



Aligning doctoral education with local industrial employers' needs: a comparative case study

Eloïse Germain-Alamartine & Saeed Moghadam-Saman

To cite this article: Eloïse Germain-Alamartine & Saeed Moghadam-Saman (2020) Aligning doctoral education with local industrial employers' needs: a comparative case study, *European Planning Studies*, 28:2, 234-254, DOI: [10.1080/09654313.2019.1637401](https://doi.org/10.1080/09654313.2019.1637401)

To link to this article: <https://doi.org/10.1080/09654313.2019.1637401>



© 2019 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 10 Jul 2019.



Submit your article to this journal [↗](#)



Article views: 1234





View related articles [↗](#)



View Crossmark data [↗](#)

Aligning doctoral education with local industrial employers' needs: a comparative case study

Eloïse Germain-Alamartine ^a and Saeed Moghadam-Saman ^b

^aHELIX Competence Centre & PIE, Linköping University, Sweden; ^bCentre for Innovation Research, UiS Business School, University of Stavanger, Norway

ABSTRACT

Doctoral education was primarily designed to answer the human resources needs of academia. However, nowadays, increasing numbers of doctorate holders seek employment outside academia. Accordingly, doctoral education can be one of the means by which universities take part in the development of industry in their regions. This study explores whether and how doctoral-level skills are being adapted to the needs of local industrial employers in two different contexts. Two research and science parks situated next to research-intensive universities in Sweden and Spain were chosen as cases for an exploratory and comparative study. In these parks, local industrial employers conduct R&D activities that make them potentially attractive destinations for doctoral graduates. Similarities in the cases were found regarding the process of adaptation of doctoral education at the adjacent universities to meet the industrial employers' needs in the parks. Discrepancies are also highlighted regarding stages of development, institutional settings, geography and culture. Implications for several stakeholders are formulated to improve the process analysed in the study concerning better alignment of doctoral education with industrial employers' need for generic skills.

ARTICLE HISTORY

Received 8 November 2018
Revised 4 June 2019
Accepted 24 June 2019

KEYWORDS

Doctoral education; science and technology parks; university–industry collaboration; generic skills; transferable skills

1. Introduction

The 2000 Lisbon Strategy demonstrated the intention of the European Union to support the development of a knowledge-based economy. Referring to this, Usher (2002) finds it a relevant question to ask whether the new mode of knowledge production in such economies implies the need for a new type of doctorate to provide graduates with the right skills for the knowledge economy. Consequently, he refers to the significance of 'human capital' in the knowledge economy, emphasizing that '[t]hose with much human capital are individuals with highly developed soft skills and the attainment of educational *qualifications* is not the only factor' (Usher, 2002, p. 3, emphasis in original). Accordingly, Usher finds the newer forms of doctoral education, such as professional doctorates and doctorates by

CONTACT Eloïse Germain-Alamartine  eloise.germain@liu.se  HELIX Competence Centre & PIE, Linköping University, Sweden

© 2019 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

project, as alternatives to PhDs by thesis, to better correspond to the skills required in the knowledge economy, because they bring academic and workplace training together.

In reality, some empirical findings highlight mismatches between non-academic employers' expectations and doctoral-level skills (De Grande, De Boyser, Vandevelde, & Van Rossem, 2010; Morgavi, McCarthy, & Metcalfe, 2007; Usher, 2002). University–industry collaborations can play a key role in addressing these mismatches (Roberts, 2018). Among the categories of organizational forms of university–industry collaboration, the establishment of 'focused structures', such as innovation centres or science and technology parks, entails the highest level of organizational involvement of a university in collaborating with industry (Ankrah & Al-Tabbaa, 2015). Through the analysis of two science and technology parks (STPs) situated near two research-intensive universities, in Sweden and Spain respectively, this paper aims to investigate whether the existence of these parks alongside universities can help to reduce the skills mismatch for doctoral researchers, and if so, how.

The research questions investigated in this exploratory study are: (a) Do the STPs currently contribute to doctoral education by facilitating various forms of university–industry interactions? (b) How do the STPs' specifics and configurations contribute to the build-up of doctoral-level skills? Exploring these issues will highlight the implications of the existence and specifics of STPs, for the better adaptation of doctoral education to the non-academic labour market.

The rest of this article is organized as follows: the next section reviews the literature about the labour market for doctorate holders and STPs. After that, the methodology adopted for this empirical study is described, and the findings of the case analyses are presented. A discussion on the comparison of these cases follows, and the article ends with a conclusion, in which contributions, policy implications, research limitations and suggestions for further research can be found.

2. Literature review

The number of doctoral graduates has steadily increased since 2000 across the OECD countries (Auriol, Misu, & Freeman, 2013). After graduation, most doctoral graduates who aspire to an academic career get temporary contracts, often postdoctoral positions. Postdocs' priority is to secure a tenure-track academic position (Sauermaann & Roach, 2012). There are, however, few who succeed (Andalib, Ghaffarzadegan, & Larson, 2018; Etmanski, Walters, & Zarifa, 2017; Hendrix, 2014). Accordingly, the private sector is increasingly becoming a destination for doctorate holders, partly corresponding to the increase in private-sector R&D capacity (Bloch, Graversen, & Pedersen, 2015).

The qualifications acquired during doctoral studies do not necessarily correspond to employers' requirements. Important skills mismatches can be observed (CEDEFOP, 2016; Kulkarni, Lengnick-Hall, & Martinez, 2015). Overeducation¹ and overskilling² are closely correlated and lead to negative effects on earnings and job satisfaction for doctorate holders (Di Paolo & Mañé, 2016; Gaeta, Lubrano Lavadera, & Pastore, 2016). International mobility and self-employment are solutions for doctoral graduates to considerably reduce this mismatch (Ghosh & Grassi, 2017; Stenard & Sauermaann, 2016). Indeed, countries that are developing their scientific and academic systems lack doctorate holders in many sectors of activity (Santos, Horta, & Heitor, 2016). The private sector also needs to be able to absorb the capabilities of the doctoral workforce; hiring doctoral graduates

enables firms to access scientific knowledge (Garcia-Quevedo, Mas-Verdú, & Polo-Otero, 2012; Herrera & Nieto, 2013; Lanciano-Morandat & Nohara, 2002). Mismatches are also due to the individual characteristics of doctorate holders (Roach & Sauermann, 2010; 2017), which evolve during doctoral studies: for example, due to their frequently decreasing interest in academic careers. Supporting doctoral students in discovering career opportunities (Thiry, Laursen, & Loshbaugh, 2015) and experiencing inter-sectoral mobility (Assbring & Nuur, 2017; Bienkowska & Klofsten, 2012; Roberts, 2018; Thune, 2010) should be more systematically integrated into doctoral education.

Manathunga, Pitt, and Critchley (2009) highlight the diversity of sectors in which doctoral graduates can find employment, and show that this implies a corresponding diversity of required skills. Accordingly, the authors emphasize the need to track doctoral graduates' employment destinations in order to make it possible for universities to more effectively produce employment-ready graduates. New forms of doctoral education have emerged with more relevance, linking university and industry more systemically: for example, the professional doctorate (Benito & Romera, 2013). Industry-based doctoral study programmes give doctoral researchers a more positive orientation towards working with industry (Harman, 2004) and industry funding can enhance their career prospects (Harman, 2002). Such programmes can also give graduates a more nuanced understanding of the different skills required in each employment sector (Manathunga et al., 2009). The skills required of doctoral students differ across countries (Matas, 2012) and within the same country (Nerad, 2015). For instance, sometimes a professional qualification or experience is required to enter a professional doctorate programme. Thus, skills development plans differ among doctoral programmes.

