WORKING PAPER

Transitions from academia to industry

How do doctorate holders fit in?

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Abstract

In policy debates, an often mentioned reason to explain the limited mobility from academia to industry is the supposed mismatch of skills needed in these different settings. In this article we contribute to this skills debate by (1) examining the career intentions of Flemish doctorate holders towards industry and other sectors; and (2) by establishing the extent to which doctoral candidates and employers in industry in Flanders differ in their views on the skills needed to perform well in this sector. To answer these questions, we draw on several data sources. The Survey of Junior Researchers (SJR) provides information on the doctoral candidates' perspective on these matters, whereas the Research & Development Survey of Flemish companies reflects the employers' views. Additional data obtained through qualitative research - using interviews with both doctorate holders and employers - provides a more in depth understanding of the transition from academia to industry. A mismatch between what doctoral candidates consider important skills for a job in industry, and what employers expect from researchers is observed. The importance of technical skills and more transferable competencies such as project management and business skills are underestimated by doctoral candidates. This raises questions on the awareness among doctoral candidates of the skills needed for a career outside academia, and on whether providing them with adjusted training and career planning could better prepare them for work in non-academic settings.

Key words Postgraduate training - Career perspectives - Skills mismatch - Intersectoral mobility - Employability

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Introduction: on the transition from academia to industry

The mobility of doctorate holders towards the non-academic labor market became an issue of growing interest for policy-makers in and outside academia over the last decade. A crucial element can be found in the regional, national and European policy agendas (crystallized among others in the Bologna Process, the Lisbon Strategy and the EU 2020 Strategy) where a greater supply of highly educated researchers is considered crucial for creating a competitive knowledge economy. As a result of policy efforts made in this perspective, the league of postgraduates which can not be adequately absorbed by the academic system, will only grow [see a.o. 1].

This article relates to the situation in Flanders, where the annual number of produced doctorates has more than doubled over the last fifteen years [2]. As in other Western European regions and countries, this evolution was not matched by an equal increase in academic career opportunities at postdoctoral and faculty levels. This means that more doctorate holders have to redirect their careers to non-academic sectors [2,3], especially industry.

One triggering element for studying the transition from academia to industry, is that despite the considerable demand for a highly skilled workforce in industry [4,5], this process proves not as straightforward as could be expected. First, during the recruitment and selection process for (senior) research jobs in industry, doctorate holders are competing with experienced master-level graduates, who may have less specialist expertise than doctorate holders, but often have more relevant work experience in industry. To some employers both kinds of work experience cannot be equally valued; some - especially smaller companies – also consider experience outside academia as more relevant to them [6,7]. This brings on a second problem: many employers (still) have a quite stereotypical view of doctorate holders, related to the myth of the doctoral candidate in his/her ivory tower, isolated from other fields and people. They therefore tend to doubt whether doctorate holders have the competences to perform well in a business environment [8,9]. Third, many doctoral candidates hope to develop an academic career and consider other employment sectors merely as second choices[1] [11]. This focus on an academic career may also prevent doctoral researchers from investing in acquiring the specific skills needed in industry, resulting in a skills mismatch.

This perceived skills mismatch is the focus of this article. In order to better understand this mismatch, we study (1) the career intentions of doctoral candidates towards employment in industry and other sectors (2) the perception of the skills and knowledge needed for research careers in industry, through the eyes of both doctoral candidates interested in such careers and those of industrial employers and HR managers in Flanders. From the existing literature several hypotheses are derived which reflect common assumptions on this issue in current policy debates (Section 2). This is followed by the description of the data and methods of analysis that are used (Section 3) and the results of the empirical study (Section 4). The last section (5) provides a reflection on possible policy implications of our findings and prospects for further research.

The skills mismatch: theory and hypotheses

Within the academic system, the main goal doctoral degrees remains contributing to original research and therefore, doctoral students are still largely trained for academic careers. However, there has been a noticeable change in the way doctoral research is performed in Flanders over the last ten years [12] as doctoral candidates are (more than in the past) expected to publish (several) articles, go to conferences, and teach. By the time they submit, they - ideally - possess a mixture of skills and knowledge that they can use in different and changing contexts. According to Enders [13] however, the idea that a good preparation for an academic career is a good preparation for any career – the ‘one size fits all’-idea - does not hold.

The limited international research into the employability of doctorate holders[2] so far has shown

[1] Higher education in fact remains the main sector of employment for doctorate holders, followed in most European countries by government, and in the case of Belgium by the business sector employing about 20% of all doctorate holders [10].

[2] Literature on the employability of higher educated employees in non-academic environments, mostly

that - according to employers – they are often lacking specific skills needed for an industrial working environment: not as much the specialist skills (problem solving skills, technical knowledge) they hold, which employers are quite positive about, but rather the more transferable or non-academic skills such as commercial thinking, the flexibility to adapt to other working environments or the ability to translate research results to a larger public [4,6,17-19].

The employers' perceptions on the skills of doctorate holders however appear to differ: the more experience employers have with doctorate holders, the higher they value their skills (VITAE, 2009). Morgavi et al. [9] found, in their overview of the existing studies (from 1998 to 2006) on employers' views of doctorate holders, that there is a difference in views between employers having doctorate holders as members of their research staff, those explicitly recruiting them and those who have not considered postgraduates as staff members: employers who intentionally recruit PhD graduates do this for their specialist skills and knowledge, whereas employers who have postgraduate staff 'by chance' or those companies with many graduate and postgraduate level staff in general, are often not able to recognize the additional or specific skills of PhD graduates, and therefore do not recruit them.

