive their knowledge and skills acquired during the doctoral study as sufficient for the practice of their job. In addition, differences between sectors of employment are examined.

In chapter 6 we compare the wages of male and female doctorate holders from different scientific disciplines who are working in different sectors of employment. However, salary is just one side of the picture and it is by far not the only factor explaining the motivation of people to start a doctoral programme. Chapter 7 therefore, is devoted to the motivation of PhD graduates for research, their interests in exploring the world and their level of desire for independent and intellectually challenging work.

Another important topic that is high on the policy agenda relating to the careers of doctorate holders, is international mobility. Chapter 8 is devoted to the international ambitions of doctorate holders. How often do doctorate holders stay abroad for research/work? Do they work together with foreign scientists by means of the internet?

In the ninth and final chapter we will pay attention to the extent to which doctorate holders are still involved in research activities. This chapter addresses the differences between the scientific disciplines in which the doctoral degree was granted and the sector of employment of the doctorate holders.

2
Evolution of the number of doctoral degrees

Karl Boosten, Karen Vandevelde

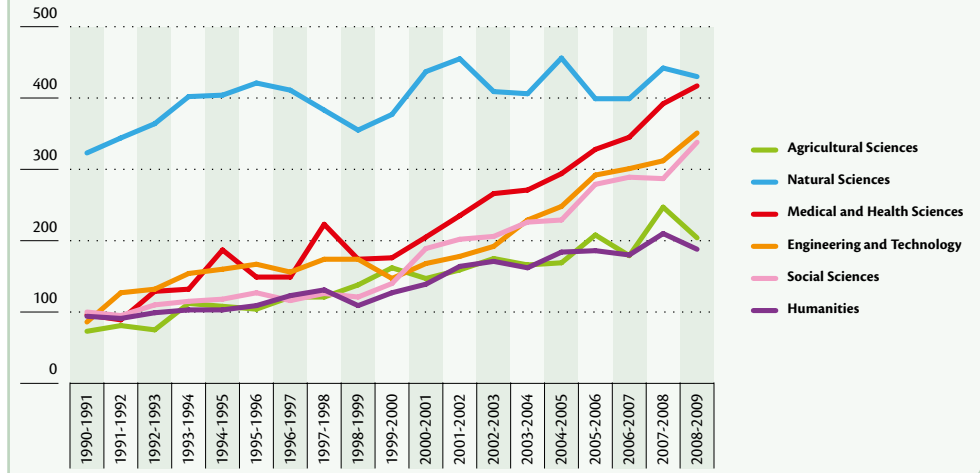
Each year the number of doctoral degrees awarded in Belgium increases and this phenomenon applies to all scientific disciplines. Considering the fact that this increase is not matched with a rising number of vacant academic positions at professorial level, one might wonder in which employment sectors doctorate holders will find a job. Rather than looking at the 'surplus' of doctorate holders as a 'spill-over effect' on the non-academic labour market, the extra investments in doctoral education were intended as a deliberate attempt to revitalise the economy with more staff who are highly-educated, innovation-ready and equipped with wide-ranging knowledge.

To answer the question on doctorate holders' careers we start our analyses by looking at the evolution of the number of doctoral degrees awarded each year for each of the scientific disciplines concerned. In this publication a distinction is made between six different disciplines: natural sciences, engineering and technology, medical and health sciences, agricultural sciences, social sciences and humanities. A detailed description of all doctoral programmes per discipline can be found in Annex 1 to this publication.

2.1 Most productive scientific discipline in terms of awarded PhDs

Not every discipline is equally productive in terms of the number of doctoral degrees granted. Annex 3 provides a complete overview of all doctorate degrees awarded at the universities in the French and the Flemish Communities between 1990-91 and 2009-2010, according to discipline, gender and nationality. Unlike the other data in this report, this population table contains the total number of doctorate degrees awarded in Belgium, a much broader group than the doctorates taken into account in the further analysis based on CDH data. Between 1990 and 2009 the annual number of doctorate degrees awarded at Belgian universities has more than doubled. While the natural sciences continue to dominate the total doctoral production during the entire period, sharper increases in the awards of doctoral degrees are identified in the fields of medical and health sciences – with nearly as many doctoral degrees awarded in 2008-2009 as in natural sciences. Engineering and technology and the social sciences also demonstrate a sharp increase in doctorate production over the entire period.

Figure 2.1: Evolution of the number of doctorate holders by discipline, 1990-91 to 2008-2009 (Source: CREF and ECOOM, full table in Annex 3)



Nearly one in three doctorates awarded in Belgium is in natural sciences (31.0%). Next, medical and health sciences take up a share of 17.3%, engineering and technology 15.3%. These are followed by the social sciences (13.9%), agricultural sciences (11.2%) and humanities (10.9%).

This distribution corresponds roughly to the distribution in the Careers of Doctorate Holders dataset. The natural sciences are the largest group of doctorate holders amongst the respondents (N=1547, 34%). The second place is occupied by engineering and technology (N=770, 16.9%) and medical and health sciences (N=737, 16.2%), followed in descending order by the social sciences (N=508, 11.2%), humanities (N=439, 9.7%) and agricultural sciences (N=398, 8.8%).

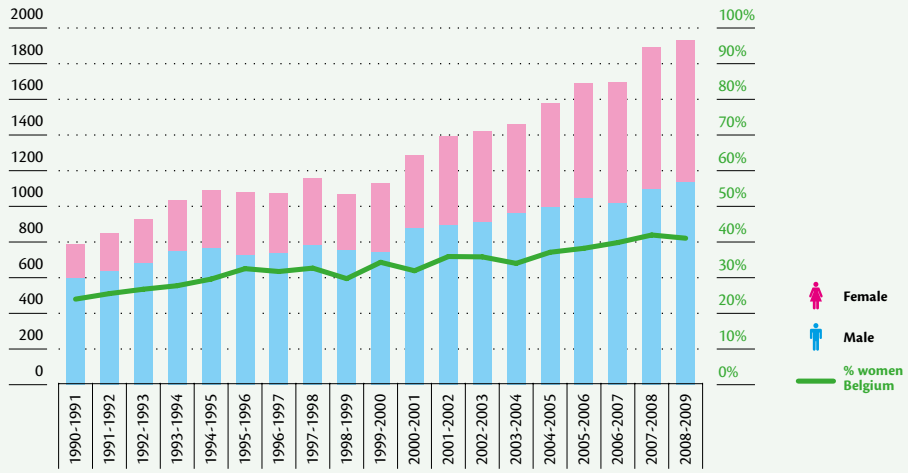
When we look at the most productive sub-disciplines in terms of the number of granted doctoral degrees within each discipline, the following appears:

- natural sciences: chemists (N=457, 29.5%)
- engineering and technology: electrical engineers (N=219, 28.4%)
- medical and health sciences: biomedical scientists (N=284, 38.5%)
- agricultural sciences: cell and gene biotechnology (N=72, 18.1%)
- social sciences: psychologists (N=115, 22.6%) and economists (N=259, 28.3%)
- humanities: historians (N=125, 28.5%) and language/literature scholars (N=141, 32.1%)

2.2 Evolution of the number of doctoral degrees by gender and scientific discipline

On average, 34.4% of all doctorate degrees granted between 1990-1991 and 2008-2009 were awarded to women. The gender distribution however changed significantly during this period. As illustrated in Figure 2.2.1. and in Annex 3, in 1990-91 only 23.9% of all doctorates awarded at Belgian universities went to female researchers, while in 2008-2009 the share of women had already increased steadily to 41.0%.

Figure 2.2.1. Doctorate degrees awarded in Belgium, by gender (1990-1991 to 2008-2009). Source: CREF and ECOOM. Full table in Annex 3.



Analyses of the CDH data confirm this, but also show that the gender distribution across disciplines developed unevenly. In the natural sciences and engineering the number of male doctorate holders is considerable higher than the number of female doctorate holders. This difference is less pronounced in the social sciences and almost disappears in the medical and agricultural sciences and the humanities. This gender difference is illustrated in graphs 2.2.2 and 2.2.3.

Figure 2.2.2: Evolution of the number of doctorate holders in engineering by gender (Source: Belgian Science Policy Office, CDH Database 2010)

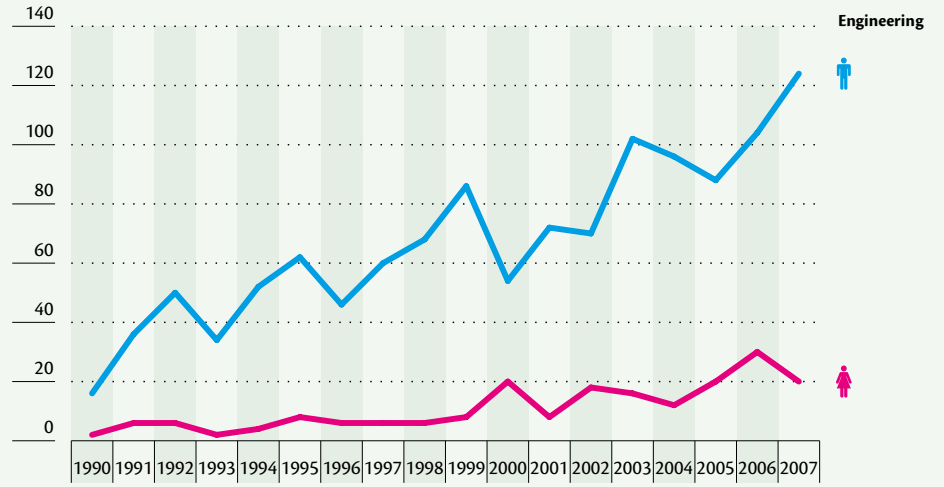
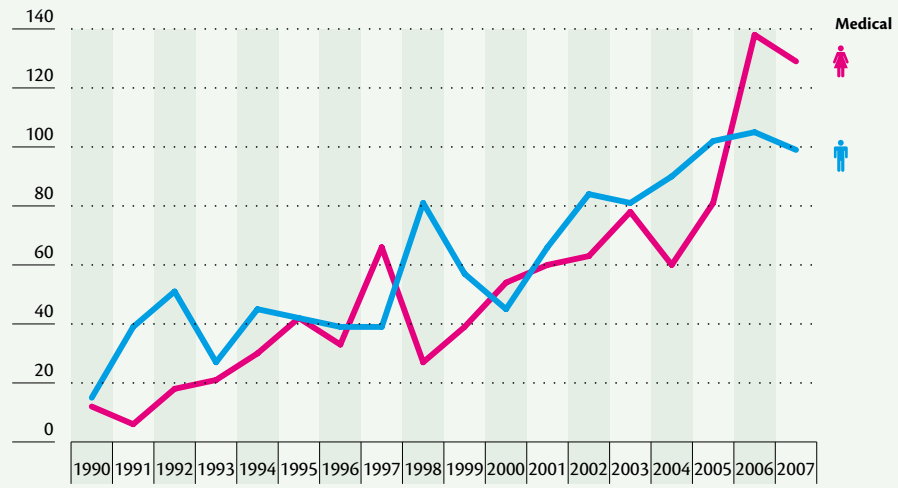


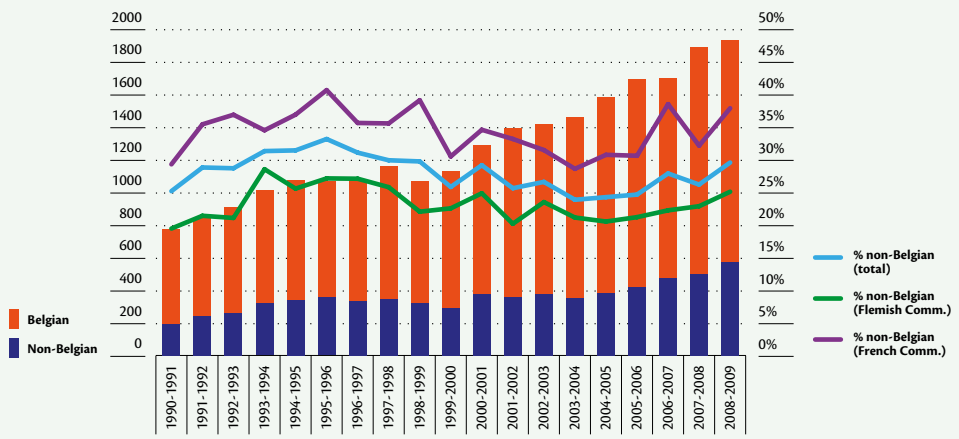
Figure 2.2.3: Evolution of the number of doctorate holders in medical sciences by gender (Source: Belgian Science Policy Office, CDH Database 2010)



2.3 Evolution of the number of doctoral degrees by nationality

Over the last few decades, higher education in Belgium has undergone a process of internationalisation like in many other countries. The share of doctoral degrees awarded to researchers from abroad, however, has increased only slightly over the last two decades, but this percentage hides the changes in absolute numbers. A remarkable increase in the numbers of foreign doctorate holders (from 195 in 1990-91 to 572 in 2008-2009) has been matched by a similar increase amongst the Belgian young researchers population (from 576 to 1356). The doctorate holders from abroad, carrying out their research work at a Belgian university, take up a larger share in the Walloon universities than in the Flemish universities. Overall, 27.9% of all doctorates have been awarded to researchers from abroad.

Figure 2.3: Doctorate degrees awarded in Belgium, by nationality (Belgian – non-Belgian), and share of non-Belgian doctorate holders in the Flemish & French Community (1990-1991 to 2008-2009). Source: CREF and ECOOM. Full table in Annex 3.