Some scholars consider that doctoral students should be regarded as research professionals (Gokhberg, Meissner, & Shmatko, 2017). However, the wide range of career opportunities for doctoral graduates increases the importance of skills that extend beyond the core research skills (Bienkowska & Klofsten, 2012). Such skills are called transferable, transversal, or generic. Most of these are usable across both research-intensive and non-research-intensive careers (Kyvik & Olsen, 2012; Sinche et al., 2017). Such skills can be acquired through formal training, an organized and systematic training explicitly aiming to build transferable skills; informal training, through everyday activities or regular academic classes; or formally organized informal training, workplace experience programmes such as industrial PhDs, internships and exchanges (OECD, 2012; see also Drummond, Nixon, & Wiltshire, 1998). Looking at the factors influencing the initial job attainment following completion of a PhD programme, Jackson and Michelson (2015) propose integrating work placement into course design or encouraging part-time paid employment during PhD studies. Their study shows that strong integration into the *research community* is an important predictor of initial job attainment for PhD graduates.

In line with this view, we aim to explore whether the existence of STPs adjacent to research-intensive universities helps to facilitate the transition to a post-PhD career. Indeed, the literature on interorganisational learning identifies different types of distances that can lead to incompatibilities and prevent successful collaborations as primary challenges: organizational, social, institutional, geographical, and cognitive distances; in other words, a lack of the corresponding proximities (Boschma, 2005). Boschma (2005, p. 71) makes it clear that, in theory, 'geographical proximity, combined with some level of cognitive proximity, is sufficient for interactive learning to take place'. In addition,

acquiring transferable skills aims to overcome the cognitive distance that significantly hinders the frequency of university–industry (UI) interactions (Muscio & Pozzali, 2013; Revilla Diez, 2000). Thus, STPs might contribute to the build-up of transferable skills during doctoral education. In their systematic review of the UI collaborations literature, Ankrah and Al-Tabbaa (2015) highlight the shortage of studies on the consequences of engagement with industry for the learning experience of students. While STPs represent the highest level of organized UI interactions, the potential benefit of their existence in the vicinity of universities for the skills acquisition of doctoral researchers, and consequently for their careers, has not been explored in the literature. Our paper, therefore, aims to close these gaps in the literature by studying whether STPs contribute to doctoral education at the adjacent universities.

In the present study, the generic term ‘STPs’ is used to designate different types of science and technology parks. However, the variety of STPs should not be overlooked. Almeida, Santos, and Rui Silva (2009) distinguished different types of parks depending on their science-intensiveness (focus on invention) on the one hand, and their business-intensiveness (focus on innovation) on the other. Their typology distinguishes R&D-intensive parks, technology parks, innovation parks, and business parks. Albahari, Pérez-Canto, Barge-Gil, and Modrego (2017) also studied the heterogeneity of STPs according to the degree of university involvement in these parks. No matter what the type of STPs, for tenant firms, the main means of obtaining knowledge from universities is maintaining ‘long-term’ relationships via both formal and informal interactions (Díez-Vial & Montoro-Sánchez, 2016). In particular, Hu (2008) demonstrates the importance of high-tech talent mobility and informal relationships for innovation performance during the various stages of science-park development.

3. Method and data

Our choice of the case study method is justified by the aim of exploring contemporary events (Yin, 1984). In addition, Yin recommends this method to answer ‘how’ research questions, like ours. Studying two cases is justified by the desire to explore different context specificities (in particular, different types of parks), to suggest implications for more than one case and potentially apply them to other, similar cases as well. In order to conduct the comparative study, the following criteria were applied when selecting the cases:

- (a) Parks and their tenants should be physically situated next to a research-intensive university and have established relationships with the university.
- (b) Park tenants’ activities should be related to STEM (Science, Technology, Engineering and Mathematics) disciplines.³
- (c) Cases should be heterogeneous; in particular, they should be embedded within different cultural and institutional settings.

This study focuses on two cases of park–university relations. Södertälje Science Park (SSCP), in Sweden, was established in 2016 on the outskirts of Stockholm, while, in Spain, the Research Park of the Autonomous University of Barcelona (henceforth UAB), called PRUAB (UAB Parc de Recerca), was established in 2007 on the outskirts of Barcelona. They were chosen, firstly, because of their strong links with nearby

research-intensive universities (UAB and KTH). In line with criterion (a), the SSCP is quite new and is developing along with the campus of the Royal Institute of Technology (henceforth KTH) in Södertälje thanks to the close cooperation between the KTH and the multinational firms based there; while PRUAB is an entity of the university itself and is a strong actor on the campus. In addition, park tenants’ activities are coherent with criterion (b): in the SSCP, biomedical and automotive industries are strongly represented; while in PRUAB, ICT and biomedicine predominate. Finally, the cases were chosen because comparable organizational choices were made (research and science parks in interaction with a nearby university), but also because they are situated in regions that differ both culturally and institutionally, in line with criterion (c). Both the SSCP and PRUAB also showed interest in taking part in the RUNIN⁴ project.

Data was collected through 17 semi-structured face-to-face interviews between September 2017 and January 2018. The aim was to recruit interviewees from universities, private companies, and all other actors potentially involved in doctoral education or the recruitment of doctorate holders. Members of the university management and employers from the SSCP and PRUAB were contacted as a priority. All interviewees have positions of responsibility in their respective organizations: they are CEOs, project managers, and heads of divisions or departments. Appendix 1 provides an overview of the interviews. Appendix 2 provides an anonymised list of interviewees and their corresponding organizations.

The methodology developed by Gioia, Corley, and Hamilton (2013) and the NVivo software were chosen for the analysis. Inspired by Glaser and Strauss’s (1967) grounded theory and designed for exploratory studies, it starts from the informants’ discourses in order to minimize the bias researchers may bring from theory and to foster the creation of new concepts. The method consists of three steps of analysis (see Table 1). Charts were built to visualize the results of our application of the chosen methodology to the cases in the different steps, facilitating the identification of their similarities (Figure 1), as well as their respective strengths and weaknesses (Figures 2 and 3).

Table 1. Overview of the methodology developed in Gioia et al. (2013) applied to the cases.

	1 st order analysis	2 nd order analysis	3 rd order analysis
Aim	Coding from the informants’ discourses	Structuring the 1 st order coding into themes	Structuring the 2 nd order coding into aggregate dimensions
Number of iterations	3	3	2
Final number of:	Nodes	Themes	Aggregate dimensions
For PRUAB case:	34	12	4
For SSCP case:	58	12	4

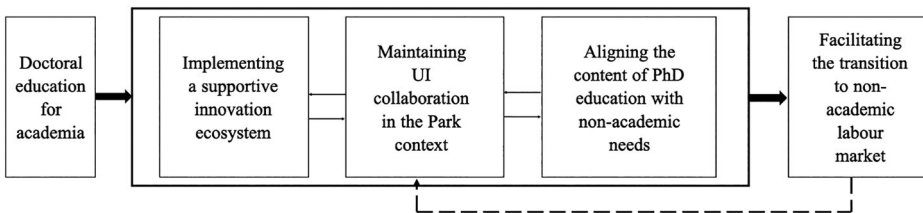


Figure 1. An analytical model of the process of adapting doctoral education to the needs of non-academic employers in both parks.