And what do doctoral candidates themselves think about skills and skills training? Evidence from qualitative studies shows that doctoral candidates often do not believe that their careers will be influenced by having the appropriate skills [20]. There however is also a substantial lack of awareness of the skills mismatch problem on behalf of the doctoral candidates. Too often they are only focused on finishing their doctoral research and fail to plan for their future careers. This not only makes them blind for what is expected of them outside academia, but also for the skills they may have acquired during their doctoral study. Orpen [21] found, that together with organisational management (in our case: doctoral training), individual career management is positively associated with further career success. In other words, individuals not only make better career choices through thinking about what they personally want, but their career choices may also be influenced by doctoral programs. In Flanders (Ghent University), a survey on the added value of skills training in doctoral schools, showed that three quarter of the doctoral candidates were positive about transferable skills training and acquiring experiences for a non-academic career [22]. Nevertheless, research shows that imposing this kind of training would not help for those doctoral students who are not convinced or aware of the need to acquire these skills (which is sometimes taken for granted) [8]. Training can only become effective if potential positive outcomes are acknowledged by the trainees, e.g. that they link career opportunities to learned skills.

According to the review of Roberts [18] success of R&D is to a large extent dependent on the availability and talent of scientists and engineers. In his review he focuses on natural scientists (in biology, physics and mathematics) and on (computer or technical) engineers. He also stresses that interdisciplinarity with medical and information scientists can boost innovative ideas, but does not include these fields of science in this review. Computer and technical engineers appear to end in R&D manufacturing more often than other doctorate holders, which is also confirmed in the career profiles presented by VITAE [23]. When it comes to the skills mismatch of doctorate holders, most studies do not differentiate between field of science, but it is apparent that doctorate holders from different disciplines are not evenly spread across the different employment sectors.

Which skills sets will we focus on in this article? Rather than engaging in a discussion on the conceptual (un)clarity of generic/transferable skills in other studies [e.g. 14,24], we opt for a practical approach to the skills required in a non-academic environment. The UK Research Councils published a joint statement on the skills doctoral researchers need to develop during their research training [25]. These skills are grouped into seven themes: (1) research skills and techniques, (2) research environment, (3) research management, (4) personal effectiveness, (5) communication skills, (6) networking and team working and (7) career management. Each of these themes are composed of a detailed list of the competencies/skills that doctorate holders should have. . Rudd, Nerad, Morrison & Picciano (2008) also differentiate between PhD-completion skills, which are skills and habits needed to complete a PhD, and professional skills, including training which prepares students for non-academic environments. The framework of these two studies was also used in establishing our skills-related survey questions.

In this article, we will test the following hypotheses. *In terms of career orientation*, we expect that - in accordance with earlier international research [11,26,27] - Flemish doctoral candidates hope to develop academic careers rather than careers in other sectors (Hypothesis 1.1). We however expect to find differences in the aspirations to work in specific non-academic labor markets according to field of study. More specifically, we expect a stronger orientation towards industry from doctoral candidates in engineering as they can more easily find their doctoral degree valued in industry [18] (1.2).

*In terms of the employers assessment of needed skills***,** we expect to find some - but limited - variation in the perceptions of employers who employ doctorate holders and those who do not, as

handles employers' demands of master students [e.g. 14,15,16].

our data do not allow to discriminate between those employer having explicitly recruited doctorate holders and those who have them as 'accidental employees'; we however do expect there to be differences by company size where we expect smaller companies to be in need of more 'generic' skills and larger companies relying to a larger extent on the in depth or specialist skills (Hypothesis 2).

In terms of the awareness of the skills needed in industry, we expect that doctoral candidates are not adequately aware of the skills needed in industry, as we assume there are differences in the perception of the skills needed to perform in industry between employers in industry and industry-oriented doctoral candidates (Hypothesis 3.1). As doctoral candidates may not be fully concerned with or focused on skills needed outside the academic walls (as they may want to keep their options open for staying at the university or are solely focused on obtaining their doctoral degree), this may impact their idea of the skills they will need in future employment. Variation in skills awareness however can be expected according to field of study and career orientation (3.2) where candidates with PhD's giving more clear-cut career prospects in industry having a better view on what is needed.

Data and methods

For this study we make use of the *Survey of Junior Researchers* (SJR) which was conducted in 2008 at the universities of Ghent, Brussels and Hasselt (ECOOM-UGent, 2008) [3]. In these universities, 4878 junior researchers, who were defined as 'non-doctorate holding research staff' were asked to participate in a web-survey. The overall response rate was 40.1% (N=1994). The data captures the views of doctoral candidates on various topics regarding their current and future (research) careers: their doctoral research, the support of their supervisor(s), the amount of intersectoral collaboration, work satisfaction, international mobility and career plans. Key questions for this article are those on the sector they prefer to work in after obtaining their doctorate: they were asked to rank the various sectors - the service sector (banks, insurance, recreation…), industry (IT, textile, chemical and pharmaceutical, etc), primary sector (agriculture, fishing, forestry, etc), government (local, regional, intergovernmental), non-profit sector (health care, social services, etc), academia and other non-academic educational institutions - from most to least preferred sector for future employment. The analyses in this article will focus on the respondents who ranked the industrial sector in their top three. We also used other variables to differentiate between the doctoral candidates. For *field of science*, we distinguish five clusters: humanities (arts, humanities, criminology & law), social sciences (social and political sciences, psychology, educational sciences, economics and business administration), natural sciences (biology, mathematics, physics, chemistry, informatics), engineering (technological & bio-engineers) and medical sciences (life sciences and medicine). Doctoral candidates also differ across the *phase of doctorate*: the first phase or planning phase, in which they define their research theme and questions; the second phase or executing phase, in which the (qualitative or quantitative) data are collected; the third or finishing phase in which the data are analyzed, also called the writing up phase; and finally the reporting phase, in which the introduction and conclusion is written and the doctoral defense takes place. We also differentiate between respondents who clearly want to stay in a research function, those who do not, those who don't know yet or have no preference (*preferred function after obtaining PhD*). Table 1 compares the characteristics of the industry-oriented respondents (N=429) with those characteristics of non-industry-oriented respondents (N=1167): there are significant differences in terms of sex, age, nationality and field of study. Percentagewise, there are more men, more engineers, and more researchers under thirty and more non-Belgian researchers than in the non-industry-oriented group. Most respondents are in the executing phase of their doctoral research and more than half want to specifically hold on to a research position further on in their careers.