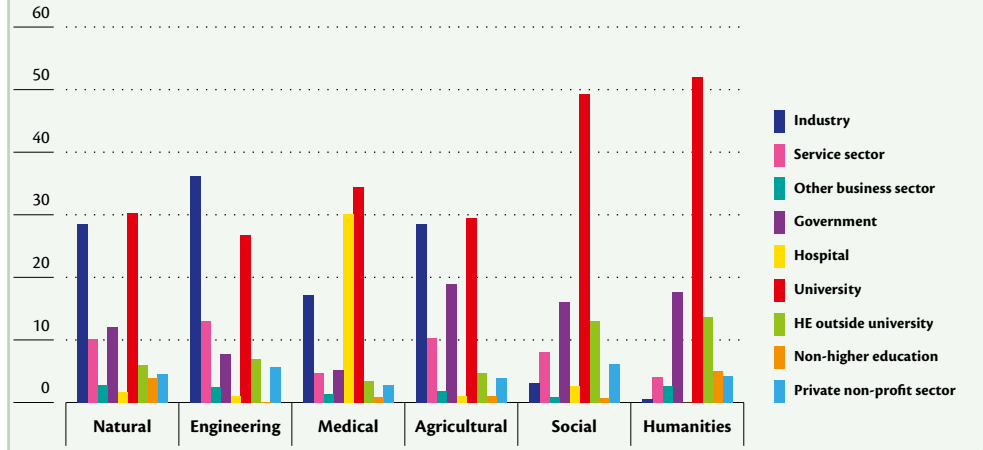


Many mobile researchers return to their home countries or continue to establish their career internationally. The fact that they are difficult to trace for a cross-sectional survey explains why the percentage of doctorate holders in the CDH dataset is as low as 4.2%. See also chapter 8 for a further study of international mobility of Belgian Doctorate Holders, based on the CDH dataset.

2.4 Employment sectors of doctorate holders

People with a doctoral degree in the natural sciences (N=1544) or engineering (N=769) are strongly represented in industry (28% and 36% respectively) and at the universities (30% and 27% respectively). For agricultural scientists (N=396) we find similar figures, except that a considerable percentage of them are employed by the government (19%). With regard to medical sciences (N=736), these doctorate holders are mainly active in industry (17%), hospitals (30%) and at university (34%). The social sciences (N=507) and humanities (N=437) deviate somewhat from this pattern, in the sense that they are strongly represented at the universities (49.3% and 52% respectively) and only in exceptional cases work in industry (3% and 0.5%). This is compensated by more employment in the government sector (16% and 17.7%) and the higher education system outside the university (13% and 13.7%).

Figure 2.4: Sector of employment by knowledge field (Source: Belgian Science Policy Office, CDH Database 2010)



3

Transition from the university to the labour market

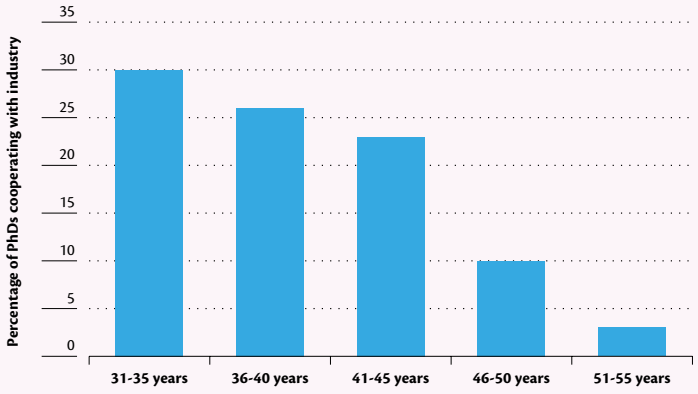
Karl Boosten

A growing number of doctorate holders are looking for a job outside university because the number of research positions in the higher education system is not sufficient to employ the growing pool of doctorate holders. In order to better understand how doctorate holders experience this change in working environment, they were given a series of statements to which they could attribute their level of agreement. Contact with other employment sectors during the doctoral track seems to smooth the path to the first job outside academia and the transition from academia to others sectors of the economy as well. Our findings suggest that PhD holders have been increasingly interested in cooperating with economic players outside academia.

3.1 Cooperation with other sectors during the doctoral trajectory

Cooperation with other sectors occurs only in a limited number of cases. When cooperation is involved, it is rather located on the level of universities themselves. This could mean that universities are linked with each other by means of networks to make optimal use of the available resources. Another remarkable fact is the growing presence of industry in scientific research. Younger age cohorts collaborate more often with industry during the preparation of their dissertation than older age cohorts.

Figure 3.1 Cooperation with industry per age cohort (Source: Belgian Science Policy Office, CDH Database 2010)

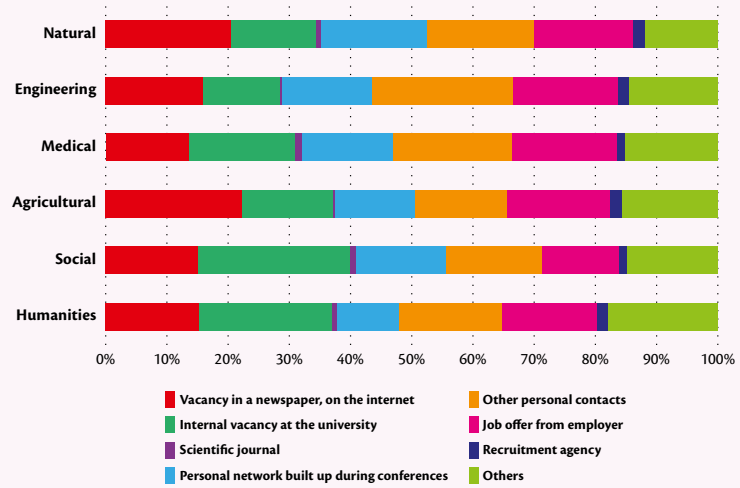


Overall, twenty-one percent of all doctorate holders have been working together with the private sector, particularly industry, during the realisation of their doctoral thesis. This type of collaboration occurs more in the natural sciences (N=253, 26.2%) and in the field of engineering (N=369, 38.2%). In the social sciences and humanities these figures are almost negligible (N=40, 4.1% and N=3, 0.3% respectively).

3.2 The first job

The number of PhD holders finding their first job through a scientific journal or recruitment agency is very small compared to the other recruitment channels PhD holders use to launch their career. Depending on the scientific discipline of the doctoral degree, doctorate holders in the agricultural (N=432, 22.2%) and natural sciences (N=1672, 20.5%) most often find a job by means of a job advertisement in a newspaper or on the internet. Internal vacancies at the university are a popular way to engage social (N=545, 24.8%) and humanities scientists (N=414, 21.7%). Personal contacts play an important role in the recruitment of engineers (N=867, 22.9%) and medical professionals (N=753, 19.5%). Job offers are of lesser importance to social scientists (N=545, 12.7%) in their search for a first job.

Figure 3.2: Recruitment channels by means of which PhD holders find their first job (Source: Belgian Science Policy Office, CDH Database 2010)



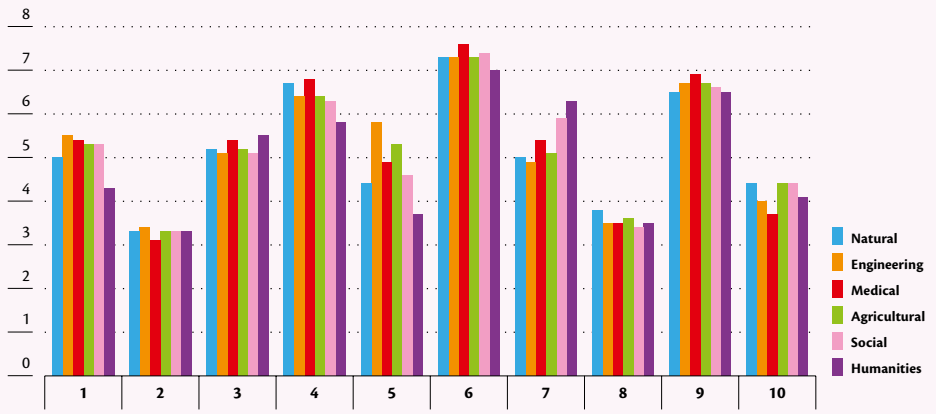
3.3 Transition from the university to the labour market

In order to examine the transition from university to other parts of the labour market, a list of 10 possible experiences was composed. Respondents expressed their agreement with each statement on a 10-point Likert scale. The following statements were presented:

1. I was properly prepared for a career outside the university.
2. If I could do my career over again, I would not have proceeded to a doctor's degree and I would have started immediately outside the academic environment.
3. It was clear to me what career opportunities I could aspire to after my doctorate was granted.
4. My doctorate helped me on the job market.
5. Cooperation with other sectors made the transition from the university easier.

6. Thanks to my doctorate I was able to offer extra added value to the company/organisation where I work.
7. If the possibility were to arise, I would return to the university.
8. During the transition I lacked the skills to cooperate with others (to work in a team, communication skills).
9. If I could do my career over again, I would make the same choices.
10. I experienced the transition to another sector as a culture shock.

Figure 3.3: Experiences of PhD holders regarding the transition from the university to the labour market (Source: Belgian Science Policy Office, CDH Database 2010)



1. I was properly prepared for a career outside the university.
2. If I could do my career over again, I would not have proceeded to a doctor's degree and I would have started immediately outside the academic environment.
3. It was clear to me what career opportunities I could aspire to after my doctorate was granted.
4. My doctorate helped me on the job market.
5. Cooperation with other sectors made the transition from the university easier.
6. Thanks to my doctorate I was able to offer extra added value to the company/organisation where I work.
7. If the possibility were to arise, I would return to the university.
8. During the transition I lacked the skills to cooperate with others (to work in a team, communication skills).
9. If I could do my career over again, I would make the same choices.
10. I experienced the transition to another sector as a culture shock.

Doctorate holders do not always have a clear-cut idea of their career possibilities after having obtained a doctoral degree, as can be demonstrated by means of the rather neutral reaction to statement 3 (N=2637, mean= 5.2). Writing a doctoral thesis is not a purely academic affair completely isolated from the subsequent career development: a considerable number of doctorate holders are convinced that the work they have conducted for their doctorate has a positive impact on their future careers. They consider their dissertation as a potential comparative advantage for entering the labour market, shown by the mainly positive reaction to statement 4 (N=2631, mean=6.4). Moreover, a lot of doctorate holders consider their research experience as a means to create added value for the company or organisation for which they work (statement 6: N=2582, mean=7.3). Statements 2, 8 and 10 that inquire into possible inherent shortcomings of following a doctoral trajectory, are generally disagreed with (statement 2: N=2629, mean=3.3 / statement 8: N=2549, mean=3.5 / statement 10: N=2527, mean=4.1).

When making a more in-depth analysis of the contrasts between the different knowledge domains regarding the above-mentioned statements, we see no significant difference in opinion for statements 2, 3, 6, 8 and 9. The attitude of doctorate holders in the humanities towards statement 1 differs significantly from all other disciplines. Of all doctorate holders they feel least prepared for a job outside the academic environment. Natural scientists and engineers differ with regard to statement 1 as well. Statement 4 ("My doctorate helped me on the job market") shows differences in opinion between PhD graduates in the humanities on the one hand and PhD holders in the natural, engineering and medical sciences on the other hand. Statements 5 and 7 – the first about collaboration, the second about returning to the university – cause the most divergence in opinion among doctorate holders when comparing results from different disciplines (for more details see table below). Statement 10 on the culture shock aspect of job transition is judged differently when comparing PhD graduates in the natural sciences with those in engineering, and comparing medical graduates with their colleagues in natural sciences, agricultural sciences and social sciences.

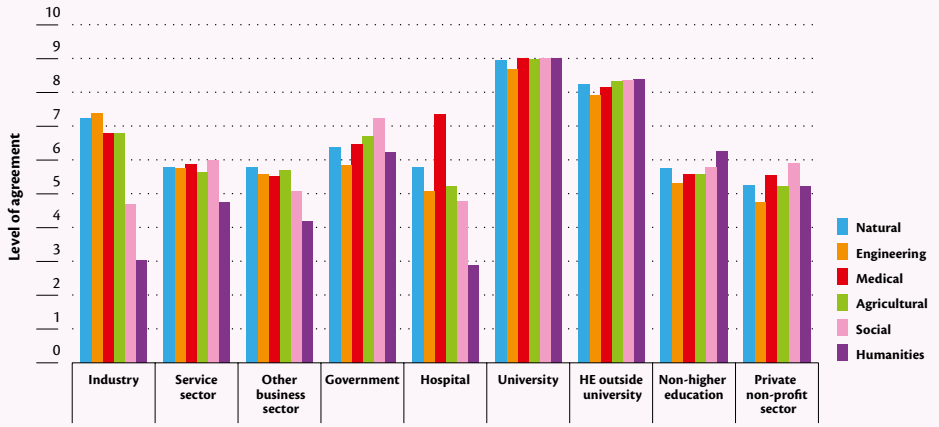
Table 3.3: Significant differences in the experiences of PhD holders regarding the transition from the university to the labour market (Source: Belgian Science Policy Office, CDH Database 2010). All hypotheses were tested by means of ANOVA post-hoc contrast analysis at the 0.01 significance level (indicated by colored blocks in the table below).

	1	2	3	4	5	6	7	8	9	10
natural vs engineering										
natural vs medical										
natural vs agricultural										
natural vs social										
natural vs humanities										
engineering vs medical										
engineering vs agricultural										
engineering vs social										
engineering vs humanities										
medical vs agricultural										
medical vs social										
medical vs humanities										
agricultural vs social										
agricultural vs humanities										
social vs humanities										

3.4 Added value of a doctoral degree

In order to discover which sectors could be considered as potential employment sectors, respondents were asked to indicate for which sector they believed their doctorate could offer added value. People with a doctoral degree obtained in engineering, natural, medical and agricultural sciences consider their doctorate as an added value for the industrial sector (N= 3740). PhD holders in the social sciences and humanities have a rather negative attitude regarding the added value of their doctorate for employment in industry – indeed very few of these doctorate holders establish a career in this sector. With regard to the value of a doctoral degree in the service sector (N=3626), doctorate holders are on average mildly positive; they also expect the governmental sector (N=3649) to be an employer who valorises the acquired knowledge and skills of doctorate holders. The universities (N=3856) and the higher education system outside the university (N=3757) score highest, most likely because of the fact that they are a 'natural habitat' for scientifically trained personnel.

Figure 3.4: Considerations of PhD holders with regard to the value of their doctoral degree, according to possible sector of employment (Source: Belgian Science Policy Office, CDH Database 2010)



The table beneath shows a detailed overview of all divergences in opinion between the different knowledge fields with regard to the potential added value of a doctoral degree in relation to the different sectors of employment. Those divergences indicated with an asterisk are significant at the α=0.01 level.