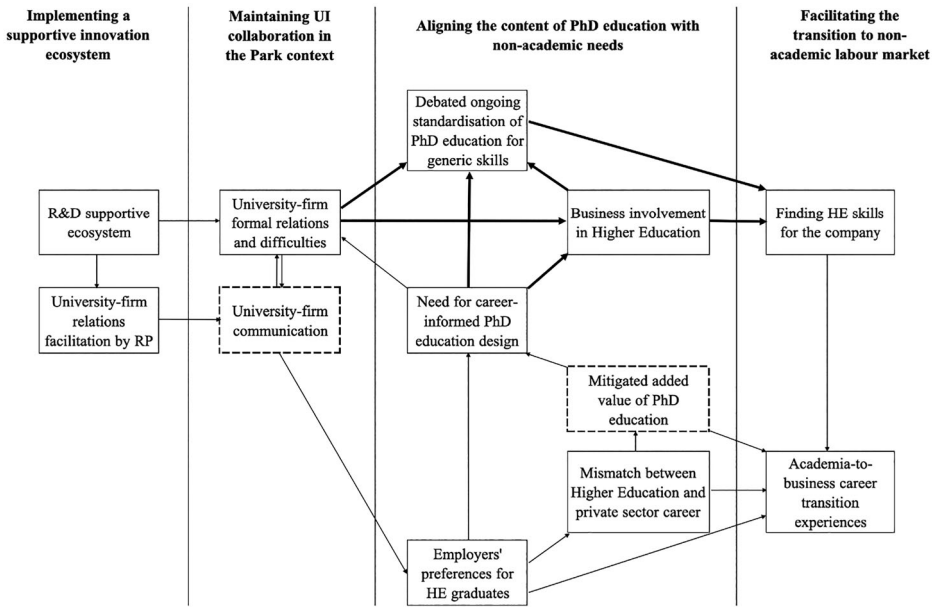


Figure 2. The process of providing doctoral-level skills in PRUAB. Squares with dashed outlines represent weaknesses. Bold arrows represent strengths.

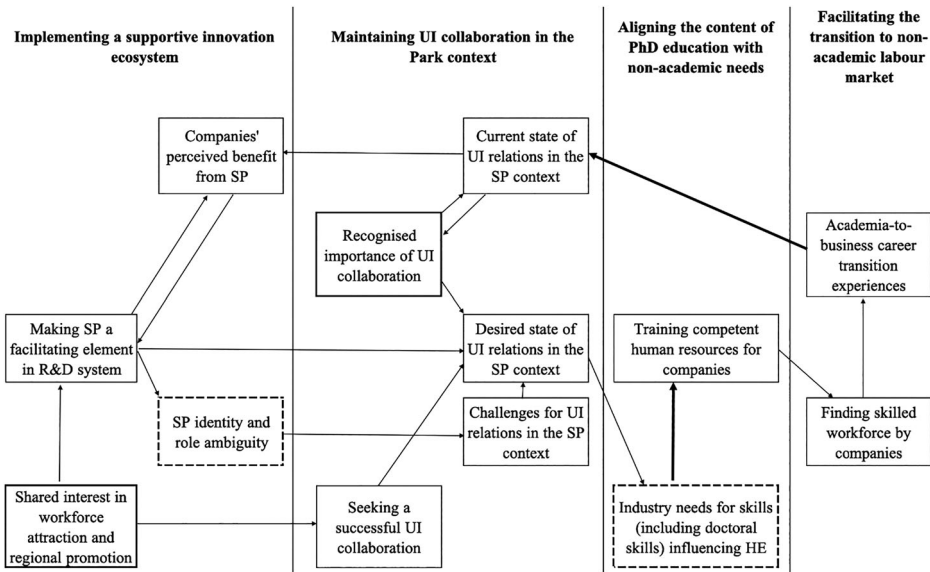


Figure 3. The process of providing doctoral-level skills in the SSCP. Squares with dashed outlines represent weaknesses. Bold squares and arrows represent strengths.

4. Findings

The implementation of this methodology led to a comparison of the cases. However, the thematic content and themes' configurations differ, reflecting the underlying heterogeneity of the SPs.

4.1. *Similar processes in the SSCP and PRUAB*

Despite their differences, identical aggregate dimensions were found in both cases. These dimensions follow a logical sequential order, making it possible to consider them as steps in a process of provision of doctoral-level skills to the parks. This process is represented in the form of an analytical model in [Figure 2](#), and takes the following point of departure for input: doctoral education is designed for academia. The output is the effect of adapting doctoral education for both academic and non-academic careers, corresponding to the dimension 'facilitating the transition to a non-academic labour market' for doctorate holders. The process is composed of three other dimensions: 'implementing a supportive innovation ecosystem' through the creation of STPs, 'maintaining UI collaboration in the park context', and 'aligning the content of doctoral education with non-academic needs'. However, the process can also be self-reinforcing since, ideally, each step reinforces the previous one. If the content of doctoral education is aligned with non-academic needs, then UI collaboration is more likely to be sustained. If this collaboration is sustainable, then stakeholders will perceive the benefit of being part of the park, enabling increasing support for the existence of the park and increasing resources. Also, if the process results in facilitating the transition to a non-academic labour market for doctorate holders, then doctoral graduates working in industry in the park are likely to maintain relationships with the university, thus reinforcing the process by encouraging the maintenance of UI collaboration in the context of the park. This is in line with Ferru's (2014) findings that most UI collaborations are renewed rather than built from scratch.

4.2. *The case of PRUAB*

The UAB (Autonomous University of Barcelona) has its main campus on the outskirts of Barcelona: the Campus of International Excellence hosting research centres, e.g. the Centre for Research in Agricultural Genomics (CRAG), and PRUAB, created by the university in 2007 to 'promote and enhance the technology and knowledge transfer activities of its members, encourage entrepreneurship through the creation of new businesses based on research, and generally facilitate interaction between research, business, and society' (PRUAB, 2018). PRUAB companies' fields of activity are mainly Information and Communications Technologies (ICT) and biomedicine. PRUAB's board is composed of members of the university as well as research centres, such as the Institute of Agri-food Research and Technology (IRTA) and the Spanish National Research Council (CSIC).

4.2.1. *Implementing a supportive innovation ecosystem*

One overall dimension emerging from the interviews is the importance of an environment that supports companies' innovation activities. Some interviewees highlighted the

advantages of establishing their business in Barcelona, citing the tax incentives for research activities and the presence of high-quality universities:

Spain was a good country, good choice, because it has many good universities, and also there are tax advantages, and then we knew Barcelona was a good fit, has some good universities, there's many companies nearby (Interviewee K).