In the questionnaire section on career plans, the respondents were asked to pick the 7 items out of a list of 27 skills/competencies which they considered important for their further careers. We have grouped these into five sets of skills, which are similar to the skills list composed by the UK Grad Programme [25] and Rudd et al. [28]: research skills and techniques (5 items), communication skills (5), general management skills (6), working with others (3) and personal effectiveness (8), see appendix.

An identical list of 27 skills/competencies was presented to the employers who completed the *Research & Development Survey*, carried out by ECOOM-KULeuven [29] in the spring of 2008. The 2597 Flemish companies, involved in R&D, were asked about their personnel, company structure, R&D activities and initiatives, innovation and collaboration with others. Almost half (1164 or 45%) of these companies participated in this survey. 479 employers answered the question on the skills they look for in a researcher. They, too, had to indicate the 7 most important ones. These employers belong to different business sectors: the primary sector (5.7%), industry (60.2%) and service sector (34.1%). About one third of the companies employ doctorate holders (36.3%). We compared the views of employers in industry (N=297) who have

[3] The junior researchers of Antwerp could not be included in the analysis because the question on their perceptions of needed skills for future employment was not asked to this group.

doctorate holders in their research staff (N=78) and those who do not employ doctorate holders (N = 139), and also look at the size (SME's/multinationals) and the subsector (pharmaceutical/chemical/technological/textiles/IT) of the companies.

Qualitative data collected within Flemish industrial firms are used to elaborate on the situation of the doctorate holders and to further illustrate the views of employers on researchers. Interviews were conducted in nine industrial companies in Flanders, all within the technological or chemical/pharmaceutical sector, both small to medium sized enterprises (SMEs) and multinationals. In total, 26 interviews were carried out: seven with employers (E) and nineteen with employees/researchers (R) who were working in or are related to the R&D department of their companies. The employers were all men and five of them had a doctoral degree themselves. Twelve of the researchers were doctorate holders, among them two were women. Their ages ranged from 23 to 50 years old. The extracts in this article were translated from Dutch.

Results

'STAYING OR GOING': CAREER ORIENTATIONS OF DOCTORAL STUDENTS

In order to better understand their career perspectives after obtaining a doctoral degree, the doctoral candidates were asked to rank eight sectors of employment according to their preference. As the results show, university is by far the most preferred sector to work in after graduation. For about half of the respondents the university is their 'most wanted' future employer; about 80% put it in their top three, which supports our first hypothesis.

Even though the university is favored in all five 'field of study'-clusters, important differences are apparent, as is presented in Table 3. For example, 89.3% of doctoral candidates in the humanities prefer to stay at the university, compared to 'only' 74.3% of those in engineering. Other popular sectors are the government (57.0%) and the non-academic educational institutions (50.1%), and these score particularly well among the social sciences and the humanities. The non-profit sector comes in fourth, with high scores among social and medical scientists. Overall, industry is ranked as the fifth sector of preference, with (only) 26.8% of the respondents ranking it in their top three. Interest in careers in industry differs strongly according to field of study: for doctoral candidates from engineering, a little more than half (50.7%) are interested in a career in industry, whereas there is very little interest from human (3.3%) or social scientists (7.7%), which further confirms our first hypothesis (1.1-1.2).

If we only consider the most preferred sector of the doctoral candidates instead of their top three, the ranking of the different sectors changes and industry jumps to the third position (Table 4). 184 respondents (or 11.5%) prefer industry most, whereas 792 respondents (or 49.5%) mentioned the university as their first choice. However, only little more than half of the respondents (56.9%) who rank the university as their most desired future employer, estimate their chances to stay in academia to be high. This is in fact still far from the real chance for doctorate holders to pursue their careers at university. Those who prefer in industry, do not perceive many problems in achieving this goal: 90.2% state that the probability is rather high that they will manage to do so. Those who want to end up in the service sector or who want to start an independent profession, are also very positive about their chances of success. Apparently they do not expect too many problems with the transition from university to these non-academic sector.

We interviewed doctorate holders with employment in industry about their perceptions of this transition. We asked, among others, what the push and pull factors were to move out of academia and into industry. Most of the respondents had a clear view on working in industry or were already working in a more applied context during their doctorate. Although some of them had considered staying at the university, most decided relatively quickly to move to the private sector as the possibilities to stay at the university were limited or the labor conditions under which they had to stay were not ideal. These two quotes illustrate common reasons not to stay in academia:

> *"Working on annual contracts until I'm forty or forty-five…I wouldn't be able to explain that at home." (R) 4*

> *"I worked on my doctorate for six years and then there were relatively few options to get a fixed term contract at the university. So I decided rather quickly that I wanted to go to industry, where I could do something scientific, or possibly something technical." (R)*

Some would have wanted to work at the university, but mainly left because there were no positions available. Most of them experienced a smooth transition to industry, do not regret their decision and are quite happy about their current situation. Differences in organizational culture were reported, but as most of the respondents were ready for a more applied, commercial setting, it did not bother them.