Table 3.4: Significant differences in the considerations of PhD holders with regard to the value of their doctoral degree (Source: Belgian Science Policy Office, CDH Database 2010).
All hypotheses were tested by means of ANOVA post-hoc contrast analysis at the 0.01 significance level (indicated by colored blocks in the table below).

	Industry	Services	Business other	Government	Hospital	University	Higher education (outside university)	Secondary education	Private non-profit sector	Self-employed
natural vs engineering										
natural vs medical										
natural vs agricultural										
natural vs social										
natural vs humanities										
engineering vs medical										
engineering vs agricultural										
engineering vs social										
engineering vs humanities										
medical vs agricultural										
medical vs social										
medical vs humanities										
agricultural vs social										
agricultural vs humanities										
social vs humanities										

4
Careers of doctorate holders

Hanne Derycke, Ronan Van Rossem

This chapter focuses on the professional situation of doctorate holders, addressing the question what researchers do after they obtained their doctoral degree. In which sectors do they work, how does this evolve over time and which occupations are common for PhD graduates? Are doctorate holders overqualified for their jobs and what is the relation between the content of their current job and the topic of their PhD?

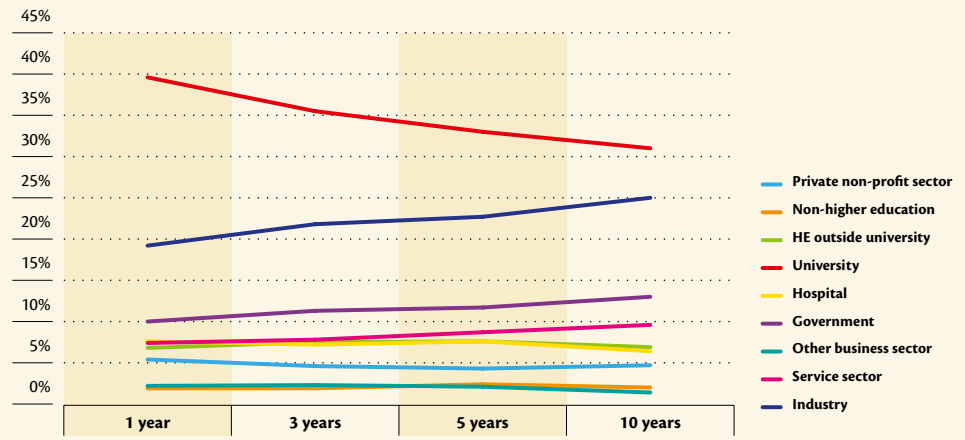
4.1. Sector of employment

After graduation, doctorate holders start working in a wide range of sectors, at university as well as in other sectors outside university, such as industry, the service sector, government, hospital, higher education (HE) outside university, non-higher education, the private non-profit sector, and in areas we define as the 'other business' sector. Our results show that 68.6% of the 4,445 respondents have been employed at least once in another sector outside university since their graduation, while 31.4% (N=1395) reported never having left university.

Figure 4.1.1 shows the evolution of the sector of employment by the time elapsed since obtaining the PhD. This changing pattern is a combined indicator of general labour market differences (younger cohorts versus older cohorts) and of individual career progression (early career versus later career). One year after graduation, 39.6% is employed at university, often as postdoctoral researchers. The percentage of doctorate holders working at university decreases over time. Five and ten years after graduation, respectively 33.0% and 31.0% of the doctorate holders are still working at a university.

The second largest sector of employment is industry. The percentage of PhD graduates in this sector increases over time, from 19.2% one year after graduation to 25.0% ten years after graduation. Government is the third largest sector of employment, providing employment to about 10.0% of the doctorate holders. This percentage remains relatively stable over time. Doctorate holders are less frequently employed in the service sector, hospitals, non-university higher education and in the private non-profit sector and they are rarely employed in the 'other business' sector and in non-higher educational institutions (e.g. secondary education).

Figure 4.1.1: Sector of employment of PhD graduates, 1 year (N=2690), 3 years (N=2679), 5 years (N=2300) and 10 years (N=1332) after graduation (Source: Belgian Science Policy Office, CDH Database 2010)



Doctorate holders represent a heterogeneous group and, therefore, we might expect considerable differences across scientific disciplines. For instance, graduates in engineering or natural sciences have knowledge and competencies which are considerably better valued in industry than those of social science or humanities graduates. We compare the sector of employment three years after graduation for doctorate holders in five disciplines: natural sciences, engineering and technology, medicine and health sciences, agriculture sciences, social sciences and humanities. Three years after graduation is far enough into their careers for most doctorate holders to have a more stable position, and still early enough to include recently graduated doctorate holders.

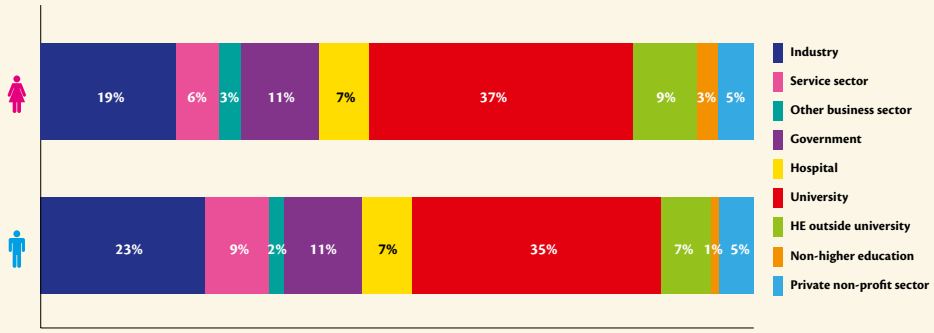
The results show significant differences in sector of employment for the various disciplines (χ^2=886.5, df=40, p<.001). University is the largest sector of employment for doctorate holders in all disciplines, except for those in engineering and technology, who are more likely to be employed in industry (37.6%) (See Table 4.1). Industry is the second most important sector of employment for graduates in agricultural (27.6%) and natural sciences (27.4%) and the third largest employment sector for graduates in medical and health sciences (14.1%). As expected, this latter group is more often employed in hospitals (32.5%). Only a small minority of the doctorate holders in social sciences and humanities work in industry, whereas about half of them hold a position at university. Together with those working at non-university higher educational institutions, respectively 63.2% and 65.6% of the PhDs in the social sciences and humanities are employed in higher education three years after graduation. Government is the second largest sector of employment for this group and the third most important sector for PhD graduates in the agricultural and the natural sciences. PhD graduates in engineering and technology, natural sciences, agricultural and social sciences are more likely to be employed in the service sector than doctoral holders in humanities and medical and health sciences. Generally, few doctoral graduates are employed in the 'other business' sector and even fewer work in education other than higher education. Doctorate holders in the natural sciences (3.0%) and humanities (5.4%) are an exception to this.

Table 4.1.1. Sector of employment 3 years after graduation according to scientific discipline of the doctoral degree (Source: Belgian Science Policy Office, CDH Database 2010)

Discipline	University	Industry	Government	Service sector	HE outside university	Private non-profit sector	Hospital	Other Business sector	Non-higher education	**Total (N)**
Engineering and technology	26.7	37.6	7.4	8.9	7.8	7.2	0.9	2.8	0.7	**460**
Agricultural sciences	31.6	27.7	18.8	10.2	5.5	3.1	1.6	1.2	0.4	**256**
Natural sciences	32.9	27.4	11.6	9.4	6.1	4.1	2.1	3.4	3.0	**923**
Medical and health sciences	36.3	14.1	5.3	3.7	3.5	2.6	32.5	1.5	0.4	**455**
Humanities	49.8	0.5	18.1	4.1	15.8	4.5	0.5	1.4	5.4	**221**
Social sciences	51.5	3.4	14.4	7.2	11.7	6.2	3.1	1.4	1.0	**291**
Total (N)	**933**	**572**	**295**	**201**	**191**	**119**	**185**	**61**	**49**	**2606**

The sector of employment three years after graduation differs significantly between men and women (χ^2=26.5, df=8, p<.001) (See Figure 4.1.2). Men more often have jobs in industry and the service sector than women, whereas women are more frequently employed in university and non-university higher educational institutions.

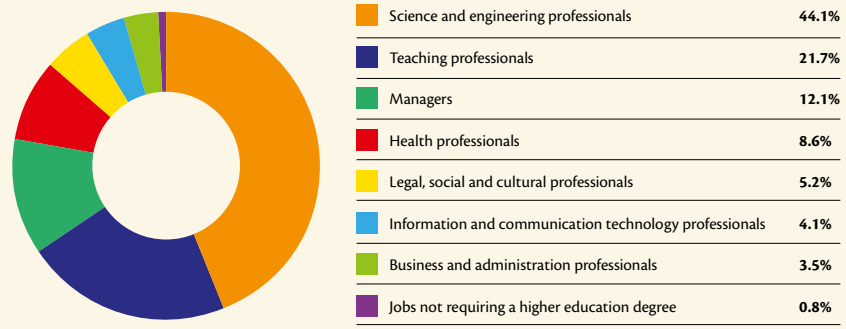
Figure 4.1.2: Sector of employment by gender, 3 years after graduation (Source: Belgian Science Policy Office, CDH Database 2010)



4.2. Occupation

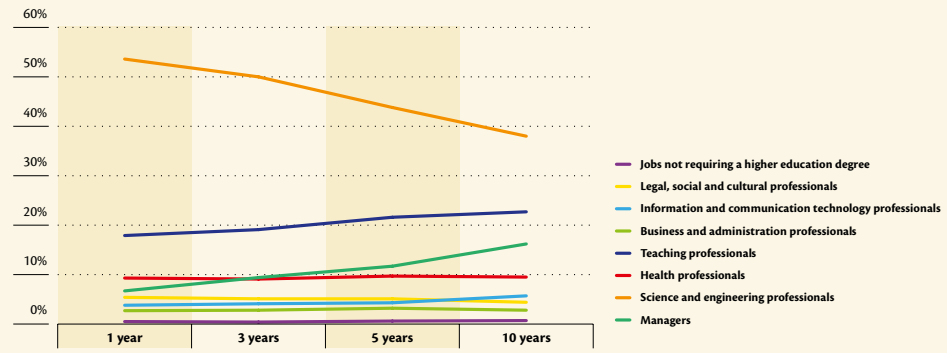
In general, the majority (87.5%) of the 4,095 respondents work as specialists, 12.1% work as managers and only a minority (0.8%) has an occupation that does not require a higher education degree (See Figure 4.2.1; ISCO codes are listed in Annex 2). The most common occupations among doctorate holders are jobs as science and engineering professional (44.1%), and as teaching professional (21.7%).

Figure 4.2.1: Doctorate holders are in their current job most often employed as a professional in science and engineering (Source: Belgian Science Policy Office, CDH Database 2010)



The occupation of doctorate holders according to the time since obtaining the doctoral degree is presented in Figure 4.2.2. One year after graduation, 53.6% are employed as a science and engineering professional. This percentage is lower (38.0%) ten years after graduation. An opposite observation is found for managers. One year after graduation 6.7% are managers by profession, while ten years after graduation, 16.2% are employed as managers. Except for a small increase in teaching professionals, the percentage of doctorate holders in other occupations remains stable over time. The changing percentages might - but do not necessarily - indicate developments due to career progression of individual researchers; also labour market conditions may be different for those graduating ten years before their younger colleagues.

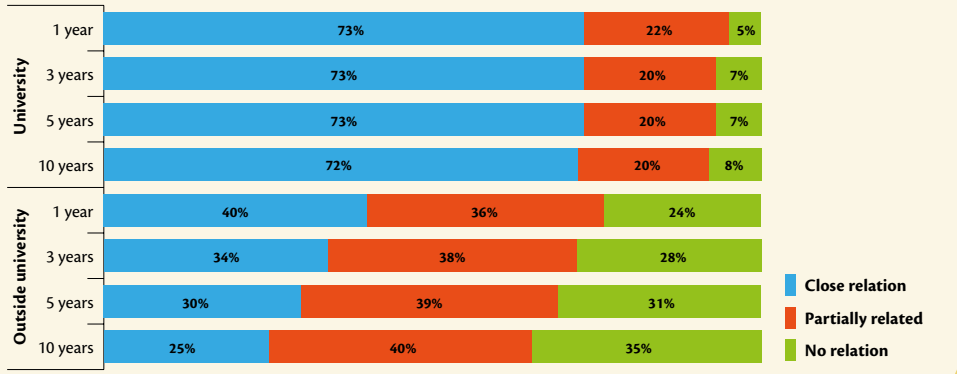
Figure 4.2.2: Common doctoral occupations, 1 year (N=3239), 3 years (N=2902), 5 years (N=2379) and 10 years (N=1308) after graduation (Source: Belgian Science Policy Office, CDH Database 2010)



4.3. Relation with doctoral degree

The relation between the topic of the doctorate and the content of the current job is different for PhD graduates working at university compared with those employed in other sectors outside university. For more than 70% of the doctorate holders employed in university, the job content is closely related to their doctoral research, whether this is one year, three years, five years or ten years after graduation (See Figure 4.3). In contrast, only 40% of the doctorate holders employed in other sectors outside university one year after graduation, indicate that there is a close relation between their doctorate and their job content, while another 36% indicated there is a partial relation. The more work experience doctorate holders have, the more likely it is that the connection between the doctorate research and the content of the job fades away. Nevertheless, ten years after graduation 25% of the doctorate holders in non-university sectors still report a close relationship between their doctorate and their current job content. Thirty-five per cent of them indicate that their job bears no relationship to their doctorate whereas this is the case for only a minority of the doctorate holders working at a university (8%).