However, when contrasted with some other advanced environments, such as the USA, Spain as a whole is considered to be an environment less favourable to the 'development' that follows 'research' in R&D. The supportive ecosystem is thus important, even more so as SPs host start-ups with limited resources. The maturity of supportive mechanisms is an important issue. For some, PRUAB has 'a lack of experience . . . it's quite new, it's 10 years old' (Interviewee L). Nevertheless, PRUAB's tenants perceive benefits from residing there, such as the infrastructure, partnerships in European projects, consultancy and incubation services, and the contact opportunities with the university and with other tenants due to geographical proximity. Some tenants use the university's labs or have the university as their customer. However, PRUAB staff listed more advantages and services, such as training courses on entrepreneurship, idea-generation programmes, and programmes to generate multi-disciplinary teams (Interviewee J), which (surprisingly) were not always mentioned by tenant interviewees.

4.2.2. Maintaining UI collaboration in the park context

PRUAB's tenants and the UAB engage in both informal and formal interactions. According to the UAB, the establishment of PRUAB was meant to serve the purpose of facilitating such relationships: 'We're using the research park as a tool to have relationships with the companies' (Interviewee I). Formal relations themselves also materialize in various formats. 'We have designated professors who help us, they're part of our concept to take care of helping the research to take the right direction' (Interviewee K). Establishing spin-offs, hiring postdocs and master's students, collaborating within the framework of European projects, and university-company staff mobility are some of the formal interactions mentioned. However, collaborating with doctoral students appears to be less prevalent among PRUAB's tenants. The most cited reason is the faster pace of firms' research activities compared to those of doctoral projects. A lack of resources is another obstacle for university-firm collaboration in the park context: 'Yes, we've had [collaboration with the UAB] and I know how to do it, I'm just waiting to get funding to do it again because we always learn something' (Interviewee M). Public-private conflicts of interest appeared to be another major issue acting against university-firm collaboration: in the university's choice of a company to implement a technology transfer, in companies' use of university facilities, in intellectual property rights issues, or in ownership of companies by university staff.

Informal interactions and communications between the university and park-based firms constitute important precursors to formal interactions. Nevertheless, these communications do not happen at the same level across all university departments:

For example, the engineering school here at the UAB, it's very close to companies so it's easier for them to have a meeting with the companies and with the researchers to put in common what are the needs, but with others it's really difficult because they're not so much in contact (Interviewee I).

Moreover, many of PRUAB's tenants think that communication with the university could be improved: 'there's no process for feedback to the university professors' (Interviewee M); '... it would be very interesting to have more cooperation among the different actors in the economy when doing PhD research, so being more linked with the real world' (Interviewee Q).

4.2.3. Aligning the content of doctoral education with non-academic needs

Most of the companies wish for closer cooperation and communication with universities, recognizing a mismatch between the skills provided by the higher education system and those needed in business-sector careers. More specifically, knowledge and understanding of customer needs is deemed crucial for creating a new product that will be successful in the market. This is valid for doctoral graduates, too, as many of them will be employed outside academia. The lack of management and business skills was specifically highlighted by interviewees:

To have people well trained from the technical point of view is nice, but the careers of those people are short. Why? Because when the product is developed, it's finished; then, we need to sell that product and to improve that product, and to improve a product is not the same as to develop a product (Interviewee P).

Some employers in PRUAB clearly stated their preference for master's graduates because they perceive them as more open and flexible to the multi-disciplinary work that is essential to the business environment.

There is a belief in the need for change in the design of doctoral education among some business leaders. However, the research-related skills acquired during doctoral education are appreciated by companies, even more than a knowledge of the specific scientific field:

Having a PhD, in a sense, is like a certification, you know, that you have that kind of experience, that you had to deal with this kind of ability to manage a problem, so in this sense, it's an added value (Interviewee N); 'It's more the skills of organising the work, of learning, of synthesising complex ideas that are very valuable' (Interviewee Q).

The industrial doctoral programme seems preferable to some non-academic employers: 'I like the industrial PhD ... because you're learning a very important thing, which is management, real management' (Interviewee L). The need for such transversal or transferable skills has been considered by the university. UAB's doctoral school recently developed the Professional Competence Model for UAB researchers. It includes the competences needed for doctoral students in six domains '... the first is interpersonal skills, the second is cognitive skills, then communication, research skills, organizational skills, and influencing and impacting skills' (Interviewee I). These skills are now taught to doctoral students across the university in the form of either mandatory or optional courses. Nevertheless, heterogeneity remains among departments and doctoral programmes within the university.

4.2.4. Facilitating the transition to the non-academic labour market

One of the advantages of being in the park that is described by PRUAB's tenants is their access to human resources due to the university's proximity. However, companies do not all follow the same path in finding skills. Hiring from the local university is not necessarily

a priority for all companies: ‘I want talent, I don’t care where the talent comes from’ (Interviewee L). This interviewee uses both local and professional social networks to recruit doctorate holders. Participation in the training of master’s students is another way for some tenants to find a potential doctoral student with whom to collaborate. Proximity to the university, the implied networking possibilities and agility in the hiring process are considered advantages:

... if necessary, next week we could be 20 people instead of four, I could call professors I know personally: Who’s good in your classroom? Who’s good in that field? Who’s good in that? That’s very important. Yes, I know there are the human resources companies, of course, but here it’s faster (Interviewee M).

In parallel, the preferences of graduates also need to be considered, such as a preference for stability:

To acquire an academic career in Spain or in Catalonia, you need to have been abroad for at least two years ... but yes, the economic situation made it kind of difficult to imagine that once you had been abroad for two years there could be any opportunity for coming back (Interviewee Q);

When you finish your PhD, you get to a point in life when you want some stability, you want to start a family, for example, or you want to be able to buy a house, and with research in a university, it’s impossible to know that, so you work on a grant that will finish in two years, and after those two years, if your PI [Principal Investigator] doesn’t have another grant, then you’re out, so you have the same feeling as when you finished your degree at the university: And now what? You have that feeling constantly, every two years’ (Interviewee O).

4.3. The SSCP case

Södertälje is situated 50 km outside of Stockholm and is thus considered to be part of the suburbs of the capital. The city has been welcoming diverse immigrant populations for the past century. It also hosts large production sites for multinational companies (approximately 20,000 employees) and is known for its success in organic food production. KTH, a highly ranked Swedish engineering school, has a small campus in Södertälje. Through this campus, the close links that KTH already had with a multinational company with a production site in the city were strengthened. These two closely related actors initiated the creation of the SP in 2016. However, this idea of creating an SP, supported by the municipality and other private actors in the area, was triggered by a particular event: the closure of the large R&D site of another multinational company, with only a small part of its activities being relocated to a different Swedish region, which caused many redundancies and the risk of a damaged image for Södertälje. The SP aims to promote Södertälje and attract economic actors and an additional workforce by branding itself as a knowledge city and by excelling in sustainable production in diverse industries.

4.3.1. Implementing a supportive innovation ecosystem

The history of the newly created SP in Södertälje is marked by an interest in promoting the city’s image. This interest is shared by the different stakeholders: the municipality, the university, and private companies; in particular, the largest ones. This consensus is a strength of the ecosystem: Sharing a common goal makes it easier to share the same vision and to

find consensus. The aim is to make the city and its surroundings an increasingly attractive place in which to both work and live: 'You can study and work in Södertälje ... we need to show the possibilities of Södertälje' (Interviewee C). According to these actors, making Södertälje recognized for its specificities, such as being a place for innovative industry through a focus on sustainable production, will enable such attraction. The creation of the SSCP is thus a means for stakeholders to structure the R&D system in Södertälje and attract companies and a workforce:

This is a way of using the parties in the science park to sort of lift Södertälje and lift all the companies in Södertälje, showing that Södertälje could be a knowledge society instead of being an area for refugees (Interviewee C).