[4] R= employee, researcher who is working in or are related to the R&D department of the company

"I like the mix between research and the concept of 'time is money'. Whereas, at the university, it was research only to publish as much as you can. Working in industry then, is more ideal, the ideal mix." (R)

A common 'belief' among these doctorate holders in industry was also that the longer doctorate holders stay at the university after graduation, the harder it would be to adapt to an industrial context. The opportunity for more result-driven work in economic terms is also one of the reasons to make the transition, although tight deadlines sometimes limit the opportunity to study issues in depth.

On the whole, these respondents did not mention any major barriers in making the transition. It was a new experience in many ways: more stress, less freedom, higher expectations on shorter terms, but none of this came unexpected. Even for those who had underestimated the extent of the changes, the transition itself was not perceived as difficult.

ON THE SKILLS DOCTORATE HOLDERS NEED IN INDUSTRY

As mentioned before, working in an industrial environment means adapting to short-term outputs, thinking commercially, doing applied rather than fundamental research. In the interviews, doctorate holders acknowledge that - although they think they had a lot to offer - they missed certain skills at the start of their non-academic career. According to these interviewees, the added value of their doctorate lies in their specialisation, in their independence and in their driven – or passionate – approach to knowledge and understanding:

"It is the possibility to cling to a certain problem, to dig in and to unravel it. To come across complex issues, to bring them together and see what you can get out of it…[Doing a doctorate] is problem-solving."(R)

Some of the interviewees also mention the transferable skills obtained throughout their doctoral research as an added value, e.g. presentation skills, networking, writing skills, whereas others stressed the lack of certain skills, e.g. working in teams, coaching abilities:

"Speaking in front of an audience (…), stand up for your own opinion in meetings…"(R)

"If you have ten people to supervise, technical capacities are not enough (…) you really have to know how to handle them, individually and together. (…) I wasn't trained for that."(R)

To get a more systematic view on what is expected of researchers in terms of skills, we also collected the views of HR-managers and employers from industry. In Table 5 we list 27 skills/competencies considered important for research careers in industry. The employers were split into two groups: employers who have doctorate holders among their research staff, and employers who do not.

Overall, employers seem to value researchers for their research skills and techniques: technical skills, analytical thinking, scientific knowledge and research skills as such. More than half of the employers indicated these skills as the most important ones on the list. The other skill sets are less homogenously valued. Within the 'personal effectiveness' set, taking initiative (56.7%) is by far considered the most important competence, and in terms of 'general management skills' project management (46.1%) and business skills (40.1%) are highly valued in a researcher. Being able to work in team (64.5%) is stated more often as an important skill than research skills (51.6%). In general, the 'communication' set covers only skills that are mentioned by less than one fifth of the employers. We could argue that these are additional skills which are appreciated but will not make the difference in the selection of candidates.

Employers in general search for the same sets of competences: technical skills, teamwork, analytical thinking, taking initiative and scientific knowledge, a mixture of research methods and interpersonal traits. Some skills however are valued somewhat differently when the two groups of employers are compared. The top five of the two groups differs by one skill: employers who already have doctorate holders amongst their workforce value research skills more than employers who do not (65.4% vs. 43.9%; χ^2=9.248, df=1, p<0,010). Also scientific knowledge and leadership are valued more by the employers of doctorate holders. The employers without doctorate holders tend to stress technical skills, independence and self-confidence more.

THE DOCTORAL CANDIDATES' VIEWS ON NECESSARY SKILLS

In this section, we look at the views of doctoral candidates regarding the necessary skills for their future employment. In Table 6 we list the same set of skills, and make a comparison between three fields of study where researchers have the highest probability of ending up in an R&D environment: science, engineering and medical science [30]. In each of the skills sets, there is a certain amount of heterogeneity, even within the set of research skills and techniques. Technical skills (23.9%) are considered less important than research skills (69.9%), scientific knowledge (67.4%) and

analytical thinking (48.5%). Within the set 'working with others', social skills and teamwork are considered important by four out of ten doctoral candidates. Within 'personal effectiveness', independence (45.9%) is rated highest and within 'communication skills' presenting to an audience (38.2%). Skills of 'general management' are only considered important by a minority of the respondents. There are a number of differences between the respondents in the three fields of study, particularly in the research skills set. The engineers indicated technical skills and analytical thinking more often and valued research skills and scientific knowledge less. Clearly, they expect a more technical setting when they think of their further careers than researchers from other disciplines. Medical researchers value stress management more and learning ability a lot less than others.

When we interviewed employers and asked which skills are decisive when selecting researchers, many of the same skills as indicated in the R&D survey were mentioned. Most important are research and technical skills, but this is sometimes not sufficient to get the job. Broader skills, like working with others, functioning in group or working independently are at least as important as specialist skills:

> *"If we meet someone who is brilliant in his own field, but cannot function in a group because he hasn't got those skills or competencies, then we won't invite him to the next selection round."(E)* [5]

This differs by the company's field of expertise, on whether they have an R&D department or not and on whether they are just spending half (or less) of their time on research and innovation (as is the case for many small- to medium-sized companies). For example, business skills are more often considered important by small companies (55.6%) than by large companies (26.9%) (χ^2=8.058, df=3, p<0.050, not in table). On the other hand, project management is more important to larger companies (59.7%) than to SME's (16.7% to 44.3%) (χ^2=11.540, df=3, p<0.010, not in table). Our second hypothesis is not fully confirmed as there are not that many differences between SMEs and multinationals as could be expected, and even less differences than between employers who are working with/without doctorate holders.