Figure 4.3: Relation between the doctoral research and the job content of doctorate holders 1 year (N=3300), 3 years (N=2965), 5 years (N=2411) and 10 years (N=1341) after graduation (Source: Belgian Science Policy Office, CDH Database 2010)



4.4 Employment situation

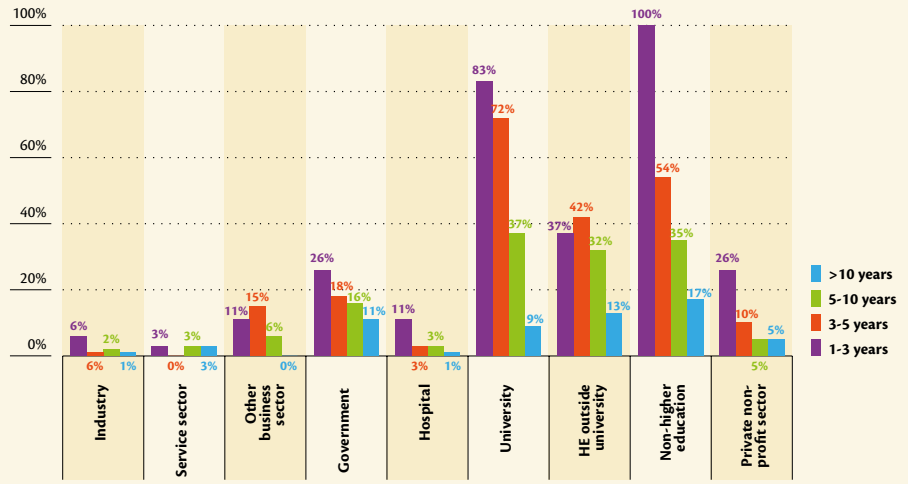
In general, the majority of doctorate holders work as employees, have a permanent contract and work full-time. However, there are differences across scientific disciplines (See Table 4.4). Of all doctorate holders, those in medical and health sciences (10.1%) are most likely to be self-employed, which may be due to the fact that 44.4% (N=295) of them work as health professionals for whom self-employment is more widespread. Part-time employment is most common among doctorate holders in humanities, social sciences and medical and health sciences: 15.5%, 14.3% and 12.1% respectively work part-time. Doctorate holders in humanities (30.5%) are most likely to be employed on a temporary basis whereas this is less common among doctorate holders in engineering and technology (16.1%). More women than men have a temporary appointment (27.5% vs. 19.6%) (χ^2=34.3, df=1, p<.001) and work part-time (19.3% vs. 5.5%) (χ^2=183.2, df=1, p<.001).

Table 4.4: Current employment situation of doctorate holders according to scientific discipline (Source: Belgian Science Policy Office, CDH Database 2010)

	Employee	Self-employed worker	Permanent	Temporary	Full-time	Part-time
Natural sciences	97.7%	2.3%	78.5%	21.5%	90.6%	9.4%
Engineering and technology	92.8%	7.2%	83.9%	16.1%	94.5%	5.5%
Medical and health sciences	89.9%	10.1%	77.0%	23.0%	87.9%	12.1%
Agricultural sciences	97.2%	2.8%	76.6%	23.4%	90.1%	9.9%
Social sciences	97.1%	2.9%	74.2%	25.8%	85.7%	14.3%
Humanities	98.1%	1.9%	69.5%	30.5%	84.5%	15.5%
Total (N)	**3945**	**190**	**3154**	**904**	**3409**	**394**

The percentage of temporary contracts differs according to the number of years of work experience since the doctorate was obtained and by sector of employment (See Figure 4.4). Doctorate holders who have between one and three years' work experience after graduation are more likely to be employed on a temporary basis compared to doctorate holders who have more years of work experience. Again, there are substantial differences between sectors of employment. In industry, the service sector and in hospitals, almost all doctoral holders - even those with only one to three years' work experience - have a permanent appointment. In contrast, the majority of PhD graduates with less than five years' work experience at university or in non-higher educational institutions have a temporary appointment. Even for those with five to ten years' work experience more than 30% still have no permanent contract. A similar observation can be made for doctorate holders employed in non-university higher educational institutions. Thirty-two per cent of those who have five to ten years' work experience still have a temporary contract. In the government sector, the private non-profit sector and the 'other business' sector, temporary contracts are also rather common, but to a far lesser extent, for doctoral holders with work experience of less than 5 years.

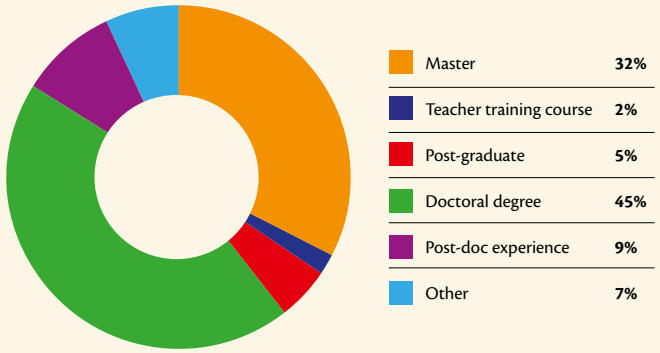
Figure 4.4: Percentage of temporary contracts according to the number of years of work experience after graduation by different sectors of employment (Source: Belgian Science Policy Office, CDH Database 2010)



4.5. Level of qualification

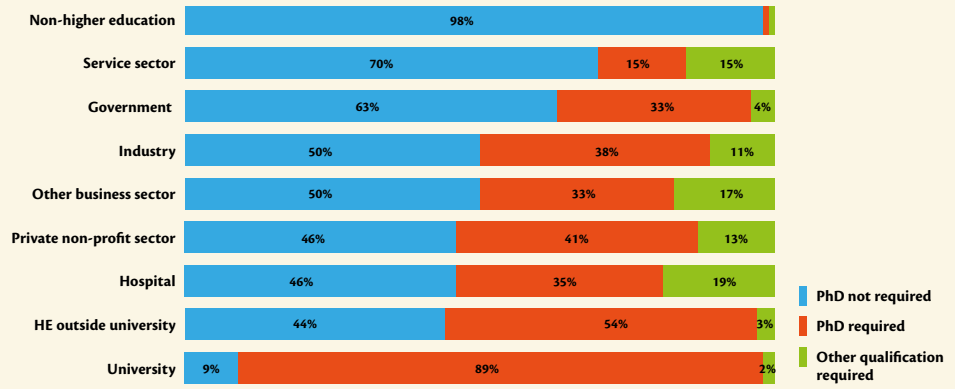
Are doctorate holders working in a job that explicitly requires a doctoral degree? For 54% (N=2273) of the respondents, the minimum level of qualification required for the principal job was a doctoral degree or post-doc experience (See Figure 4.5.1). At least 39% of doctorate holders work in jobs that require no more than a master-level degree, a teacher training degree or a post-graduate degree.

Figure 4.5.1: Minimum required level of education (N=4239) for the principal job (Source: Belgian Science Policy Office, CDH Database 2010)



However, the need for a doctoral degree as minimum required level of education for the principal job depends strongly on the sector of employment (χ^2=84.5, df=10, p<.001). For 89% and 54% of doctorate holders respectively working in university and non-university higher educational institutions, a doctorate degree is required for their job (See Figure 4.5.2). For doctorate holders working in the private non-profit sector, industry, hospitals, 'other business' sector and government, a PhD is less often required: between 33% and 41% need this degree for their principal job. Hence, many PhD graduates employed in sectors outside higher education may be formally overqualified for their job. For those employed in the service sector and in non-higher educational institutions at least 70% state that a PhD is not required for their current position. Nevertheless, in terms of job content and job requirements these employees are not necessarily overqualified: quite often the doctorate is not a 'required' degree, but still a 'desired' degree.

Figure 4.5.2: Extent to which a PhD is required for the principal job according to sector of employment. (Source: Belgian Science Policy Office, CDH Database 2010)



5 Competencies of doctorate holders

Adriana te Kaat, Karen Vandevelde

5.1 Introduction

Being competent in a wide range of skills and aptitudes is crucial for doctorate holders when bridging the gap between their PhD research on the one hand and their professional career on the other, both within and outside academia. Respondents to the Belgian CDH questionnaire were asked two sets of questions in order to examine whether the competencies they acquired during the PhD fit the needs of the labour market. Firstly, we investigate which competencies they perceive as 'acquired' during the PhD track and which competencies they perceive as 'required' during their current type of employment. Do significant discrepancies appear between specific acquired and required competencies? Secondly, we examine the extent to which discrepancies may vary according to sector of employment.

5.2 Method

The CDH respondents were presented with the following question: "*To what extent did you acquire the following skills, knowledge and characteristics during your doctorate? Also indicate to what extent you need those skills, knowledge and characteristics for your current job. Please indicate with a number ranging from 1 (not at all) to 10 (to a large extent).*"

The list of 25 items being surveyed corresponds to five competency clusters (Table 5.2): research skills, management skills, team skills, communication skills and personal effectiveness.[1] The items selected and the competency clusters were inspired by the Joint Skills Statement (UK Grad Programme, 2001) and a study by Rudd et al. (2008) on doctoral education.[2] This type of questioning does not allow for actual skills assessment. Instead, the respondents' level of engagement with particular skills and competencies is investigated.

(1) Only doctorate holders who filled out at least three items corresponding to each cluster and whose current sector of employment was known, were included in the analyses.
(2) For more information, see De Grande et al., 2010.

Table 5.2: Surveyed competencies

Research skills:	**Communication skills:**
Technical skills	Presentation skills
Research skills	Teaching skills
Specific scientific knowledge	Knowledge of languages
Knowledge of data analysis/synthesis	Written communication skills
Critical reflection	Networking skills
Management skills:	Negotiating skills
Project management	**Personal effectiveness:**
Leadership skills	Taking the initiative
Knowledge of IP and patents	Being flexible
Commercial skills	Being able to work under pressure
Team skills:	Time management skills
Being able to work in a team	Being creative/innovation minded
Being able to deal with diversity/interdisciplinarity	Being able to work independently
Social skills	Being eager to learn

5.3 Discrepancies between 'acquired' and 'required' competencies

Table 5.3 shows the mean scores on the five competency clusters that doctorate holders perceive as acquired during the doctoral degree and necessary in the current job. It also shows the gap between these two scores (the 'discrepancy') as well as the significance of the discrepancy. A negative discrepancy indicates a perceived 'lack' of skills, whereas a positive gap indicates a 'surplus'.

The gap between 'acquired' and 'required' is very small for research skills and for competencies related to personal effectiveness (i.e. taking the initiative, being flexible, being able to work under pressure, etc.), suggesting that doctorate holders feel ready to meet these expectations.

When it comes to the type of skills that are most highly needed, team skills and personal effectiveness are rated higher than the other skills in the current job, whereas the need for management skills is relatively low. Management skills are also rated lowest in the level of acquisition during the doctoral training phase.

For management skills, the gap is relatively wide but communication skills and team skills in particular may pose a problem: the latter are highly necessary in the labour market but underdeveloped during the PhD track, whereas management skills generally seem to be of less concern for doctorate holders' jobs. Note that these discrepancies do not suggest that doctorate holders currently lack the skills needed for their job, but only that they have not yet acquired them sufficiently during their doctoral training. Further training also remains a responsibility of employers and of doctoral graduates themselves.

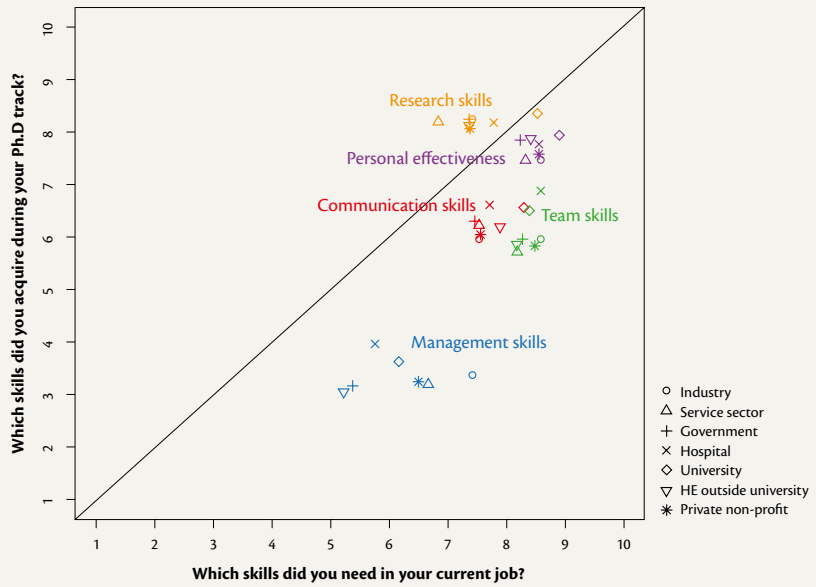
Table 5.3: PhD graduates' level of engagement with five clusters of competencies (N=3713)
(Source: Belgian Science Policy Office, CDH Database 2010)

Competencies	*Acquired*	*Required*	*Discre-pancy*	*Paired samples t test*		
	Mean	*Mean*		*t*	df	*p*
Research skills	8.3	7.7	0.5	18.7	3712	<0.01
Management skills	3.4	6.3	-2.9	-76.7	3712	<0.01
Communication skills	6.3	7.8	-1.5	-53.5	3712	<0.01
Team skills	6.2	8.4	-2.2	-61.9	3712	<0.01
Personal effectiveness	7.7	8.6	-0.9	-34.9	3712	<0.01

5.4 Important competencies in different sectors

PhD graduates in Belgium from various disciplines and employed in various sectors in or outside academia also have different experiences and needs. As the discipline and the sector of employment are strongly related, we focus on the latter. In figure 5.4, competencies necessary in the current job and competencies acquired during the doctoral programme are plotted for seven sectors of employment[3].

Figure 5.4: Competencies needed vs. acquired in different sectors (N=3563)
(Source: Belgian Science Policy Office, CDH Database 2010)



(3) In total, nine sectors of employment are included in the analysis. In the scatterplot however, two sectors are excluded due to their low numbers: the 'other business sector' (N=77) and the non-higher educational institutions (N=73)

Figure 5.4 depicts variation according to sector, particularly when it comes to the needs in the current job. The largest variation can be observed in management skills, which seem to be much more important in industry than in other sectors – at least from the perspective of the doctorate holders themselves. Research skills and personal effectiveness are situated close to the diagonal, suggesting that these competencies match the needs of the job sufficiently. Except for doctorate holders working in university, there is a slight 'surplus' of research skills, even for those currently working in industry (including R&D).