All the stakeholders, and in particular private companies, seem to expect the SP to be a facilitating element in the ecosystem:

... an enabler where we can do things, where we can kind of accelerate ideas, also working together with [another private company] and other partners, and to really make the Södertälje brand stronger (Interviewee E).

This is a virtuous circle: The more they perceive this as a benefit, the more the SP will be able to act as a facilitating element. However, stakeholders have many additional expectations of the SSCP, which itself seems to have a varied list of missions: 'It's a meeting place' (Interviewee C), 'an arena where private firms and academia can discuss things' (Interviewee A); it's 'an innovative place or [...] innovative atmosphere' (Interviewee D). The lack of a precise or targeted role for the SP can be perceived and is sometimes explicitly expressed: 'Where does the science park fit in, into the context?' (Interviewee B). Even the identity of the park is difficult to grasp since its board is composed of varied members of the public and private sectors and of academia. This ambiguity in the identity and role of the SP can be a weakness to the extent that, without more clarity, the stakeholders might not know how to make use of it or may not wish to do so: 'If the science park was not there, I would still do it [collaborate with the university]' (Interviewee G).

4.3.2. Maintaining UI collaboration in the park context

Even though UI collaboration has already happened and still occurs outside the framework of the SP in Södertälje ('there is such a strong relationship between KTH and Scania' [Interviewee C]), one of the main aims of the SP is to foster UI collaboration. Here again, a consensus can be observed regarding the importance of UI collaboration, which is recognized by all stakeholders. This is a strength that both feeds the current UI relations occurring in the context of the SP and is fed by them. Despite their recent emergence, current UI relations in the context of the SP are satisfactory and look promising: Strategic partnerships already exist ('there are different reference groups, steering groups with industry involved' [Interviewee B]) as well as industry sponsorship ('these [professorships] are important for us so [...] we're paying for two of those professorships in cash' [Interviewee E]). This reinforces the perception of benefits accruing from the SP by stakeholders, even though the SP organization itself does not have any direct involvement in many of these collaborations. A successful UI collaboration is sought by the stakeholders because it is considered to be a key factor for the success of regional attraction

and promotion: ‘It’s all about having a good collaboration with the universities, I think that’s the key’ (Interviewee F). What is also striking in the case of the SSCP is that all the stakeholders express a vision of the future for their own organizations and for the SP. They all suggest their own insights into a desired state of UI relations in the context of the SP: sharing facilities, developing strategic partnerships, and constructing a research and education environment, including involvement from industry. This is due not only to the existing consensuses but also to the recognition of challenges raised by the SP’s identity and role ambiguity, e.g. the challenge of communication. On the university’s side: ‘We need to make sure that we can communicate new knowledge all the time, continuously’ (Interviewee B). On industry’s side: ‘One of my working areas is contact, dialogue with the universities’ (Interviewee F).

4.3.3. Aligning the content of doctoral education with non-academic needs

Regarding doctoral education and doctoral-level skills, both the current and desired state of UI relations in the SP context mainly deal with the issue of industry’s needs influencing higher education. Competence is crucial for industry, including at the doctoral level:

We need these really scientific strong people who can handle very complex questions and also analyse them in an analytical way, and we also need to ensure that universities continuously start supplying us with the good researchers and that they’re building up new state-of-the-art knowledge technologies and so on (Interviewee E).

The identification of industry’s need for skills and the communication of these to the providers of education, namely, the local university, is being developed. SMEs⁵ find such anticipation difficult, but established companies can do it. One multinational company has conducted an in-depth study, resulting in a roadmap covering the next 20 years that enables the anticipation of the need for particular skills. Communication of the need for skills is, however, ad hoc and specific to each organization whenever it is done. Working on this issue is a strength because it enables the training of competent human resources by the local university on behalf of the regional companies, where students are ‘a recruitment base for the future’ for these companies (Interviewee F). However, the fact that the great majority of these efforts are targeted at undergraduate education is a weakness, considering the focus of this study.

4.3.4. Facilitating the transition to a non-academic labour market

Thus, regional private companies can spot and hire doctorate recipients from the local university. These graduates might have relevant skills that can answer the needs of the hiring company. For companies, especially SMEs, ‘the key is to find the right person’ (Interviewee H), which is all the more important as they do not have the means to train a junior workforce:

I think that maybe [a multinational company], if they employ one [junior], they can employ straight from the university, it’s good they have fresh new knowledge and basic knowledge and they’re easy to form, they’re easy to adapt to a new environment, but if you have the small companies that don’t have time to train someone for two years before they start producing so ... it’s a big risk, they need some experience (Interviewee G).

Hiring from the local university enables more frequent, easier, and better matching transitions from academia to the business world for doctorate recipients, who are needed in the

doctorate-holders' labour market. Such transitions are also a strength for the system because they reinforce the UI relationships in the STP context. Currently, many individuals (five of our interviewees) involved in the park from the various stakeholders are doctorate recipients.

5. Discussion

In both of our case studies, interviewees recognize a need for more relevance to industry within doctoral education, and, in line with that, a need for greater involvement of non-academic employers in the process of doctoral education. In fact, what stands out from the interviews is that, although they need employees with doctoral-level skills, most non-academic employers in the parks would rather invest in the recruitment and additional training of a master's graduate over a doctorate holder because master's graduates are perceived to be more adaptable, and thus easier and cheaper to train to be ready to work in the company. Nevertheless, initiatives to bring more relevance into doctoral education can be observed in both cases, although they vary in their degree of formalization. This enables us to compare the cases: for example, the 'Professional Competence Model for UAB Researchers' is quite formalized, while on the KTH campus in Södertälje, doctoral education is not yet in place. In the following, we discuss the two cases in terms of this paper's research questions.

5.1. *The indirect contribution of STPs to doctoral education*

The STPs do not really contribute to doctoral education, at least not directly. Indeed, the respective missions of the parks do not explicitly mention doctoral education, or even the provision of human resources to park tenants. Park missions do, however, entail UI collaboration, through knowledge transfer in one case, and for municipality branding in the other. The interviews show that doctoral education is clearly not seen as a priority by most of the stakeholders, and is sometimes not even thought of. However, the geographical proximity implied in the study of these parks might enable the potential for them to contribute indirectly to doctoral education, by supporting the development of a cognitive proximity between local industrial employers and the university in such areas as applied research and business skills.