Some of the employers who were interviewed do not expect researchers who start in their companies to already have all the necessary skills, but they must be able to improve. This reminds us of 'learning ability', which was considered important by 26.3% of the employers. Some skills can only be learned on the job. One employer stated that acquiring new skills is an issue for later, when one is familiar with the organization and its staff. They do not specifically look for doctorate holders to fill these research functions. Most employers, even those who have doctorate holders amongst their research staff, believe that these skills are not specific to a certain degree, as they are considered personality traits of the person in question. Doctorate holders also have to compete in this respect with master-level graduates (with work experience).

> *"But I don't even know if the skills that are important for those functions are directly linked to obtaining a doctorate. Besides being competent engineers, they are mature men, or not just men, I mean, men and women. (...) You don't recognize a doctor in those people. If you don't know, you will not discover it." (E)*

In this respect, collaborating with industry during the doctoral research can improve transferable skills and provide doctoral candidates with additional experience when competing with experienced master graduates. In the SJR, 8.7% of the respondents collaborate with industry, mostly for contract research or knowledge exchange. Overall, they perceived this collaboration as quite positive, 83.4% stated that it enhanced their skills and 80.7% thought this contact might open up their career opportunities outside academia. Doctorate holders who were interviewed were also positive about collaborations, as long as it constitutes an added value to the doctoral project.

> *"The link with practice is quite important. Although it's only about a few issues, [it's about how] you can transfer the theoretical base into applications."(R)*

IS THERE A MISMATCH IN PERCEPTION ON NEEDED SKILLS BETWEEN (DOCTORAL) CANDIDATES AND INDUSTRIAL EMPLOYERS?

To what extent do the perceptions of important skills by doctoral candidates with an interest in a career in industry match those of their potential employers? To answer this question, we filtered out the respondents (1) who have - besides the aim of an industrial career - a strong preference to stay in academia; (2) who came from social and human sciences as it is rather exceptional that HR managers in industry recruit these kinds of researchers for their R&D department, except when it involves behavioral changes of consumers or societal concern (Borrell-Damian, 2009); and (3) who no longer want a research position. The resulting sample holds 160 respondents, of which for the majority (70.0%) industry was their top choice of employment sector. As the views of engineers differed most from the

[5] E= Employer or HR-manager of one of the cooperating companies

views held by other doctoral candidates, we include them in the comparison next to the non-engineering group and the total group of industry-oriented researchers. Table 7 shows the percentages (for each item) of the respondents who find the various skills important, and according to these percentages they are ranked from most important (1) to least important (27). There is considerable more variation in the response patterns among doctoral candidates than among employers. When comparing the responses of the total group of doctoral candidates with those of the total group of employers, one can observe that their top five has three items in common: scientific knowledge, analytical thinking and teamwork. Technical skills are not included in the top ten of doctoral candidates; only one quarter mentions it as important for their further career. In an interview, one of the employers underlined the importance of technologically-skilled researchers for an R&D department. Obviously, doctorate holders do have such specialist skills, but perhaps they are unaware of the advantage of their technical experience with lab tests, protocols or data analysis. There are other large gaps as well: project management is ranked twelfth by doctoral candidates and seventh by employers, business skills are rated 'important' by only one tenth of the doctoral candidates, whereas about 40% of the employers find them important. Some skills are also overrated by doctoral candidates when compared to employers: this is the case for social skills, although this is in the top ten of all the groups, and also for language knowledge and presentation skills. This does not mean that employers do not appreciate these skills, but when they look for a good researcher, these skills are not decisive. The perception of engineers does not always follow the overall view of doctoral candidates who want to work in industry, and comes closer to the perception of employers with doctorate holders in their research team. This gives us credit for our hypothesis 3.2. The difference in the views on technical skills becomes smaller when we look at the rankings: employers with doctorate holders position this skill fourth, whereas it is seventh for engineers. The gap however remains in percentage: more than one third of the engineers state this skill as important against almost two thirds of the employers. Engineers underestimate the importance of project management, business skills, flexibility and dealing with diversity, while overemphasizing social skills, self-confidence and negotiation skills. Although the perception of engineers comes slightly closer to HR managers'ideal picture of a researcher according to in industry, their overall expectations still show substantial discrepancies, which confirms our third hypothesis.

Discussion & Conclusions

In this article we shed light on the mismatch between the skills that doctorate holders perceive as necessary for future employment in industry and the expectations from industry, by bringing together and contrasting the views of doctoral candidates, as well as those of doctorate holders and employers in industry. The results show that Flemish doctoral candidates still prefer careers in academia after obtaining their doctorate. Even when the differences among fields of study are taken into account, the popularity of the university as potential future employer far exceeds that of government or industry. However, almost half of the respondents who prefer academia think there is only a low probability of actually finding a job there, whereas respondents who prefer industry do not anticipate major problems. Evidence from other research also suggests that more doctorate holders actually end up in the private sector than those who had planned to do so [31]. Doctorate holders who work in industry are also rather positive about the transition from academia to industry. So, should we conclude that there isn't really much of a transition challenge after all?

Our research results indicate that what doctoral candidates expect of industry, in terms of employability skills differs significantly from what industry expects. This mismatch can constitute a problem. Employers expect researchers to have a mix of technical skills and a broader set of transferable competencies like being able to work with others, and having notions of general management, such as project management and business skills. Technical skills and managerial skills are also highlighted by the EUA [6] as skills needed in industry. Although industry-oriented engineers stress these skills more than other industry-oriented doctoral candidates, there remains a large gap between what most of them perceive as important skills and what employers stress as important.

