Doctoral education in the entrepreneurial university: enhanced employability?

Eloïse Germain-Alamartine

Linköping Studies in Science and Technology
Dissertations, No. 2043

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2020

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Linköping Studies in Science and Technology, Dissertations, No. 2043

ISBN: 978-91-7929-914-9

ISSN: 0345-7524

Printed by: LiU-Tryck, Linköping

Distributed by:
Linköping University
Department of Management and Engineering
SE-581 83 Linköping, Sweden
Tel: +46 13 281000

ABSTRACT

This dissertation explores the issue of employability of doctorate holders through the theoretical lens of the model of the entrepreneurial university. It starts from the observation that there is a bottleneck in the academic labour market in many countries, making it increasingly difficult for recent doctoral graduates to engage in an academic career. Traditionally, doctoral education was designed for a career in academia; but the employment situations of doctorate holders call for more relevance of doctoral education and doctoral-level skills on the non-academic labour market. The main argument of this dissertation is that the openness and the interactions of the entrepreneurial university with its environment, in particular its region, makes it a relevant model to enhance the employability of doctorate holders outside academia. The thesis is based on five publications written either solely by the author or in collaboration with other scholars, mostly case studies compiling both qualitative and quantitative data and approaches.

Three main findings can be highlighted from the research: *(i)* the entrepreneurial university increases its socioeconomic impact by building an alignment with regional stakeholders over the years and thanks to key individuals, by retaining human and social capital within itself and by broadening the scope of its activities and stakeholders; *(ii)* doctorate holders' employability is key in the entrepreneurial university's regional socioeconomic impact, as they are increasingly employed outside academia but are likely to experience job mismatches in this situation, mainly related to education and skills; *(iii)* regional stakeholders can take different types of initiatives to enhance the employability of doctorate holders, and increase the entrepreneurial university's socioeconomic impact: more specifically, doctorate holders and non-academic employers can get to know each other better; intermediaries such as Science Parks can support them through the creation of meeting places.

The dissertation contributes to the literature on the entrepreneurial university by focusing on the population of doctoral students and doctorate holders, at the crossroads of its three missions (education, research and 'third mission'). It also suggests the following main recommendations: to universities, beyond adapting the content of doctoral education to the needs of non-academic employers, put emphasis on marketing it to them, so that they understand what it is worth; to doctorate holders, expand their knowledge of career possibilities, and behave entrepreneurially by initiating activities to complement what could be missing in their education; to non-academic employers, collaborate with universities and communicate their needs to them to influence the design of curricula.

Keywords: *Entrepreneurial university, doctoral education, job mismatches, regional development, entrepreneurship, non-academic careers, employability.*

SAMMANFATTNING

Avhandlingen undersöker anställningsbarheten för en disputerad person med teoretisk utgångspunkt i en modell av det entreprenöriella universitetet. I de flesta länder är det svårt för nyexaminerade doktorer att komma in på arbetsmarknaden, inte minst för dem som vill fortsätta inom akademien. Traditionellt är en doktorandutbildning utformad för en fortsatt karriär inom akademien, men på grund av de begränsade möjligheterna på arbetsmarknaden krävs doktorandutbildningar med större relevans och som även ger färdigheter inför en icke akademisk karriär. Huvudtesen i denna avhandling är att det entreprenöriella universitetets öppenhet och interaktionen med det omgivande samhället, inte minst med den närliggande regionen, ökar de nydisputerades anställningsbarhet utanför akademien.

Avhandling baseras på fem publikationer skrivna antingen av en enskild författare eller i samarbete med kollegor och som grundar sig på såväl kvalitativa som kvantitativa studier. Tre huvudsakliga resultat kan lyftas från forskningen: (i) Det entreprenöriella universitetet ökar sitt socioekonomiska inflytande genom att skapa en plattform för samarbete med regionala aktörer, som utvecklas över åren och där mänskligt och ekonomiskt kapital i sig bidrar till att öka och bredda samarbetet ytterligare. (ii) De disputerades anställningsbarhet är en nyckel till det entreprenöriella universitetets möjlighet till socioekonomisk regional påverkan. Detta beror på att de disputerade i ökande utsträckning anställs utanför akademien och sannolikt upplever att det finns en miss-match i kunskaper och färdigheter. (iii) Regionala aktörer kan ta olika typer av initiativ för att öka anställningsbarheten för nyexaminerade doktorer och därmed också öka det entreprenöriella universitetets socioekonomiska inflytande. Mer specifikt bör doktorander och arbetsgivare utanför akademien lära känna varandra bättre. Intermediärer som närliggande forskningsbyar, Science parks, kan ge stöd genom att inrätta olika typer av mötesplatser.

Avhandlingen bidrar till litteraturen inom området entreprenöriella universitet genom att sätta fokus på doktorander och nyblivna doktorer i skärningspunkten mellan utbildning, forskning och den 'tredje uppgiften'. I avhandlingen ges också rekommendationer: Till universiteten: Utöver att anpassa innehållet i doktorandutbildningen till behoven hos arbetsgivare utanför akademien behöver akademien också lägga tonvikt på marknadsföring så att företagare och organisationer i regionen inser värdet av en doktorsexamen. Till nyblivna doktorer: utvidga kunskaperna om vilka karriärmöjligheter som står till buds och agera entreprenöriellt för att komplettera de brister de upplever i sin utbildning. Till arbetsgivare utanför akademien: samarbeta med universiteten och kommunicera vilka behov de har för att påverka läroplaner och inriktningar.