The interviews provide enough information for us to visualize the processes of adaptation of doctoral education to industrial employers' needs (see [Figure 2](#)). The parks' two main contributions are: to enable and support different kinds of collaboration, preferably long term, between the tenant firms and the nearby university; and to encourage the launching of entrepreneurial ventures. In the case of PRUAB, collaborating with entities situated on campus (including the university) is actually a condition for being accepted as a tenant. The parks can be meeting places for tenants to meet university students and researchers: in both cases, they are situated within the university's campus (in the SSCP, the park and the university actually share buildings). Encouraging meetings between park tenants and university students and faculty is crucial in order to overcome geographical and cognitive distances, and transform them into proximities. In other words, the geographical proximity which characterizes the parks in both cases can enable the reduction of cognitive distance, by providing opportunities for the academic

and industrial parties to communicate, and to get to know each other's needs. Getting to meet can provide stakeholders with occasions for developing relationships and research-related collaborations, through both formal and informal contacts and exchanges of information. Among them, the need for doctoral-level skills can be discussed between the partners, as well as possibilities for non-academic partners to become involved in doctoral education in order to enhance the employability of doctorate holders. However, this indirect contribution to doctoral education is identical in the two parks: [Figures 2 and 3](#) enable us to visualize and compare the processes in each case, and to identify different strengths and weaknesses, which are analysed below.

5.2. Influence of the parks' configurations

Referring to Almeida et al. (2009) and Albahari et al. (2017), it can be argued that the two cases correspond to different types of parks, because of the differing extent and form of the involvement of the respective universities in the ownership and operation of the parks. PRUAB actually stems from the UAB and is more oriented towards research, while the SSCP is a joint initiative of the university, the municipality and large companies, and is more oriented towards product and service development.

This difference in stakeholder configurations explains the differences in strengths and weaknesses identified in each case. On the one hand, in PRUAB, despite the UI geographical proximity, there seems to be little communication, at least regarding skills, and particularly doctoral-level skills. Thus, many employers in PRUAB do not consider a doctoral degree to be any more valuable than a master's degree in terms of employability, which is also linked to an existing mismatch between the expectations of employers and the doctoral-level skills acquired in universities. The strength of the case lies in the initiative of the university to create a framework of generic skills to be taught within doctoral programmes, with contributions from private companies in curriculum design. On the other hand, in the SSCP, the weaknesses lie in the absence of a clear definition of the role of the science park, which might discourage stakeholders from using what it offers, and the fact that industry involvement in higher education is largely focused on undergraduate education, overlooking doctoral programmes. However, in the undergraduate education, there is a combined effort by universities and major companies to train competent human resources for the companies. Moreover, many of the people who play a key role in the current UI relationships in the SSCP, which rely on the cognitive proximity existing between stakeholders regarding the need for regional promotion, the necessity of an STP, and the importance of UI collaboration, are actually doctorate holders themselves.

5.3. Influence of the cases' strengths and weaknesses

The different strengths and weaknesses of the parks also have different consequences for their potential to adapt doctoral education to the needs of non-academic employers. On the one hand, in the case of UAB, training in some generic skills is formalized in the shape of mandatory courses for all doctoral students. This was implemented after a consultation with employers from the private sector. Employers in PRUAB are small: most of them are SMEs, and the larger companies have a presence in the form of small units, such as a small laboratory. They might not themselves have the means, in terms of human and

financial resources, to invest in training recently graduated doctorate holders. It seems that the companies delegate this complementary training to create ready-to-work graduates to the university. The training in generic skills is thus more theoretical, and in the hands of the university. In addition, the majority of park tenants are oriented towards research, which is what doctoral students are trained for. Thus, the university can logically include the teaching of the skills they will need in the curricula for doctoral education. On the other hand, the SSCP is home to larger companies, which are very active and have the capacity to invest both in the university by taking part in teaching, and within their own organization by hiring industrial doctoral students. Companies are more legitimate entities to provide what can be seen as more practical training that the doctoral students and doctorate holders might lack, since product or service development is their core activity. In summary, we can distinguish between the theoretical and practical training through which industrial employers influence doctoral education, so that doctorate holders acquire the skills these employers need. The theoretical training in generic skills complements the research education and is provided within the university, while the practical training for those skills is provided within the companies to convey training on product or service development. This is a natural distinction resulting from the configurations of the parks, both in terms of activities (research vs. development) and company structure (SMEs vs. large companies). Nevertheless, both types of training are relevant and important for doctoral education, to develop the right skills and the means for doctorate holders to find a relevant job outside academia.

5.4. Geographical and cognitive proximities

The parks present some contrasting functions in their respective settings. [Figures 2 and 3](#) depict differences in the configuration of themes which emerge from the interviews within each case. In general, in the case of PRUAB, the university and the park are both well-established, but their collaboration related to higher education has not yet matured. Indeed, in [Figure 3](#), the aggregate dimension related to implementing a supportive innovation ecosystem is thematically less rich, while the one related to aligning the content of doctoral education with non-academic needs is thematically more elaborate. On the other hand, considering the same aggregate dimensions for the SSCP, the culture of collaboration between the university and the park firms is already strong, while the respective support organizations and campus-based doctoral education are still not fully developed.

Accordingly, there seems to be a paradox; in the SSCP, a strong cognitive proximity causes the various stakeholders (in particular, the university and large companies) to be aligned; at the same time, large companies have the means to invest in education and take responsibility for part of it. This means that, theoretically, they have enough influence to make their voices stronger and their interest weigh more in this context. In addition, tenants of the Science Park are all geographically situated within the municipality of Södertälje, but spread across it. In PRUAB, a comparable level of cognitive proximity is not observable. The companies seem to delegate their responsibility for taking part in education – so that it answers their needs in a more relevant way – to the university; this logically should lead to more communication and greater alignment between the employers and the university, which should be facilitated by the large majority of companies being geographically concentrated within a couple of buildings on campus. One reason for such a paradox

could be the difference between the two parks' representativeness of the total pool of local research-intensive employers: in the SSCP, tenants might represent a majority of the pool, considering the number of industrial employers in Södertälje and its suburbs, while in PRUAB, the tenants might only represent a small share of the pool, considering the number of employers in Barcelona and its suburbs. This shows that, in the case of PRUAB, the geographical proximity is in fact underexploited and could be better used to develop a cognitive proximity between industrial employers and the university.

6. Conclusion

This study contributes to the literature on process-oriented studies of Science and Technology Parks (Autio & Klofsten, 1998) and to the literature on doctoral education and the careers of doctorate holders, by exploring the contribution of STPs and their tenants to doctoral education. To the best of our knowledge, this is the first attempt in the literature to study the actual and potential role that STPs can play in the career-preparedness of doctoral students.

These findings have theoretical implications: *intrasectoral* collaboration and communication (e.g. within the university and within the business community) have positive consequences for *intersectoral* linkages and interactions because they smooth the process of reaching consensus within each sector. The findings from the SSCP case show that a well-functioning intrasectoral collaboration and common language can bring about the necessary pre-conditions for the establishment of cognitive proximity between the heterogeneous sectors.

Our findings also carry several implications for universities, industrial employers, and regional policymakers. In particular, the following recommendations might support the contribution of STPs to the build-up of doctoral-level skills. A more systematic anticipation of the need for particular skills by industrial employers, and the communication of these needs to universities through the creation of discussion spaces, such as forums on skills, would enable the universities to consider these needs in doctoral education curricula. The creation, communication, and support of opportunities for intersectoral mobility, e.g. through short-term industrial experience during doctoral education (in line with Etmanski et al., 2017; Roberts, 2018), could be used as a source of prevention against the skills mismatch, addressed to both doctoral students and industrial employers. Initiatives such as Marie Skłodowska-Curie actions already exist at the European level.