At least three types of stakeholders can be involved when addressing this skill mismatch: universities, as they have to provide adjusted training; doctoral candidates, as they need to become aware of which skills are required; and industries that absorbs a large number of doctorate holders. Universities have started taking on responsibility in this debate, by broadening the scope of doctoral training to the development of transferable skills, in addition to scientific knowledge and skills, [4,18,32]. Some universities even go further and adopt a more 'entrepreneurial academic model' [3,20,33], in which the application of knowledge is considered more important and crosses disciplinary and organizational borders. Strategic research can possibly bridge the gap between fundamental and applied research fields [3], with the result that the

training provided for doctoral candidates also incorporates a mix of specialist and transferable skills. There is, however, much debate on whether this trend should be followed or not, since some academics have the feeling that their freedom is at stake [34] and that the growing attention for applied research could leave less room for fundamental research. One of the other stakeholders, the industrial sector as a whole, for now does not seem to have a joint set of general skills they search for in a researcher. It depends, to some extent on the size of the company and on whether there are already doctorate holders in the research staff, which are two factors that often intertwine. In the UK there are sector skills councils (SSC) who represent employers' views on skills issues. Employers' federations in Flanders could also consider starting up similar programs specific to the skills set problem, in order to set up competency profiles per subsector for doctorate holders.

The format and content of the preparation of doctoral candidates for future careers (a.o. in doctoral training) is an important issue in higher education which affects all mentioned stakeholders. First, even though career planning isn't seen as priority by doctoral candidates, nor by employers in our survey, it is actually important for doctoral candidates to know the options are after obtaining their degree, as universities will only be able to absorb a small part of them. Career services where they can discuss future perspectives can be a valuable option [4], preferably in cooperation with doctoral programs or with recruitment agencies. Career fairs are another option where there can be a direct link to possible future employers and where doctoral candidates can become better aware of what is expected in other sectors. Last but not least, skills like teamwork and project management are also getting more important in an academic environment, with more doctorates that are obtained in projects (rather than the traditional individual path) or through partnerships with other institutions or companies. In this way, a wider set of skills can benefit not only those who move to other sectors (e.g. industry), but also those who stay in a postdoc position or become faculty: they have to supervise more (PhD)students than before and could also make use of managerial skills [35]. Moving towards different types of doctorates, as is done in the UK [36], can also be an option, where the specific learning outcomes for the professional doctorate can be adjusted to skills sets that are needed on the labour market. As such, doctoral candidates are also stimulated to think about their future ambitions at the start and during the doctoral research process. The interviews with employers however informed us that not the amount of skills training, but the type of training is important. Some skills cannot be learned by following courses, but need to be learned on the job, and/ or through collaboration with other companies.

Further research integrating the views of all stakeholders (employers, doctorate holders, doctoral researchers and universities) will help to make relevant recommendations on doctoral training programmes to better anticipate on what doctoral candidates might possess and need on the labor market, on how the skill acquisition can be improved, and how the university can facilitate the transition to non-academic sectors of employment. University research is not designed to deliver research staff tailor-made to the demands of the labor market. However, bridging the gap between employers' expectations on the one hand and researchers' potential on the other, will result in a win-win situation for all.

Appendix

As mentioned in the 'data and method' section, we used five sets of skills, which are similar to the skills list composed by the UK Grad Programme [25] and Rudd et al. [28], completed with some skills of our own.

	UK Grad programme	Rudd et al.	own
Research skills and techniques			
Research skills	x	x	
Scientific knowledge	x		
Analytical thinking	x		
Technical skills	x		
Teaching skills	x		
Working with others			
Teamwork		x	
Social skills	x		
Dealing with diversity		x	
General management			
Leadership		x	
Project management	x		
Business skills			x
Career planning	x		
Knowledge about IP	x		
Financial management		x	
Communication skills			
Presentation skills	x	x	
Language knowlegde			x
Networking	x		
Negotiation skills & persuasion	x		

Writing skills	x	x	
Personal effectiveness			
Independence	x		
Taking initiative	x		
Learning ability	x		
Stress management			x
Self-confidence	x		
Flexibility	x		
Time management			x
Dealing with failures			x

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Tables

Table 1: Characteristics of all doctoral candidates versus those who want to work in industry (SJR)

		Not industry oriented		*Industry oriented*		
		%	N	%	N	χ^2
Sex	Female	53.1	609	39.2	162	
	Male	46.9	537	60.8	251	
	Total		1146		413	23.520***
Age	22-25	30.4	348	32.0	132	
	26-30	46.7	535	52.5	217	
	31-40	17.6	202	13.3	55	
	41-61	5.2	60	2.2	9	
	Total		1145		413	12.233**
Nationality	Belgian	81.5	951	70.2	302	
	Non-Belgian	18.5	216	29.8	128	
	Total		1167		430	22.626***
Field of science	Human	18.2	207	1.7	7	
	Social	22.2	253	5.1	21	
	Natural	19.9	227	28.9	119	
	Engineering	16.3	186	46.4	191	
	Medical	23.3	265	18.0	74	
	Total		1138		412	236.601***
Phase of doctorate	Planning	21.1	208	16.7	66	
	Executing	56.1	553	58.7	232	
	Finishing	15.1	149	16.2	64	
	Reporting	7.6	75	8.4	33	
	Total		985		395	3.501
Preferred function after obtaining PhD						
	Research function	55.8	651	58.0	249	
	Non-research function	13.4	156	15.2	65	
	No preference	9.7	113	9.1	39	
	Doesn't know yet	21.2	147	17.7	76	
	Total		1167		429	2.965