By means of variance analysis, we examined which skills are most essential in jobs across sectors of employment. Doctorate holders in university perceive their research skills as far more 'necessary' for their job than other PhD graduates, especially when compared to those who work in the non-higher educational institutions, the service sector and the 'other business' sector (F=71.3, df=8, p<.01). Management skills are particularly necessary in industry, in contrast with education sectors outside university and government where PhD graduates rate their own needs for management skills much lower (F=80.11, df=8, p<.01). Communication skills are in high demand in most sectors but particularly in academia (F=33.4, df=8, p<.01). Also team skills are highly desired in every sector but people who work in hospital and in industry rate the need for these competencies higher compared to PhD graduates in other sectors (F=4.4, df=8, p<.01). Finally, personal effectiveness is significantly more in demand at university than in other sectors of employment (F=20.6, df=8, p<.01).

5.5. Conclusion

Generally, doctoral graduates across all sectors of the labour market perceive their research skills (e.g. technical skills, analytical thinking and specific knowledge) and personal effectiveness (e.g. taking the initiative, being flexible, independent, creative and being able to work under pressure) as sufficient to meet their job requirements. The self-perceived discrepancy between acquired competencies and required competencies in the current job is more substantial for management skills, communication skills and team skills.

However, considerable differences occur between sectors of employment. The requirement of management skills in particular varies strongly from sector to sector: mainly PhD graduates employed in business sectors rate their needs for project management, leadership skills and commercial skills highly. Communication skills and team skills appear to be almost equally important in every sector. An examination of doctoral graduates' competencies and their transition phase into the non-academic labour market demonstrates that academic as well as non-academic jobs expect more than just brains and knowledge. This competency development can be enhanced during the PhD phase, but will continue well beyond the first job after the PhD.

6
Salary and satisfaction

Karl Boosten

This chapter presents a series of figures with regard to the wages of doctorate holders. In comparison with other groups on the labour market doctorate holders are less confronted with unemployment. While the average unemployment rate in Belgium is currently at 7.3 % (Eurostat, 2012), only 2.5% of the responding doctorate holders is unemployed. Furthermore, doctorate holders can count on attractive financial rewards.

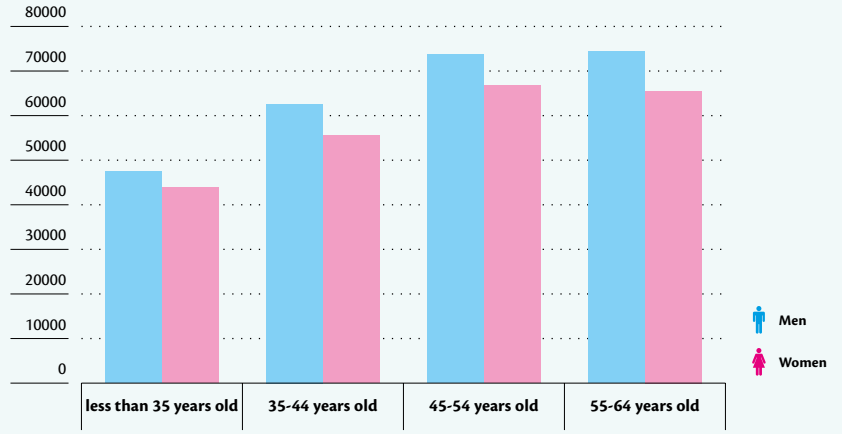
That said, we must remark there are significant differences according to gender, age and scientific discipline of the doctoral degree. Other factors such as being involved in research or the fact that one has been working abroad have no significant influence on the salary being paid.

6.1 Age and gender

We start our analysis of the wages of doctorate holders by taking into account two factors, namely age and gender. We use four different age categories (younger than 35, 35-44, 45-54 or 55-64 years old). The salary of the average doctorate holder increases with age. Nevertheless, we should add for the sake of completeness that this trend decreases slightly for the oldest age category (55-64). This group earns a lower or equal salary when compared with their younger colleagues. The difference between the age groups is significant, except for the difference between the last two age groups (Manova: contrast <35 versus 35+: $p<.001$, contrast 35+ versus 45+: $p<.001$, contrast 45+ versus 55+: $p=.43$).

When comparing the wages of both sexes, we notice that the traditional wage difference between men and women manifests itself also for people with a doctoral degree. Male doctorate holders earn on average more than female doctorate holders and this difference is persistent throughout their careers (Independent t test: $p<.001$).

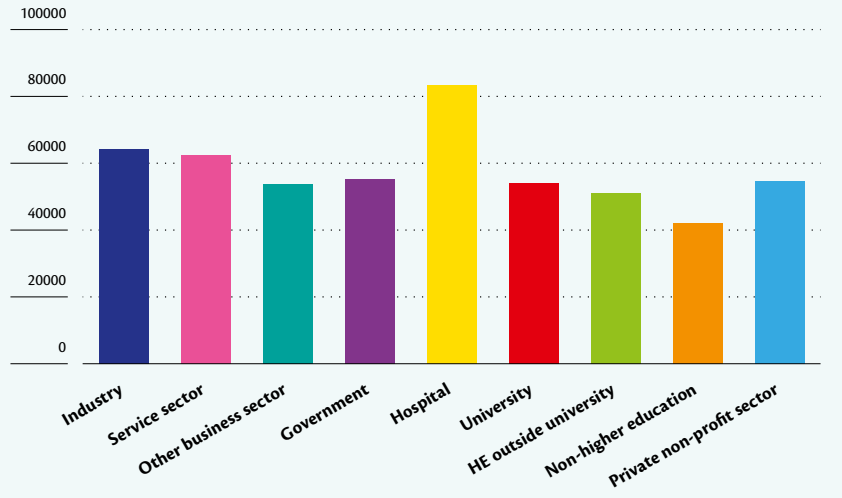
Figure 6.1: Evolution of average annual gross salary (in euros) according to age and gender (<35: N=670, 35-44: N=994, 45-54: N=524, 55-64: N=76, men: N=2277, women: N=1071) (Source: Belgian Science Policy Office, CDH Database 2010)



6.2 Sector of employment

The wages of doctorate holders are strongly dependent upon their sector of employment. The medical sector shows to be the best paying sector followed by industry and the service sector. Salaries paid by the government, university, the non-university higher education sector and the private non-profit sector are comparable. The lowest incomes can be found in secondary education.

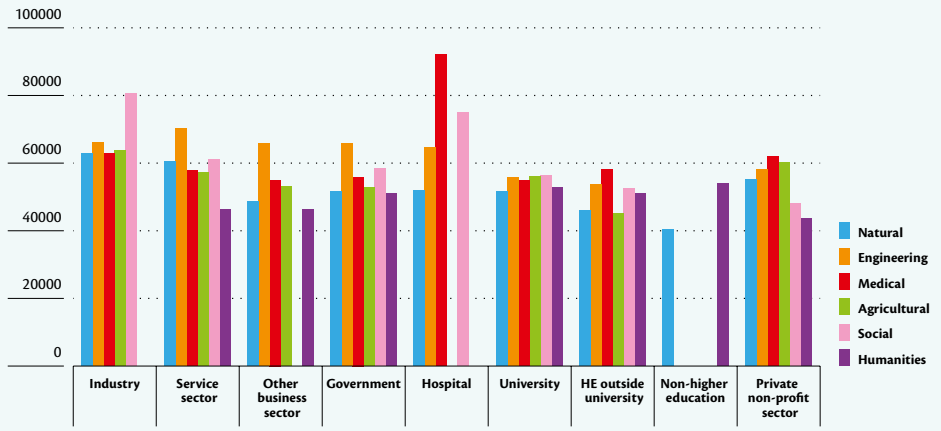
Figure 6.2: Average annual gross salary (in euro) by sector of employment (industry: N=749, service sector: N=303, government: N=400, hospital: N=205, university: N=1154, higher education outside university: N=232, non-higher education: N=59, private non-profit sector: N=152) (Source: Belgian Science Policy Office, CDH Database 2010)



6.3 Scientific discipline

In this section we try to determine the best paying sector depending on the scientific discipline of the doctoral degree. Figure 6.3 shows which sector is most lucrative according to scientific discipline. In university, there is little difference in salary for all doctorate holders. In the medical and health sciences sector, it is the medically trained doctorate holders who are obviously best paid. The wages of doctorate holders in the humanities are generally lower compared to those of doctorate holders in other disciplines, in particular in industry and the service sector. However, it should be noticed that PhD graduates in the humanities are only rarely employed in these latter sectors. The peaks in salary in industry and hospitals earned by social sciences doctorate holders must be interpreted with caution due to the strong influence of a very small group of high earners in high-level positions.

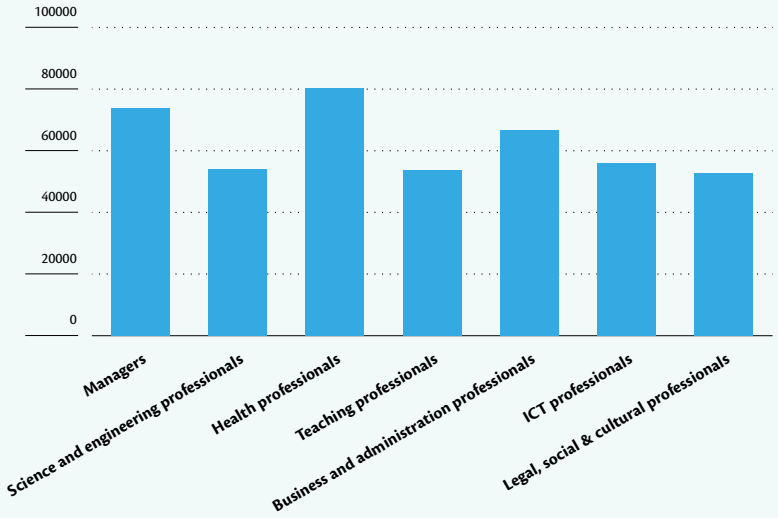
Figure 6.3: Average annual gross salary (in euro) by sector and scientific discipline (industry: N=749, service sector: N=303, government: N=400, hospital: N=205, university: N=1154, higher education outside university: N=232, non-higher education: N=59, private non-profit sector: N=152 / natural sciences: N=1151, engineering and technology: N=610, medical and health sciences: N=532, agricultural sciences: N=310, social sciences: N=361, humanities: N=301) (Source: Belgian Science Policy Office, CDH Database 2010)



6.4 Occupation

Salaries not only differ depending on the sector of employment but also depending on the position one holds inside a company or organisation. We take a closer look at the salary of PhD holders according to their profession. The classification we use to divide doctorate holders in occupational categories is the international standardised ISCO-classification that can be found in annex 2. Health professionals receive the highest salaries. Managers come in second place, followed by business and administration professionals and information and communication (ICT) specialists. The remaining categories fall more or less in the same income group.

Figure 6.4.1: Average annual gross salary (in euro) by occupation (managers: N=402, science and engineering professionals: N=1421, health professionals: N=255, teaching professionals: N=681, business and administration professionals: N=105, ICT professionals: N=127, legal, social and cultural professionals: N=169) (Source: Belgian Science Policy Office, CDH Database 2010)



In order to put the results of the previous figure in a broader perspective, we compared doctorate holders' occupations according to the discipline of their doctoral degree.

Figure 6.4.2: Composition of the different occupational categories according to scientific discipline (Source: Belgian Science Policy Office, CDH Database 2010)

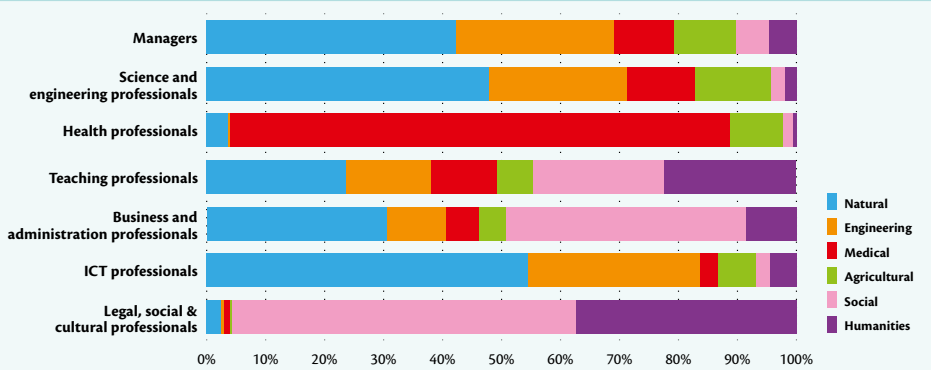


Figure 6.4.2 shows that managers, science/engineering professionals and ICT specialists are occupational categories which are dominated by PhD graduates in natural sciences and engineering and technology sciences. Doctorate holders in the social and natural sciences are frequently recruited for an occupation as business or administration professionals. The legal, social and cultural professions are mainly occupied by social sciences and humanities doctorate holders.

6.5 Mobility / researchers versus non-researchers

Doctorate holders who have stayed abroad during a certain period within the scope of research and/or work-related activities (mobile doctorate holders), in general do not earn more than their non-mobile counterparts. It appears that a stay abroad has no influence on the level of salary (mobile doctorate holders: N=663, non-mobile doctorate holders: N=2583, Satterthwaite independent t-test $p>.28$). Similar findings are obtained for the salaries of researchers versus doctorate holders with a non-research job: The wages of researchers are comparable to those of people who are no longer involved in research activities (researchers: N=2275, non-researchers: N=857, t-test $p>.30$).