Nyckelord: *entreprenöriella universitet, doktorsexamen, matchning på arbetsmarknaden, regional utveckling, entreprenörskap, icke-akademisk karriär, anställningsbarhet.*

ACKNOWLEDGMENTS

I would like to thank my academic supervisors, Magnus Klofsten and Dzamila Bienkowska, for having given me the opportunity to pursue doctoral studies, guided me during this three-year-journey, and taught me the craft of being a researcher.

I also wish to extend a special thank you to Ina Drejer for being my opponent at my end seminar and for her very relevant questions and recommendations: they helped me a great deal in shaping and polishing this *kappa*. I am also grateful in this matter for the help of all my other proof-readers, in particular Mats Abrahamsson.

A warm thanks to my each of my co-authors, in particular Saeed Moghadam-Saman and Eduardo Cadorin, with whom I learned so much and discovered some of the most exciting (and stressful) events of a researcher's life: getting one's work published!

Many thanks to each member of the RUNIN project, for making this Ph.D. journey an extraordinary experience, through obviously hard work and a quite nomadic lifestyle, but also through many great human, social, intellectual and cultural discoveries.

Thanks also to all members of P.I.E., who have welcomed me at the university during this time, supported me in growing as a researcher, and enabled me to discover the Swedish culture, in particular during the traditional *fredagsfika*. Also, thanks to Monica Westman Svenselius who kindly translated my abstract into Swedish.

This project would have been impossible without the financial support of the Marie Skłodowska-Curie actions¹ and HELIX Competence Centre; nor without the participation of my interviewees. I am also thankful for the support of Region Östergötland, in particular through Peter Larsson and Mattias Flodström.

À mes parents, mon fiancé, ma sœur et mes frères, qui m'ont encouragée à saisir cette opportunité inattendue, et qui m'ont continuellement soutenue pendant ces trois années de déracinement : merci. J'ai aussi une pensée pour chacun de mes grands-parents, avec lesquels j'aurais aimé partager cet accomplissement.

Last but not least, I would also like to convey my gratitude to Grégoire Croidieu for having introduced me to the research world, believed in my abilities since the very beginning, convinced me to engage in a Ph.D. and encouraged me all along the way.

Eloïse Germain-Alamartine, Linköping, 2019

¹ The project has received funding from the European Union's Horizon 2020 research and innovation programme under Marie Skłodowska-Curie grant agreement No. 722295.

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Paper 1. **Germain-Alamartine, E.** (accepted) Transitioning from an economic to a broader social impact: the case of a Swedish university. (accepted for publication in forthcoming Springer book)

Paper 2. Etzkowitz, H., **Germain-Alamartine, E.**, Keel, J., Kumar, C., Smith, K. N., Albats, E. (2019) Entrepreneurial university dynamics: Structured ambivalence, relative deprivation and institution-formation in the Stanford innovation system. *Technological Forecasting and Social Change*, 141, 159-171.

Paper 3. Cadarin, E., **Germain-Alamartine, E.**, Bienkowska, D., & Klofsten, M. (2019). Universities and Science Parks: Engagements and Interactions in Developing and Attracting Talent. In *Developing Engaged and Entrepreneurial Universities* (pp. 151-169). Springer, Singapore.

Paper 4. **Germain-Alamartine, E.** (2019) Doctoral education and employment in the regions: the case of Catalonia. *Regional Studies Regional Science*, 6(1), 299-318.

Paper 5. **Germain-Alamartine E.** & Moghadam-Saman S. (2020) Aligning doctoral education with local industrial employers' needs: a comparative case study. *European Planning Studies*, 28(2), 234-254.

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LIST OF ABBREVIATIONS

AQU	Agency for the Quality of the University System in Catalonia
ANRT	French National Association for Research and Technology
CIFRE	French Industrial research training agreements
ECTS	European Credit Transfer Scale
ECIU	European Consortium of Innovative Universities (consortium of universities based in Brussels)
IT	Information Technology
ITN	Innovative Training Networks (one type of EU Marie Klodowska-Curie actions)
LARM	LinTeks Arbetsmarknadsdagar (job fair organised by a student organization at Linköping University)
LERU	League of European Research Universities
LiU	Linköping University
OECD	Organisation for Economic Co-operation and Development
PRUAB	Autonomous University of Barcelona Research Park
RUNIN	The Role of Universities in Innovation and Regional Development (EU-funded research project)
SME	Small and Medium-sized Enterprises
SP	Science Park
SSCP	Södertälje Science Park
SSH	Social Sciences and Humanities disciplines
STEM	Science, Technology, Engineering and Mathematics disciplines
UI collaboration	University-Industry collaboration
YERUN	Young European Research Universities (network of universities based in Brussels)

PART I. SYNTHESIS

CHAPTER 1. Introduction

This chapter introduces the focus of the dissertation: the entrepreneurial university and doctoral education. It sets the background of the thesis by discussing the roles of entrepreneurial universities in the knowledge-based economy and in their regions. The key concepts of the dissertation are clarified, giving way to a highlight of the identified research gaps and their corresponding research questions. The outline of the thesis is also detailed, concluding the chapter.