Source: ECOOM-UGent [37]; **: p<0.010; ***: p<0.001

Table 2: Characteristics of the company/organization of the employers (R&D Survey) who completed the skills questionnaire

		%	N
Sector	Service sector	34.1	168
	Industry: IT	27.2	134
	Industry: food, textiles, wood	16.6	82
	Industry: chemical & pharmaceutical	16.4	81
	Primary sector & Construction	5.7	28
	Total		493
Research staff	With doctorate holders	36.5	162
	Without docorate holders	63.5	282
	Total		444
# employees	Less than 10	18.7	92
	Between 10 and 49	33.5	165
	Between 50 and 249	28.2	139
	250 or more	19.7	97
	Total		493
Turnover	Less than 2 million	21.7	104
	2 to 10 million	27.3	131
	11 to 50 million	25.3	121
	more than 50 million	25.7	123
	Total		479

Source: ECOOM-KULeuven [29], own calculations

Table 3: Crosstabs of preferred sector (first, second or third choice) by field of study, in %

	Human sciences	Social sciences	Natural sciences	Engineering	Medical sciences	Total	χ^2
University	89.3	82.1	81.8	74.3	84.7	81.7	24.080***
Government sector	68.2	62.4	56.4	55.7	47.5	57.0	27.084***
Non-academic educational institution	66.8	54.4	51.2	36.3	50.4	50.1	54.669***
Non-profit sector	28.0	44.9	24.0	16.2	48.1	31.6	116.978***
Industry	3.3	7.7	34.4	50.7	21.8	26.6	236.603***
Service sector	18.2	28.8	26.6	34.2	14.2	25.0	46.222***
Independent profession	24.3	16.4	16.2	19.6	27.4	20.6	18.700**
Primary sector	1.9	3.3	9.5	13.0	5.9	7.4	36.893***
N	214	274	346	377	339	1550	

Source: ECOOM-UGent [37]; df=4; *: p<0.050; **: p<0.010; ***: p<0.001

Table 4: Most preferred sector and perceived probability of future employment in this sector

	First choice	Rather low probability[a]	Rather high probability[b]	N
University	49.6	43.1	56.9	792
Government sector	11.8	28.2	71.8	189
Industry	11.5	9.7	90.3	184
Non-academic educational institution	9.0	27.1	72.9	144
Non-profit sector	6.6	19.6	80.4	105
Service sector	5.4	11.1	88.9	86
Independent profession	5.1	9.1	90.9	69
Primary sector	1.8	30.8	69.2	28

Source: ECOOM-UGent [37]; N=1597

a: includes categories very low, low and rather low, b: includes categories rather high, high, very high

Table 5: Evaluation of skills of doctorate holders by employers who do or do not work with doctorate holders (in %)

	Employers without DH[a]	Employers with DH[a]	Total	χ^2	p
Research skills and techniques					
Technical skills	76.3	61.5	71.0	5.225	*
Analytical thinking	57.6	59.0	58.1	0.041	
Scientific knowledge	48.9	69.2	56.2	8.373	**
Research skills	43.9	65.4	51.6	9.248	**
Average	56.7	63.8	59.2		
Personal effectiveness					
Taking initiative	60.4	50.0	56.7	2.214	
Independence	37.4	24.4	32.7	3.866	*
Flexibility	26.6	30.8	28.1	0.426	
Learning ability	22.3	33.3	26.3	3.139	
Stress management	28.8	16.7	24.4	3.970	
Time management	12.9	5.1	10.1	3.355	
Self-confidence	12.9	3.8	9.7	2.688	*
Dealing with failures	10.8	6.4	9.2	1.146	
Average	26.5	21.3	24.7		
Working with others					
Teamwork	61.9	69.2	64.5	1.182	
Social skills	30.2	33.3	31.3	0.226	
Dealing with diversity	9.4	12.8	10.6	0.634	
Average	20.3	23.1	21.3		
General management					
Project management	43.2	51.3	46.1	1.325	
Business skills	43.9	33.3	40.1	2.316	
Leadership	7.9	16.7	11.1	3.891	*
Knowledge about IP	3.6	2.6	3.2	0.171	
Financial management	3.6	0.0	2.3	2.872	
Career planning	0.0	0.0	0.0	0.000	
Average	17.0	17.3	17.1		
Communication skills					
Language knowledge	18.0	20.5	18.9	0.208	
Presentation skills	12.9	12.8	12.9	0.001	
Networking	10.1	9.0	9.7	0.069	
Writing skills	7.2	7.7	7.4	0.018	
Negotiation skills & persuasion	6.5	2.6	5.1	1.588	
Teaching skills	2.9	2.6	2.8	0.018	
Average	9.6	9.2	9.5		
	139	78	217		

Source: ECOOM-KULeuven [29], own calculations
N=217; df=1; [a]: Doctorate Holder; *: p<0.050; **: p<0.010

Table 6: Evaluation of perceived importance of skills for future career[1] by doctoral candidates from three fields of study, in %