7 Motivation and satisfaction

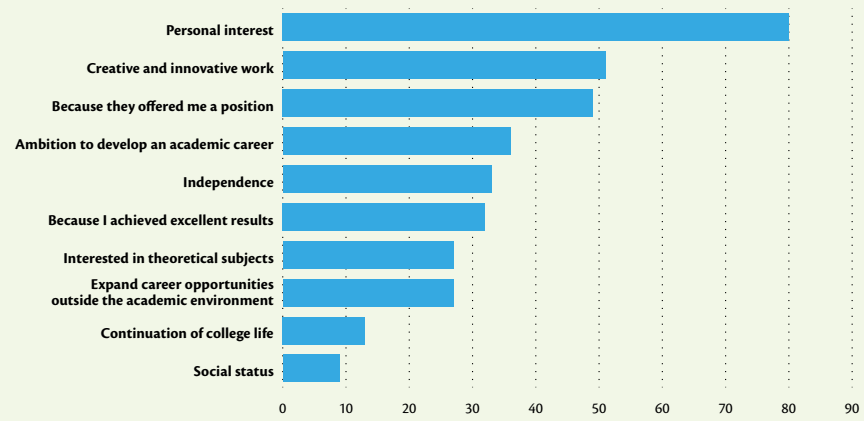
Karl Boosten

Salary plays an important role in feeling satisfied with a job. As salary is however not the only motivating factor for satisfaction, we aim to expand the findings we obtained in the previous chapter by means of examining other elements that might contribute to the decision to start a doctorate and a career in scientific research.

7.1 Reasons to start a doctorate

The majority of the respondents (N=3636, 79.9%) chose to write a dissertation because of personal interest or because of the creative and innovative work a doctorate implies (N=2342, 51.5%). Social status (N=416, 9.1%) plays a less important role in the consideration to start a doctoral track. This suggests that doctoral students are internally rather than externally motivated. Furthermore, a substantial part of the respondents is employed in doctoral research because he/she was offered a position (N=2223, 48.9%). Finally, excellent study results and the ambition to develop an academic career (respectively N=1436, 31.6% and N=1649, 36.3%) are important reasons to start a doctoral study.

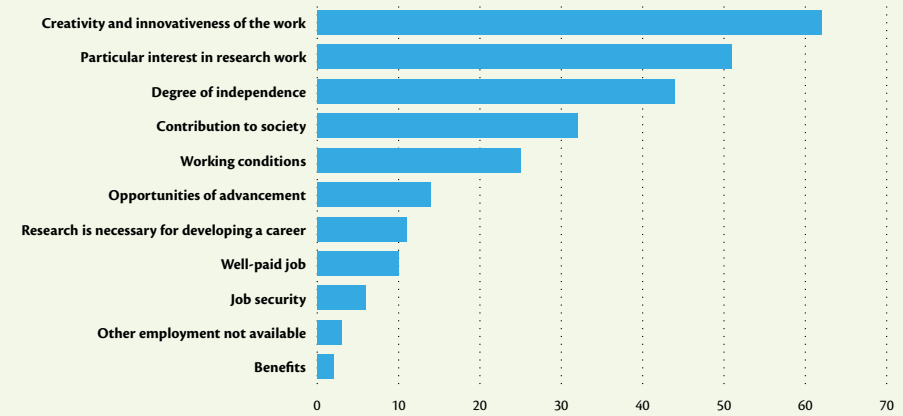
Figure 7.1: Reasons to start a doctorate in percentages (note: respondents were allowed to mark more than one alternative. If a respondent marks item 1 and 6, he/she will be counted for both items) (Source: Belgian Science Policy Office, CDH Database 2010)



7.2 Reasons to choose a research career

In the previous section we made a few explanatory remarks to the question why doctorate holders decided to start a doctoral career. In line with this question and because of the fact that the majority of the respondents are active as researchers, a similar question was asked with regard to the reasons why doctorate holders chose a career in research. The reasons for doing a doctorate are similar to the reasons for establishing a research career: half of the respondents chose this career because of their specific interest in scientific research (N=2337, 51.4%). Other elements that underscore an intrinsic interest in scientific research, in particular the creativeness and innovativeness of the work (N=2814, 61.9%), but also the possibility to work independently (N=2007, 44.1%) and the contribution to society (N=1454, 32%) are decisive for starting a career in research.

Figure 7.2: Reasons to choose a research career in percentages (remark: respondents were allowed to mark more than one alternative, this implies that if a respondent marks item 1 and 6, he/she will be counted for both items) (Source: Belgian Science Policy Office, CDH Database 2010)



7.3 Satisfaction with job and salary

In this section, we examine the satisfaction of doctorate holders with regard to their financial rewards and with regard to the satisfaction they experience in carrying out their profession. For this purpose, two factors were compared. The first factor includes intellectual challenge, level of responsibility and degree of independence, combined into 'job content'. The second factor assesses to what extent doctorate holders are satisfied with the financial aspect of their job.

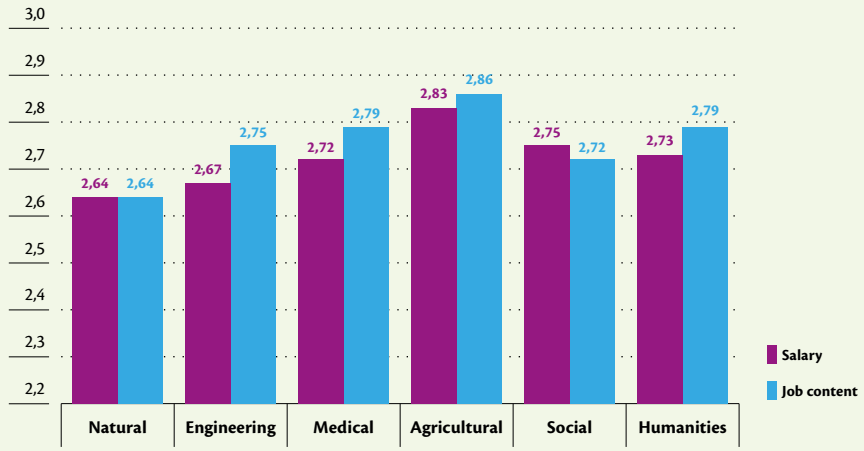
In general, approximately 60% of the respondents indicate being satisfied with the content of their job as well as with their salary. In the next sections, we address possible differences between scientific disciplines, sectors of employment and differences between researchers and non-researchers.

7.3.1 Scientific disciplines

On average, agricultural PhD holders are the most satisfied with their salary; graduates with a PhD in the natural sciences are the least satisfied. Results for satisfaction regarding the job content are similar. Doctorate holders holding a PhD in natural sciences are the least satisfied and agricultural scientists are the most

satisfied with their job content. Natural science and agricultural science PhD graduates differ significantly in their satisfaction with regard to the salary they earn. The same conclusion can be made for PhD holders in engineering and agricultural sciences. Analyses of the figures for job content satisfaction show significant differences between natural science PhD holders on the one side and those who have a doctoral degree in medical and agricultural sciences and the humanities on the other side. Although the bars in the figure beneath seem to suggest a difference in the relation of doctorate holders with respect to their salary and the content of their job, none of these differences can be considered as significant.

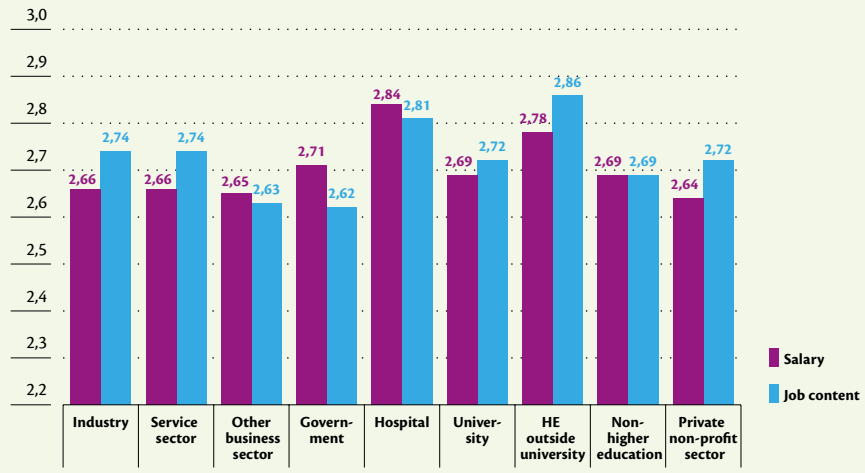
Figure 7.3.1: Satisfaction with regard to salary and job content per scientific discipline (Source: Belgian Science Policy Office, CDH Database 2010)



7.3.2 Sectors of employment

Hospital staff members are the most satisfied with their salary, whereas their colleagues in the non-profit sector are the least satisfied. With regard to job content, doctorate holders employed in higher education institutions outside universities are the most satisfied and those who work for governmental institutions are the least satisfied. In general PhD holders in the private sector earn more than their public sector counterparts, but when it comes to salary related satisfaction they appear to be less happy with their income. The satisfaction scores suggest a significant difference in salary appreciation between doctorate holders employed in industry and those working in hospital. Considerations related to content of the job signal a significant divergence between government officials (least satisfied) and staff of the higher education sector (most satisfied). Salary-related and job content-related satisfaction do not differ significantly from one another in any of the examined sectors.

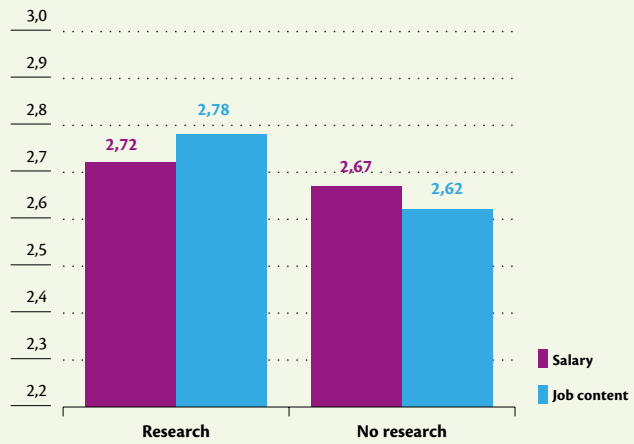
Figure 7.3.2: Satisfaction with regard to salary and job content per employment sector (Source: Belgian Science Policy Office, CDH Database 2010)



7.3.3 Researchers and non-researchers

Doctorate holders with research jobs are more satisfied with their salary compared to doctorate holders who are not involved in research activities in their current employment (not significant at α=0.05). This finding applies similarly to job content satisfaction: researchers are more satisfied than non-researchers (significant at α=0.05). The levels of appreciation of the PhD holders with regard to salary and job content are not significantly different between those involved in research activities and those no longer working as researchers.

Figure 7.3.3: Satisfaction with regard to salary and job content for researchers and non-researchers (Source: Belgian Science Policy Office, CDH Database 2010)



8 International mobility of doctorate holders

Karl Boosten

Scientific research has always been an international activity, operating across national borders, but over the last decade this has been encouraged specifically in order to increase knowledge mobility and to improve research careers. In order to investigate the mobility of Belgian doctorate holders, respondents were surveyed about their international ambitions and experiences. Important to bear in mind in the discussion below is the fact that only 4.2% of the CDH survey respondents were researchers from outside Belgium. The investigation is probably missing out on many of the international researchers having moved to Belgium to obtain a doctoral degree, namely more than a quarter (26.4%) of the actual population (source: CREF & ECOOM). In addition, it is to be expected that the results below contain few data on Belgian researchers living abroad since they have earned their doctoral degree, although an estimate of this group could not be made.

8.1 Profile of an internationally mobile doctorate holder

The majority of respondents (80%) have not been mobile since they started their doctoral study, neither for professional duties nor for research visits abroad. However, there are differences between groups of doctorate holders. Men have generally been more mobile than women (men: N=605, 20.5%; women: N=232, 14.6%; χ^2=23.56, df=1, p<.001). Doctorate holders younger than 44 have been more inclined to spend a part of their career abroad than their older colleagues (<=44 years: N=739, 21.9%, >44 years: N=94, 8.2%; χ^2=107.1, df=1, p<.001). This suggests a change in mentality and in mobility patterns. An important detail to take into account when considering these results is that mobile researchers who were officially registered as living outside Belgium at the time of the survey, could not be targeted with a questionnaire and are therefore excluded from these figures. Also those residing abroad, more than likely never received the questionnaire sent to their official Belgian address. Their responses might alter current findings.

When we look at the scientific discipline of the doctoral degree, we see that no general correlation exists between the disciplines and the number of stays spent abroad (χ^2=7.1, df=5, p=.208). Investigating the employment sectors, it appears that doctorate holders who work in university have stayed abroad more frequently for professional reasons (N=450, 31.7%) than employees in other sectors, such as industry (N=130, 14.2%) and the government (N=73, 15.1%). Overall, a certain percentage of all employees in these sectors have been abroad for research-related or professional reasons for a limited period of time during their career. These figures are supported by a significant correlation between the sector in which one is employed and the number of mobility experiences (χ^2=212.5, df=8, p<.0001).

Finally, doctorate holders in research positions (N=667, 23.7%) are more often internationally mobile than doctorate holders who are not or no longer involved in research activities (N=159, 13.8%; χ^2=48.3, df=1, p<.0001). All of these data suggest that doctorate holders working in academia and/or working as researchers tend to be more mobile than doctorate holders in other professions, which is even more the case for the younger generation. This provides some evidence towards the effectiveness of mobility incentives in the academic sector, strongly encouraged in European and OECD countries over the last few decades in order to boost knowledge transfer and the attractiveness of researchers' careers (European Commission, 2001; OECD, 2008) – however to a far lesser extent in industrial R&D.

8.2 Incentives and barriers for being mobile

Doctorate holders who have been internationally mobile during and/or after their doctorate degree (N=837) and who are intending to go abroad (N=46) were asked what their main incentives were. PhD holders who had never stayed abroad (N=3665) were asked to indicate what their main barriers are. The following diagram gives an overview of all possible options presented in the survey.

Table 8.2: Overview of incentives and barriers for being mobile

INCENTIVES	BARRIERS
Job-related or economic factors:	**Family or personal reasons:**
job search	financial reasons
sent as expat by employer	not interested
better guarantee of finding a job	poor knowledge of languages
job offer	family reasons
Academic factors:	limited job opportunities
better access to publishing	competition on the international job market is too fierce
continuity of thesis work	administrative and legal impediments
work in a specific area non-existent in Belgium	
possibility of creation of own research team or new research area	

When we compare both groups (experience abroad and intention to go abroad versus non-mobile doctorate holders) it appears that they use opposing arguments for motivating their decision. For the group with an intention to go abroad and the group that has been internationally mobile, economic and academic factors play an important role (stayed abroad: economic = 42.9% and academic = 49.6% / intention to leave: economic = 54.7% and academic = 59.1%). Personal and family reasons are less relevant for this group. For the group that is rather reluctant to stay outside Belgium we observe the opposite; they rather emphasize family reasons as an impediment to going abroad (51.4%).