This research has some limitations. The considered universities are of different types: while KTH in Sweden is a technical university, UAB is a comprehensive university. The nature and amount of focus on technology transfer activities might thus differ. Furthermore, the parks are at different stages of maturity: the SSCP is fairly new, while PRUAB has a longer history. One area for further research is to compare each park with similar cases. Also, since the SSCP is newly created, strategies and interactions might be evolving very quickly; thus, it would be worth observing the SSCP's evolution over a longer period of time.

Notes

1. Overeducation refers to a situation in which an individual has more education than the current job requires (measured in years) (CEDEFOP, 2010).

2. Overskilling refers to a situation in which an individual is not able to fully utilise his or her skills and abilities in the current job (CEDEFOP, 2010).
3. See Isaksen and Karlsen (2010), who explain that the mode of innovation in regional industries significantly influences their level of cooperation with universities.
4. 'The Role of Universities in Innovation and Regional Development' is a research project funded by the European Commission.
5. An SME is a Small or Medium-Sized Enterprise.

Acknowledgments

The authors thank the HELIX Competence Centre and Marie Skłodowska-Curie Actions grant agreement No. 722295 (RUNIN Project) for providing resources to conduct this study. The authors also appreciate comments on an earlier version of this paper from anonymous reviewers and from the audience of the Triple Helix Conference 2018 and the Regional Innovation Policies Conference 2018.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by H2020 Marie Skłodowska-Curie Actions: [Grant Number 722295].

ORCID

Eloïse Germain-Alamartine  <http://orcid.org/0000-0003-1188-4422>

Saeed Moghadam-Saman  <http://orcid.org/0000-0001-6715-7924>

References

- Albahari, A., Pérez-Canto, S., Barge-Gil, A., & Modrego, A. (2017). Technology parks versus science parks: Does the university make the difference? *Technological Forecasting and Social Change*, 116, 13–28. doi:10.1016/j.techfore.2016.11.012
- Almeida, A., Santos, C., & Rui Silva, M. (2009). Science and technologic parks in regional innovation systems: A cluster analysis. *Cape Verde Congress of Regional Development*, 2091–2118. Retrieved from <http://www.apdr.pt/congresso/2009/pdf/Sess%C3%A3o%2021/53A.pdf>
- Andalib, M. A., Ghaffarzadegan, N., & Larson, R. C. (2018). The postdoc queue: A labour force in waiting. *Systems Research and Behavioral Science, Online version*, 1–12. Retrieved from <https://doi.org/10.1002/sres.2510>
- Ankrah, S., & Al-Tabbaa, O. (2015). University-industry collaboration: A systematic review. *Scandinavian Journal of Management*, 31, 387–408. doi:10.1016/j.scaman.2015.02.003
- Assbring, L., & Nuur, C. (2017). What's in it for industry? A case study on collaborative doctoral education in Sweden. *Industry and Higher Education*, 31(3), 184–194. doi:10.1177/0950422217705245
- Auriol, L., Misu, M., & Freeman, R. A. (2013). Careers of doctorate holders: Analysis of labour market and mobility indicators. *OECD Science, Technology and Industry Working Papers*, 2013/04, OECD Publishing. Retrieved from <http://dx.doi.org/10.1787/5k43nxgs289w-en>
- Autio, E., & Klofsten, M. (1998). A comparative study of two European business incubators. *Journal of Small Business Management*, 36(1), 30–43.
- Benito, M., & Romera, R. (2013). *How to Boost the PHD Labour Market? Facts from the PhD System Side* (No. ws132824). Universidad Carlos III de Madrid. Departamento de Estadística.
- Bienkowska, D., & Klofsten, M. (2012). Creating entrepreneurial networks: Academic entrepreneurship, mobility and collaboration during PhD education. *Higher Education*, 64(2), 207–222. doi:10.1007/s10734-011-9488-x

- Bloch, C., Graversen, E. K., & Pedersen, H. S. (2015). Researcher mobility and sector career choices among doctorate holders. *Research Evaluation*, 24(2), 171–180. doi:10.1093/reseval/rvv004
- Boschma, R. (2005). Proximity and innovation: A critical assessment. *Regional Studies*, 39(1), 61–74. doi:10.1080/0034340052000320887
- CEDEFOP. (2010). *The skill matching challenge: Analysing skill mismatch and policy implications*. Luxembourg: Publications Office. Retrieved from https://www.cedefop.europa.eu/files/3056_en.pdf
- CEDEFOP. (2016). *Future Skill needs in Europe: Critical labour Force Trends*. Luxembourg: Publications Office. CEDEFOP research paper; No 59.
- De Grande, H., De Boyser, K., Vandeveld, K., & Van Rossem, R. (2010). Transitions from academia to industry: How do doctorate holders fit in? *M&SS Working Paper*, 8.
- Di Paolo, A., & Mañé, F. (2016). Misusing our talent? Overeducation, overskilling and skill under-utilisation among Spanish PhD graduates. *The Economic and Labour Relations Review*, 27(4), 432–452. doi:10.1177/1035304616657479
- Díez-Vial, I., & Montoro-Sánchez, Á. (2016). How knowledge links with universities may foster innovation: The case of a science park. *Technovation*, 50, 41–52. doi:10.1016/j.technovation.2015.09.001
- Drummond, I., Nixon, I., & Wiltshire, J. (1998). Personal transferable skills in higher education: The problems of implementing good practice. *Quality Assurance in Education*, 6(1), 19–27. doi:10.1108/09684889810200359
- Etmanski, B., Walters, D., & Zarifa, D. (2017). Not what I expected: Early career prospects of doctoral graduates in academia. *Canadian Journal of Higher Education*, 47(3), 152–169. doi:10.7202/1043243ar
- Ferru, M. (2014). Partners connection process and spatial effects: New insights from a comparative inter-organizational partnerships analysis. *European Planning Studies*, 22(5), 975–994. doi:10.1080/09654313.2012.752440
- Gaeta, G. L., Lubrano Lavadera, G., & Pastore, F. (2016). Much ado about nothing? The wage effect of holding a PhD degree but not a PhD job position. *IZA Discussion Paper No. 10051*. Retrieved from <https://ssrn.com/abstract=2810462>
- Garcia-Quevedo, J., Mas-Verdú, F., & Polo-Otero, J. (2012). Which firms want PhDs? An analysis of the determinants of the demand. *Higher Education*, 63(5), 607–620. doi:10.1007/s10734-011-9461-8
- Ghosh, S., & Grassi, E. (2017). Overeducation and overskilling in the early careers of PhD graduates: Does international migration reduce labor market mismatch? Mimeo.
- Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, 16(1), 15–31. doi:10.1177/1094428112452151
- Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine de Gruyter.
- Gokhberg, L., Meissner, D., & Shmatko, N. (2017). Myths and realities of highly qualified labor and what it means for PhDs. *Journal of the Knowledge Economy*, 8(2), 758–767. doi:10.1007/s13132-016-0403-7
- Harman, G. (2002). Producing PhD graduates in Australia for the knowledge economy. *Higher Education Research & Development*, 21(2), 179–190. doi:10.1080/07294360220144097
- Harman, K. M. (2004). Producing ‘industry-ready’ doctorates: Australian Cooperative Research Centre approaches to doctoral education. *Studies in Continuing Education*, 26(3), 387–404. doi:10.1080/0158037042000265944
- Hendrix, S. (2014). Should I become a professor? Success rate 3%! Retrieved from <https://www.smartsciencecareer.com/become-a-professor/>
- Herrera, L., & Nieto, M. (2013). Recruitment of PhD researchers by firms. In *35th DRUID Celebration Conference, Barcelona, Spain*. Google Scholar.
- Hu, T. (2008). Interaction among high-tech talent and its impact on innovation performance: A comparison of Taiwanese science parks at different stages of development. *European Planning Studies*, 16(2), 163–187. doi:10.1080/09654310701814462