	Natural Sciences	Engineering	Medical Sciences	Total	χ^2	p
Research skills and techniques						
Research skills	69.9	63.6	76.8	69.9	11.253	**
Scientific knowledge	70.6	58.7	73.7	67.4	15.881	***
Analytical thinking	49.4	58.7	36.3	48.5	27.236	***
Technical skills	25.3	33.6	12.0	23.9	35.077	***
Average	47.5	45.2	46.7	46.5		
Working with others						
Social skills	35.3	39.6	41.3	38.7	2.135	
Teamwork	36.8	40.3	37.8	38.3	0.748	
Dealing with diversity	6.7	6.0	2.3	5.1	6.082	
Average	26.3	28.6	27.2	27.4		
Personal effectiveness						
Independence	45.4	42.0	48.3	45.1	0.347	
Taking initiative	31.2	29.0	35.5	31.8	2.735	
Stress management	29.0	24.7	34.7	29.3	6.564	*
Self-confidence	23.8	30.0	30.1	28.0	3.520	
Learning ability	27.5	30.4	18.5	25.6	10.700	**
Flexibility	25.7	20.8	24.7	23.7	1.986	
Time management	14.9	16.3	19.7	16.9	2.311	
Dealing with failures	14.5	11.0	15.1	13.4	2.345	
Average	26.5	25.5	28.3	26.7		
Communication skills						
Presentation skills	37.5	36.0	41.3	38.2	1.669	
Language knowledge	33.5	28.6	24.7	29.0	4.932	
Teaching skills	26.8	23.0	27.0	25.5	1.498	
Networking	21.2	17.7	23.2	20.6	2.588	
Writing skills	15.6	14.5	14.7	14.9	0.156	
Negotiation skills & persuasion	9.3	14.1	10.8	11.5	3.345	
Average	24.0	22.3	23.6	23.3		
General management						
Project management	20.4	26.1	19.7	22.2	3.798	
Leadership	16.0	21.6	18.5	18.7	2.820	
Business skills	7.1	6.4	3.9	5.8	2.733	
Career planning	3.3	3.9	2.3	3.2	1.100	
Financial management	2.2	1.8	3.5	2.5	1.733	
Knowledge about IP	1.1	1.8	3.5	2.1	3.810	
Average	8.4	10.2	8.6	9.1		
	269	283	259	811		

Sources: ECOOM-UGent [37] & ECOOM-KULeuven [29], own calculations
;N=811; df=2; *: p<0.050; **: p<0.010; ***: p<0.001

Table 7: Comparison of percentages and ranking of skills of industry oriented (IR) doctoral candidates and HR-managers/employers

	doctoral candidates[a]						employers					
	engineering		non-engineering		Total IR		without DH[b]		with DH		Total employers	
	%	rank	%	rank	%	rank	%	Rank	%	rank	%	rank
Technical skills	36.7	7	17.3	18	26.9	11	76.3	1	61.5	4	71.0	1
Teamwork	48.1	4	35.8	7	41.9	5	61.9	2	69.2	1	64.5	2
Analytical thinking	63.3	2	45.7	4	54.4	3	57.6	4	59.0	5	58.1	3
Taking initiative	35.4	8	34.6	8	35.0	8	60.4	3	50.0	7	56.7	4
Scientific knowledge	51.9	3	72.8	2	62.5	2	48.9	5	69.2	2	56.2	5
Research skills	69.6	1	76.5	1	73.1	1	43.9	6	65.4	3	51.6	6
Project management	25.3	13	28.4	10	26.9	12	43.2	8	51.3	6	46.1	7
Business skills	7.6	23	14.8	19	11.3	21	43.9	7	33.3	8	40.1	8
Independence	34.2	9	46.9	3	40.6	6	37.4	9	24.4	12	32.7	9
Social skills	44.3	5	42.0	6	43.1	4	30.2	10	33.3	9	31.3	10
Flexibility	15.2	17	28.4	11	21.9	15	26.6	12	30.8	11	28.1	11
Learning ability	25.3	14	24.7	13	25.0	14	22.3	13	33.3	10	26.3	12
Stress management	34.2	10	25.9	12	30.0	10	28.8	11	16.7	14	24.4	13
Language knowlegde	32.9	11	43.2	5	38.1	7	18.0	14	20.5	13	18.9	14
Presentation skills	38.0	6	32.1	9	35.0	9	12.9	15	12.8	16	12.9	15
Leadership	29.1	12	22.2	14	25.6	13	7.9	21	16.7	15	11.1	16
Dealing with diversity	6.3	24	14.8	20	3.8	24	9.4	20	12.8	17	10.6	17
Time management	11.4	20	18.5	16	15.0	18	12.9	16	5.1	21	10.1	18
Self-confidence	24.1	15	18.5	17	21.3	16	10.1	19	9.0	18	9.7	20
Networking	12.7	19	18.5	15	15.6	17	12.9	17	3.8	22	9.7	19
Dealing with failures	13.9	18	1.2	27	14.4	19	10.8	18	6.4	20	9.2	21
Writing skills	8.9	22	11.1	21	10.0	22	7.2	22	7.7	19	7.4	22
Negotiation skills & persuasion	19.0	16	8.6	23	13.8	20	6.5	23	2.6	23	5.1	23
Knowledge about IP	1.3	25	3.7	24	2.5	25	3.6	24	2.6	24	3.2	24
Teaching skills	10.1	21	8.6	22	9.4	23	2.9	26	2.6	25	2.8	25
Financial management	1.3	26	2.5	25	1.9	26	3.6	25	0.0	26	2.3	26
Career planning	0.0	27	2.5	26	1.3	27	0.0	27	0.0	27	0.0	27
N	79		81		160		78		139		217	

Source: ECOOM-UGent [37]; [a]: industry-oriented doctoral candidates without an academic preference, want to stay in a research function
ECOOM-KULeuven [28]; own calculations; [b]: Doctorate Holders

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