Doctorate holders who have spent a certain time abroad during their study career before the doctorate, for example within the framework of an exchange programme, are more inclined to acquire further experience abroad during their subsequent professional career (χ^2=52.91, df=1, p<.001). Earlier mobility indeed has some influence, either on a person's ambition to develop an international career, on their coping strategies with barriers, or on their perspectives on the advantages of mobility.

8.3 Most important destinations of mobile doctorate holders

Belgian doctorate holders most often go to the United States and the United Kingdom. Many of the world's most acclaimed research institutes, attracting researchers with excellent facilities and top-level colleagues, are established in these countries. Also non-European countries with a strong tradition in scientific research such as Canada and Australia and neighbouring countries as Germany, France, and the Netherlands have accommodated a fair share of Belgian doctorate holders. Actual brain circulation figures, however, are difficult to construct on the basis of CDH data, as researchers who have moved abroad long-term were impossible to trace in the Belgian National Register data and were therefore not invited to fill out the survey.

8.4 Average length of stay abroad

The average length of stays abroad equals 21 months, the median length is 12 months. This implies that 50% of mobile PhD graduates stay abroad for less than 12 months. When we study the length of stay in more detail, it becomes obvious that most mobile doctorate holders (73%) have spent some time abroad for professional reasons, at the most for two years. When we take into account the number of stays abroad we observe a decrease in the length of stay in correlation with an increase in the number of stays. This means that PhD holders who have been abroad only once have spent a longer period outside Belgium than those who have been in other countries several times. The more one goes abroad, the shorter the visits' duration becomes.

8.5 Remarks on physical mobility

A stay abroad contributes to a researcher's development exposes a person to new research environments and provides an opportunity to establish new networks (Leyman et al, 2009). However, today's technologies provide many alternatives to making a journey abroad in order to cooperate with scientists in other parts of the world. With increased possibilities in telecommunication and computer networks, travelling is no longer a prerequisite. Two questions pertaining to cooperation networks with foreign research groups using the internet were added to the questionnaire. Firstly, respondents were asked whether they currently work on a joint publication with people in other countries. Secondly, respondents were asked whether they collaborate from a distance on a joint research project with researchers in another country.

Doctorate holders who have acquired research experience abroad have more regular contacts with foreign researchers for publication purposes (N=609, χ^2=112.3, df=1, p<.001) and/or are more involved in internationally coordinated research projects (N=581, χ^2=44.8, df=1, p<.001). We can thus conclude that having stayed abroad is not a condition for establishing an international network of contacts, but nevertheless increases the chances for cross-national 'virtual' cooperation.

8.6 Long-term effects of mobility

In order to assess whether a stay abroad has any long-lasting impact on researchers' careers, respondents were asked to indicate whether they maintain relations with the country where they have been. In this section we have narrowed our attention to research-related stays abroad (N=665). Stays that are purely job-related but not associated with research, are not taken into consideration.

Figure 8.6: Percentage of doctorate holders who keep in touch with the country where they stayed to carry out research since the last stay abroad (Source: Belgian Science Policy Office, CDH Database 2010).

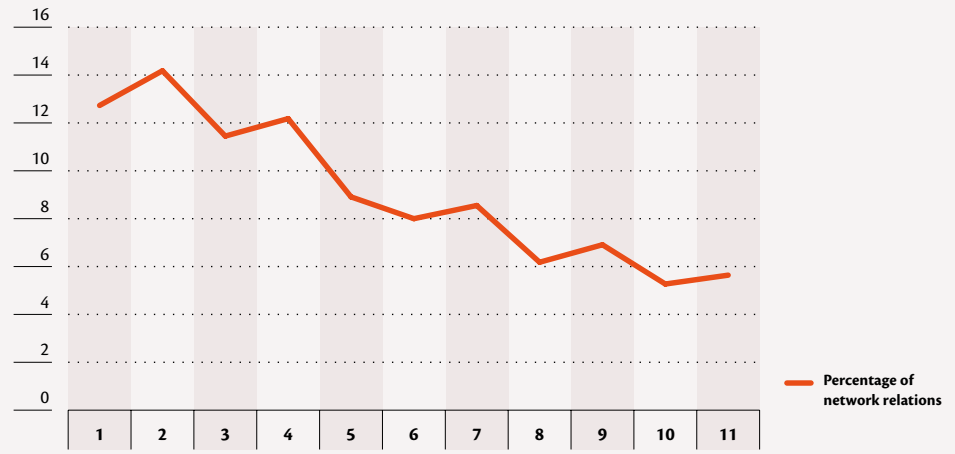


Figure 8.6 indicates that the further in the past the last stay abroad took place, the more the network relations start to disintegrate. Having an international network of contacts thus requires a permanent investment in travelling.

9 Profile sketch of a researcher

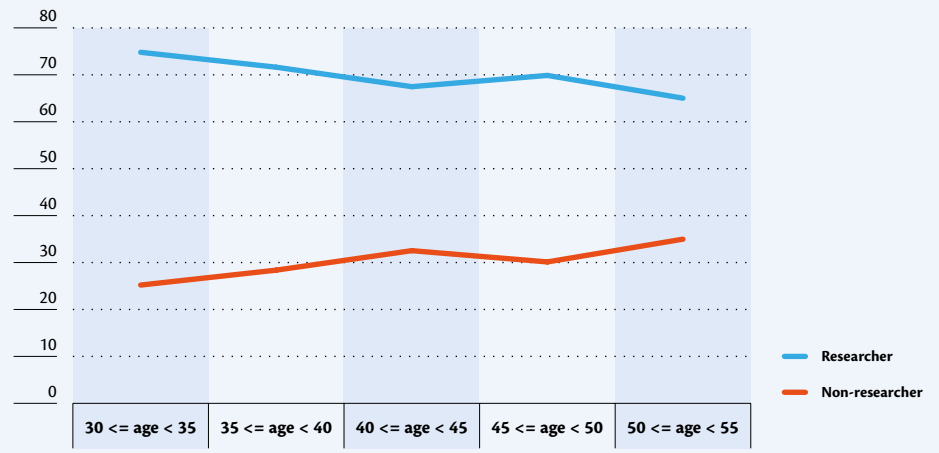
Karl Boosten

The central question in this chapter is whether doctorate holders are involved in research activities in their current job. As the need for specifically trained researchers is increasingly high for Europe's knowledge-intensive economy, it is of utter importance that doctorate holders occupy positions that require strong research skills. Generally, almost 70% of responding doctorate holders carry out research as part of their main job. Of those who are currently not involved in research, approximately 46% conducted research in their previous employment(s). These findings suggest that a large majority of all PhD graduates are employed as researchers for at least a certain time during their career, despite the fact that a substantial group was not involved in any research activities after the doctoral degree was obtained.

An interesting finding was observed when comparing the share of respondents reporting to have been active as researchers between the 2006 cohort and the 2010 cohort. When asked, 'Are you employed as a researcher?' in the 2006 survey, only 39.6% responded positively. Faced with a more elaborate question in 2010, far more respondents identified themselves as being 'engaged in research and/or experimental development work, i.e. [being] engaged in the conception or creation of new knowledge, products, processes, methods or systems or in the management of such projects'. Rather than interpreting this as a major shift in the situation of researchers' careers between 2006 and 2010, we can assume that many might not think their own job meets the commonly understood narrow definition of 'research' (as the question was posed in 2006), while they do consider themselves as being involved in knowledge production, innovation or knowledge management (the formula in 2010).

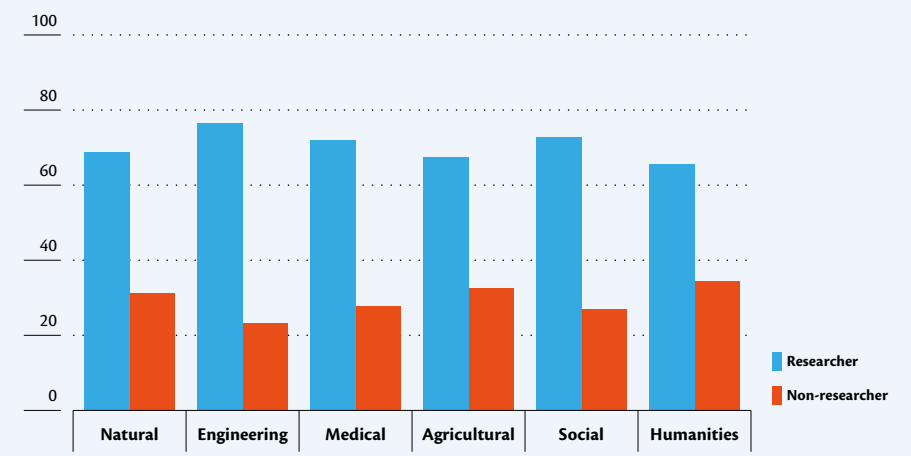
Generally, women (N=1344, 62.1%) are to a lesser extent involved in research activities than men are (N=2616, 75.1%). In addition, age has an influence on the chances of working as a researcher. At the beginning of their careers almost 80% of the respondents are working as a researcher. At the age of 55, only 60% is still actively conducting research. Especially in R&D, moving from a research-job to a non-research position is often an indication of experience-related promotion into managerial positions.

Figure 9.1: Share of researchers versus non-researchers by age (Source: Belgian Science Policy Office, CDH Database 2010)



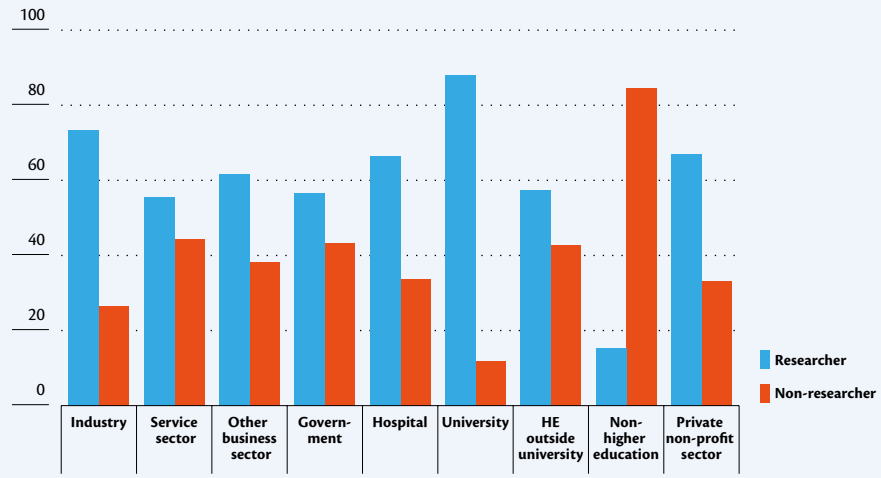
Not in all scientific disciplines doctorate holders are equally involved in research-related jobs. Especially in the humanities (N=369, 34.4%), agricultural (N=359, 32.6%) and natural sciences (N=1353, 31.2%), doctorate holders are less often working as researchers. On the contrary, the majority of engineers (N=698, 76.7%) use their acquired research skills in research-focused professional positions.

Figure 9.2: Share of researchers by scientific discipline (Source: Belgian Science Policy Office, CDH Database 2010)



Some sectors of employment are more research-intensive than others, as can be inferred from the proportion of doctorate holders that is employed as a researcher per sector. The university is quite obviously the most research-intensive sector of employment. The majority of doctoral employees in industry (N=868, 73.6%) and hospitals (N=237, 67.1%) also invest a considerable part of their working hours in research activities. In the services sector (N=340, 55.6%), the government sector (N=442, 57%) and the non-profit sector (N=178, 66.3%) the figures are less distinct, although the group of employees who are carrying out research work is still larger than those who are not. In secondary education the roles are reversed (N=81, 17.3%) as most secondary school teachers maintain no links with scientific research.

Figure 9.3: Share of researchers by sector (Source: Belgian Science Policy Office, CDH Database 2010)



10 Conclusions

Karl Boosten & Karen Vandevelde

Although the number of doctorate holders shows an increasing trend over the last two decades, the number of academic positions available has increased very little in the same period. Most doctorate holders have coped very well with the new career opportunities they pursued and have taken up positions in which they continue to apply their research experience and/or rely on their doctoral experience to contribute substantially to their work environment. Vacant positions in the non-academic labour market have been increasingly taken up by highly skilled candidates.

In the light of these findings, one could wonder whether the increased investment in doctoral education, resulting in a rapid growth of doctorate holders in the labour market, is indeed an appropriate measure to stimulate the knowledge economy, especially in the context of the limited academic career possibilities. Does the investment pay off, on a personal level, on a career level and/or on the level of the general economy?

Although there is no simple answer to this question, requiring an investigation on the part of employers, doctorate holders and policy makers alike, there are a number of indications in the survey responses prompting us to answer this question affirmatively from the doctorate holders' perspective.

First of all, doctorate holders across various sectors of employment and from the widest possible range of disciplines generally report high satisfaction rates for their salaries as well as their job contents.

Second, the fact that many doctorate holders outside academia are still involved in research and research-related activities in private companies, industry and other organisations outside of higher education, points to the transferability of high-level skills and knowledge as well as their employability across a wide range of sectors. Moreover, this finding indicates the increasingly innovative potential of the Belgian economy, relying for a substantial part on the talent for research and innovation of its HR potential. Indeed, doctorate holders who chose a research career did so because of its potential for creativity, innovation and independent work. Doctorate holders are not simply trained to meet current labour market needs, but are also expected to make their mark on today's labour market in order to address innovation opportunities still ahead. For this potential to be realised, however, further improvements could be made in the transition phase between doctorate holders' exit from academia and their entry into the non-academic labour market – and possibly their re-entry into academia.