- Isaksen, A., & Karlsen, J. (2010). Different modes of innovation and the challenge of connecting universities and industry: Case studies of two regional industries in Norway. *European Planning Studies*, 18(12), 1993–2008.
- Jackson, D., & Michelson, G. (2015). Factors influencing the employment of Australian PhD graduates. *Studies in Higher Education*, 40(9), 1660–1678. doi:10.1080/03075079.2014.899344
- Kulkarni, M., Lengnick-Hall, M. L., & Martinez, P. G. (2015). Overqualification, mismatched qualification, and hiring decisions: Perceptions of employers. *Personnel Review*, 44(4), 529–549. doi:10.1108/PR-11-2013-0204
- Kyvik, S., & Olsen, T. B. (2012). The relevance of doctoral training in different labour markets. *Journal of Education and Work*, 25(2), 205–224. doi:10.1080/13639080.2010.538376
- Lanciano-Morandat, C., & Nohara, H. (2002). *The New Production of Young Scientists (PhDs): A Labour Market Analysis in International Perspective* (No. 03-04). DRUID Working Paper.
- Manathunga, C., Pitt, R., & Critchley, C. (2009). Graduate attribute development and employment outcomes: Tracking PhD graduates. *Assessment & Evaluation in Higher Education*, 34(1), 91–103. doi:10.1080/02602930801955945
- Matas, C. P. (2012). Doctoral education and skills development: An international perspective. *REDU: Revista de Docencia Universitaria*, 10(2), 163. doi:10.4995/redu.2012.6102
- Morgavi, A., McCarthy, M., & Metcalfe, J. (2007). *Employers' views of researchers' skills: A comprehensive review of the existing literature into employers' views of the skills of early career researchers*. Cambridge: UK Grad Programme.
- Muscio, A., & Pozzali, A. (2013). The effects of cognitive distance in university–industry collaborations: Some evidence from Italian universities. *The Journal of Technology Transfer*, 38(4), 486–508. doi:10.1007/s10961-012-9262-y
- Nerad, M. (2015). Professional development for doctoral students: What is it? Why now? *Who Does it?* *Nagoya Journal of Higher Education*, 15, 285–319.
- OECD. (2012). *Transferable skills training for researchers: Supporting career development and research*. Paris: OECD Publishing. Retrieved from https://read.oecd-ilibrary.org/science-and-technology/transferable-skills-training-for-researchers_9789264179721-en#page1
- PRUAB. (2018). UAB Research Park. Retrieved from <http://www.uab.cat/web/about-the-park/strong-uab-research-park/strong-1345674962855.html>
- Revilla Diez, J. (2000). The importance of public research institutes in innovative networks: Empirical results from the Metropolitan innovation systems Barcelona, Stockholm and Vienna. *European Planning Studies*, 8(4), 451–463. doi:10.1080/713666418
- Roach, M., & Sauermann, H. (2010). A taste for science? PhD scientists' academic orientation and self-selection into research careers in industry. *Research Policy*, 39(3), 422–434. doi:10.1016/j.respol.2010.01.004
- Roach, M., & Sauermann, H. (2017). The declining interest in an academic career. *PLoS ONE*, 12(9), e0184130.
- Roberts, A. G. (2018). Industry and PhD engagement programs: Inspiring collaboration and driving knowledge exchange. *Perspectives: Policy and Practice in Higher Education*, 22(4), 115–126. doi:10.1080/13603108.2018.1456492
- Santos, J. M., Horta, H., & Heitor, M. (2016). Too many PhDs? An invalid argument for countries developing their scientific and academic systems: The case of Portugal. *Technological Forecasting and Social Change*, 113, 352–362. doi:10.1016/j.techfore.2015.12.013
- Sauermann, H., & Roach, M. (2012). Science PhD career preferences: Levels, changes, and advisor encouragement. *PloS ONE*, 7(5), e36307. doi:10.1371/journal.pone.0036307
- Sinche, M., Layton, R. L., Brandt, P. D., O'Connell, A. B., Hall, J. D., Freeman, A. M., ... Brennwald, P. J. (2017). An evidence-based evaluation of transferrable skills and job satisfaction for science PhDs. *PloS One*, 12(9), e0185023. doi:10.1371/journal.pone.0185023
- Stenard, B. S., & Sauermann, H. (2016). Educational mismatch, work outcomes, and entry into entrepreneurship. *Organization Science*, 27(4), 801–824. doi:10.1287/orsc.2016.1071
- Thiry, H., Laursen, S. L., & Loshbaugh, H. G. (2015). 'How do I get from here to there?' An examination of PhD science students' career preparation and decision making. *International Journal of Doctoral Studies*, 10, 237–256. doi:10.28945/2280

- Thune, T. (2010). The training of ‘triple helix workers’? Doctoral students in university–industry–government collaborations. *Minerva*, 48(4), 463–483. doi:10.1007/s11024-010-9158-7
- Usher, R. (2002). A diversity of doctorates: Fitness for the knowledge economy? *Higher Education Research & Development*, 21, 143–153. doi:10.1080/07294360220144060
- Yin, R. (1984). *Case study research*. Beverly Hills, California: Sage Publications.

Appendices

Appendix 1: Overview of the interviews

Case	SSCP	PRUAB
Number of interviews	8	9
Min-max length of interviews	27 min – 1 h 36 min	28 min – 1 h 11 min
Number of organizations represented		
• Of which, from the private sector	7	9
• Of which:	4	7
○ SMEs	2	6
○ Established companies	2	1

Appendix 2: Profiles of the interviewees

Case:	Interviewee code:	Type of organization:	Field of activity of organization:
SSCP	A	Engineering school	Higher education
SSCP	B	Engineering school	Higher education
SSCP	C	Science Park	Sustainable production
SSCP	D	Public organization	City management
SSCP	E	Multinational private company	Automotive industry
SSCP	F	Multinational private company	Pharmaceutical industry
SSCP	G	Research Park	Chemistry
SSCP	H	Small private company	Biomedicine
PRUAB	I	University	Higher education
PRUAB	J	Research Park	Innovation and entrepreneurship
PRUAB	K	Multinational private company	Material science
PRUAB	L	Private start-up, spin-off of UAB	Biomedicine
PRUAB	M	Private start-up	Environmental science and sustainability
PRUAB	N	Private start-up	Bioinformatics
PRUAB	O	Small private company	Biomedicine
PRUAB	P	Private start-up, spin-off of UAB	Environmental science and sustainability
PRUAB	Q	Private start-up, spin-off of UAB	Environmental science and sustainability

Appendix 3: Second-order themes and aggregate dimensions