Another interesting finding is the large number of doctorate holders still pursuing a career in academia, pointing to the attractiveness of the academic profession. This promises a continuation of high-level performance at Belgian universities. In terms of financial rewards, however, academia loses the competition with certain better-paid sectors of employment for the highly skilled, in particular hospitals, industry and the service sector. Creating further opportunities for cross-sector collaboration, encouraging researchers' mobility from industry into academia, and safeguarding the attraction of the academic profession, all of these will be necessary for universities to keep their best researchers in certain academic fields.

Next, an examination of doctorate holders' skills suggests that what they have acquired during their doctoral degree and what they need in their current job is generally perceived to be a good match, notwithstanding some discrepancies which are larger in some sectors of employment than in others. In particular with regard to research skills and personal effectiveness, doctorate holders find their competencies sufficiently meet their job requirements. In business-oriented jobs, however, commercial skills, project management skills and leadership skills in particular are often reported to be underdeveloped at the time of completing the doctorate. In the current climate of life-long learning, this need for further skills development is not a major worry, but the issue does need to be addressed further. Solutions are most likely to be found in collaboration between universities, their doctoral schools and industry, preparing researchers for a wide range of careers before and after this moment of transition. Not only doctorate holders themselves report that they provide additional benefits to the organisation in which they work, also employers having doctorate holders amongst their staff, are generally positive about their added value (Vitae, 2009, De Grande et al, 2010). A focus on skills development is expected to be the key to an adequate employment match between doctorate holders and organisations.

Finally, we need to accept these positive findings with some reservation as the overall results differentiate substantially across scientific fields. The chances to capitalise on their research skills in the non-academic labour market is significantly larger for doctorate holders in engineering as opposed to doctorate holders in the humanities. The former perceive fewer problems in the transition from academia to other sectors, earn higher salaries and more often continue to perform research jobs when establishing a career outside university than the latter. The other scientific fields are positioned somewhere between these poles with regard to these indicators, with doctorate holders in medicine and the natural sciences enjoying many benefits from the doctoral experience, and agricultural and social sciences to a lesser extent, but still more so than doctorate holders in the humanities.

While some will question the value of increasing research investments in those scientific fields that are in lesser demand outside academia, one could also pose the question whether it is the non-academic labour market itself that has yet to discover the innovative potential of highly-trained professionals in these fields.

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Appendix

ANNEX 1: FIELS OF SCIENCE

1. NATURAL SCIENCES
101. Mathematics
102. Computer and information sciences (excluding electrical engineering and computer engineering: see 204. and 205. and bio-informatics: see 310.)
103. Physical sciences
104. Chemical sciences
105. Geology / Earth sciences
106. Geography
107. Biological sciences (excluding biomedical and agricultural sciences: see 304. and 4.)
108. Biochemistry en biotechnology
109. Statistics
110. Other natural sciences (not otherwise classified)

2. ENGINEERING AND TECHNOLOGY
201. Architectural engineering
202. Civil engineering
203. Geophysical and mining engineering
204. Electrical engineering (electronics, information and communication technology)
205. Computer engineering
206. Mechanical engineering (mechanics, electromechanics, automation and control engineering, energy technology)
207. Chemical engineering
208. Materials engineering
209. Biomedical engineering
210. Mathematical engineering
211. Physical engineering
212. Engineering: photonics
213. Engineering: nuclear technology
214. Nanosciences
215. Other engineering sciences (not otherwise classified)

3. MEDICAL AND HEALTH SCIENCES
301. Basic medicine
302. Specialist medicine
303. Health sciences (e.g. public health management and policy)
304. Biomedical sciences
305. Dentistry
306. Pharmacology
307. Logopaedics en audiology
308. Physical education en kinesiology
309. Rehabilitation sciences en kinesotherapy
310. Bio-informatics
311. Nursing and midwifery
312. Other medical and health sciences (not otherwise classified)

4. AGRICULTURAL SCIENCES
401. Agricultural engineering
402. Land, environment, forest and water resources management
403. Chemistry and bioprocessing technology
404. Food science
405. Biosystems technology
406. Cell en gene biotechnology
407. Environmental sciences
408. Veterinary medicine
409. Other agricultural sciences (not otherwise classified)

5. SOCIAL SCIENCES
501. Psychology
502. Economics en business
503. Actuarial sciences
504. Education
505. Sociology
506. Social en cultural anthropology
507. Law
508. Criminology
509. Political sciences
510. Media and communication
511. Tourism
512. Other social sciences (not otherwise classified)

6. HUMANITIES
601. Archaeology
602. History
603. Languages and literature
604. Philosophy and ethics
605. Religious studies
606. Arts (history of arts, performing arts, musicology)
607. Other humanities (not otherwise classified)

ANNEX 2: OCCUPATIONS (ISCO-08)

1. MANAGERS
10. Managers
100. Managers

2. PROFESSIONALS
21. Science and engineering professionals
211. Physical professionals
212. Earth science professionals
213. Chemical professionals
214. Mathematicians, actuaries and statisticians
215. Life science professionals: biological engineering, biochemistry, pharmacology, ...
216. Engineering professionals
217. Architects and planners
218. Other science and engineering professionals

22. Health professionals
221. Medical doctors
222. Nursing and midwifery professionals
223. Dentists
224. Veterinarians
225. Pharmacists
226. Kinesotherapists
227. Speech therapists
228. Other health professionals

23. Teaching professionals
231. University and higher education teachers
232. Vocational education teachers
233. Secondary education teachers
234. Other teaching professionals

24. Business and administration professionals
241. Business and finance professionals
242. Administration professionals
243. Sales, marketing and public relations professionals
244. Other business and administration professionals

25. Information and communication technology professionals
251. Software and applications developers and analysts
252. Database and network professionals
253. Other information and communication technology professionals

26. Legal, social and cultural professionals
261. Legal professionals
262. Librarians, archivists and curators
263. Sociologists, philosophers and political scientists
264. Authors, journalists and linguists (translators, interpreters, ...)
265. Creative and performing artists
266. Psychologists and educational specialists
267. Other legal, social and cultural professionals

3. PROFESSIONS FOR WHICH A HIGHER EDUCATION DEGREE IS NOT REQUIRED
30. Professions for which a higher education degree is not required
300. Professions for which a higher education degree is not required

Doctorates by discipline

French Community	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Humanities	63	56	48	45	50	53	52	59	46	53	65	55	72	51	58	63	57	63	*56*	1065
Social Sciences	70	49	61	62	70	62	75	74	60	70	101	89	88	117	101	110	129	119	*136*	1643
Engineering and Technology	46	68	45	58	74	68	78	68	64	53	67	64	67	82	71	91	93	98	*107*	1362
Medical and Health Sciences	64	53	73	70	88	49	49	60	66	50	67	92	84	69	93	106	95	122	*122*	1472
Natural Sciences	150	160	158	169	205	209	200	188	176	184	208	227	183	166	201	188	154	195	*191*	3512
Agricultural Sciences	42	32	34	53	54	35	47	39	70	54	60	56	57	48	53	64	60	79	*62*	999
Unknown	14	24	19	14	13	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*	84
Total	**449**	**442**	**438**	**471**	**554**	**476**	**501**	**488**	**482**	**464**	**568**	**583**	**551**	**533**	**577**	**622**	**588**	**676**	**674**	**10137**
Flemish Community	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Humanities	31	35	51	58	53	56	71	72	63	74	74	109	99	111	126	123	123	147	132	*1608*
Social Sciences	30	46	49	53	48	65	41	52	61	70	88	113	118	109	128	169	160	168	202	*1770*
Engineering and Technology	40	59	87	96	86	99	78	106	110	94	101	114	125	147	177	201	208	214	244	*2386*
Medical and Health Sciences	32	36	56	62	99	100	100	163	108	126	138	143	182	202	201	222	250	270	295	*2785*
Natural Sciences	173	184	206	233	199	212	211	195	179	193	229	228	226	240	255	211	245	247	239	*4105*
Agricultural Sciences	31	49	41	59	54	69	74	82	68	108	87	103	118	118	116	144	119	168	142	*1750*
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**337**	**409**	**490**	**561**	**539**	**601**	**575**	**670**	**589**	**665**	**717**	**810**	**868**	**927**	**1003**	**1070**	**1105**	**1214**	**1254**	**14404**

Total Belgium	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Humanities	94	91	99	103	103	109	123	131	109	127	139	164	171	162	184	186	180	210	188	2673
Social Sciences	100	95	110	115	118	127	116	126	121	140	189	202	206	226	229	279	289	287	338	3413
Engineering and Technology	86	127	132	154	160	167	156	174	174	147	168	178	192	229	248	292	301	312	351	3748
Medical and Health Sciences	96	89	129	132	187	149	149	223	174	176	205	235	266	271	294	328	345	392	417	4257
Natural Sciences	323	344	364	402	404	421	411	383	355	377	437	455	409	406	456	399	399	442	430	7617
Agricultural Sciences	73	81	75	112	108	104	121	121	138	162	147	159	175	166	169	208	179	247	204	2749
Unknown	14	24	19	14	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84
Total	**786**	**851**	**928**	**1032**	**1093**	**1077**	**1076**	**1158**	**1071**	**1129**	**1285**	**1393**	**1419**	**1460**	**1580**	**1692**	**1693**	**1890**	**1928**	**24541**

French Community: data 2008-2009 (red in table) not included in CDH survey sample.

Doctorates by gender																				
French Community	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Male	348	315	320	349	397	316	344	328	354	305	391	379	339	351	359	400	361	397	404	6757
Female	101	127	118	122	157	160	157	160	128	159	177	204	212	182	218	222	227	279	270	3380
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	449	442	438	471	554	476	501	488	482	464	568	583	551	533	577	622	588	676	674	10137
% women French Community	**22,5%**	**28,7%**	**26,9%**	**25,9%**	**28,3%**	**33,6%**	**31,3%**	**32,8%**	**26,6%**	**34,3%**	**31,2%**	**35,0%**	**38,5%**	**34,1%**	**37,8%**	**35,7%**	**38,6%**	**41,3%**	**40,1%**	**33,3%**
Flemish Community	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Male	249	319	360	397	370	411	391	452	399	437	484	514	572	613	635	645	658	700	733	9339
Female	87	90	130	164	165	190	184	218	190	228	233	296	296	314	368	424	447	513	521	5058
Unknown	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	0	1	0	7
Total	337	409	490	561	539	601	575	670	589	665	717	810	868	927	1003	1070	1105	1214	1254	14404
% women Flemish Community	**25,9%**	**22,0%**	**26,5%**	**29,2%**	**30,8%**	**31,6%**	**32,0%**	**32,5%**	**32,3%**	**34,3%**	**32,5%**	**36,5%**	**34,1%**	**33,9%**	**36,7%**	**39,7%**	**40,5%**	**42,3%**	**41,5%**	**35,1%**
Total Belgium	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Male	597	634	680	746	767	727	735	780	753	742	875	893	911	964	994	1045	1019	1097	1137	16096
Female	188	217	248	286	322	350	341	378	318	387	410	500	508	496	586	646	674	792	791	8438
Unknown	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	0	1	0	7
Total	786	851	928	1032	1093	1077	1076	1158	1071	1129	1285	1393	1419	1460	1580	1692	1693	1890	1928	24541
% women Belgium (total)	**23,9%**	**25,5%**	**26,7%**	**27,7%**	**29,6%**	**32,5%**	**31,7%**	**32,6%**	**29,7%**	**34,3%**	**31,9%**	**35,9%**	**35,8%**	**34,0%**	**37,1%**	**38,2%**	**39,8%**	**41,9%**	**41,0%**	**34,4%**

French Community: data 2008-2009 (red in table) not included in CDH survey sample.

Doctorates by nationality (Belgian / non-Belgian)																				
French Community	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Belgian	317	285	276	308	349	282	322	314	293	322	371	389	377	380	399	431	361	458	418	6652
Non-Belgian	132	157	162	163	205	194	179	174	189	142	197	194	174	153	178	191	227	218	256	3485
Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	449	442	438	471	554	476	501	488	482	464	568	583	551	533	577	622	588	676	674	10137
% non-Belgian (French Community)	**29,4%**	**35,5%**	**37,0%**	**34,6%**	**37,0%**	**40,8%**	**35,7%**	**35,7%**	**39,2%**	**30,6%**	**34,7%**	**33,3%**	**31,6%**	**28,7%**	**30,8%**	**30,7%**	**38,6%**	**32,2%**	**38,0%**	**34,4%**
Flemish Community	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Belgian	259	310	372	386	385	430	415	495	457	512	538	644	663	730	796	842	858	935	938	10965
Non-Belgian	63	85	100	155	133	161	155	173	130	150	179	164	205	197	207	228	247	279	316	3327
Unknown	15	14	18	20	21	10	5	2	2	3	0	2	0	0	0	0	0	0	0	112
Total	337	409	490	561	539	601	575	670	589	665	717	810	868	927	1003	1070	1105	1214	1254	14404
% non-Belgian (Flemish Community)	**19,6%**	**21,5%**	**21,2%**	**28,7%**	**25,7%**	**27,2%**	**27,2%**	**25,9%**	**22,1%**	**22,7%**	**25,0%**	**20,3%**	**23,6%**	**21,3%**	**20,6%**	**21,3%**	**22,4%**	**23,0%**	**25,2%**	**23,3%**
Total Belgium	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Belgian	576	595	648	694	734	712	737	809	750	834	909	1033	1040	1110	1195	1273	1219	1393	1356	17617
Non-Belgian	195	242	262	318	338	355	334	347	319	292	376	358	379	350	385	419	474	497	572	6812
Unknown	15	14	18	20	21	10	5	2	2	3	0	2	0	0	0	0	0	0	0	112
Total	786	851	928	1032	1093	1077	1076	1158	1071	1129	1285	1393	1419	1460	1580	1692	1693	1890	1928	24541
% non-Belgian (total)	**25,3%**	**28,9%**	**28,8%**	**31,4%**	**31,5%**	**33,3%**	**31,2%**	**30,0%**	**29,8%**	**25,9%**	**29,3%**	**25,7%**	**26,7%**	**24,0%**	**24,4%**	**24,8%**	**28,0%**	**26,3%**	**29,7%**	**27,9%**

French Community: data 2008-2009 (red in table) not included in CDH survey sample.

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