1. Background and objective

At first glance, doctoral education might seem quite anecdotal since only a minority of the world population pursue doctoral studies: around 755,000 individuals only in the European Union in 2016². Besides, being so few, and considering the increasing demand in highly-educated workers in knowledge-based economies, one might assume that they have a privileged access to the labour market, as they are the most educated workers (Neumann & Tan, 2011).

So why bother with the situation of doctorate holders?

The share of doctorate holders keeps growing³ (Auriol, Misu, & Freeman, 2013). Although the yearly number of graduates has been stabilizing in some countries (around 3,500 in Sweden and 13,500 in France), it has increased by 6% in the EU since 2013 to reach approximately 137,000, and some countries such as Spain have experienced a drastic growth during this period (+50%, to reach 20,000 new PhD graduates in 2017). The paradigm of the knowledge-based economy (Lisbon European Council, 2000), translated into strategy Europe 2020, has given priority to innovation and human capital since the beginning of the century. This strategy has had a concrete influence on the number of doctoral students, as investments in research and development have been increasing by +0.4 points of EU's GDP between 2006 and 2017⁴. However, individuals' motivations to pursue doctoral studies should not be under-estimated (Calatrava Moreno & Kollanus, 2013; Hakala, 2009). On the one hand, higher education has been considered as a good investment for social mobility (Abel & Deitz, 2014). Such an investment has become accessible to an increasing number of families, thanks to recent changes

² From Eurostat online database on students enrolled in doctoral education, updated in 2019.

³ From Eurostat online database on graduates of doctoral level, updated in 2019.

⁴ From Eurostat statistics explained, R&D expenditure, updated in 2019: https://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure

in higher education (more universities, possibilities to get bursaries or bank loans, MOOCs⁵, etc.), even though a gap in terms of social mobility persists between the richer and the poorer (Brezis & Hellier, 2018). On the other hand, unemployment rates have been increasing in the past decades, and pursuing longer studies can be considered by many individuals as a means to enter later on the labour market (Calatrava Moreno & Kollanus, 2013).

Thus, there is an increasing competition on the labour market. Employment opportunities are not as ideal as one might think: there is actually an over-production of PhDs in many countries, and a bottleneck in academia (Andalib, Ghaffarzadegan, & Larson, 2018; Hayter & Parker, 2019; Larson, Ghaffarzadegan, & Xue, 2014). Moreover, there is an increasing number of doctorate holders getting employed outside academia: 65% of researchers in the EU, 78% in Sweden, 75% in France and 52% in Spain⁶. However, doctoral education was traditionally designed for a career in academia (Charle & Verger, 2012). In the past decade, researchers have been calling for more relevance of doctoral education especially regarding employment on the non-academic labour market (Nyquist, 2010; Roberts, 2018; Thune et al., 2012).

But why focus on the entrepreneurial university?

Doctoral education is provided by higher education institutions. However, literature has shown that universities are far from being an homogenous type of organization: although all of them face increasing pressure from their varied stakeholders (Benneworth & Jongbloed, 2010), universities react differently, with their respective philosophies and strategies, which translates into different theoretical models of universities (Uyarra, 2010). The model of the entrepreneurial university is characterized by an emphasis put on research valorisation and regional socioeconomic impact, through the support of entrepreneurship and of knowledge exchange and collaboration (Galán-Muros, van der Sijde, Groenewegen, & Baaken, 2017; Klofsten et al., 2019; Urbano & Guerrero, 2013). This model is particularly interesting in the case of doctoral students, because it places doctoral students in transversal positions, being involved in teaching, in research as well as in the valorisation of research results. Doctoral students of the entrepreneurial university are often at the interface between university and industry (Bienkowska, Etkowitz, & Klofsten, 2015; Thune, 2009). It is thus possible that doctoral education benefit from the university's interactions with regional stakeholders to be

⁵ MOOC stands for Massive Open Online Course

⁶ From Eurostat statistics explained, R&D personnel, updated in 2019.

more relevant in terms of employability of PhDs, and that in turn, doctoral students support their respective entrepreneurial universities to increase their regional socioeconomic impact.

The objective of this dissertation is to explore the socioeconomic impact of the entrepreneurial university, in particular through doctoral education and the employability of doctoral workforce. It studies how the entrepreneurial university can use its characteristics, in particular its regional activities and impact, to enhance the employability of doctorate holders; and how this in turn can enhance its regional socioeconomic impact.

2. Knowledge gaps and research questions

2.1. Socioeconomic impact and evolution of entrepreneurial universities

Measuring the impact of entrepreneurial universities is quite difficult (Klofsten et al., 2019). In general, economic impact measurement is the most easily implemented, for instance with the survival rate of university spin-offs, or the number of patents; although the relevance of some of these measurements remains debated (Klofsten et al., 2019). However, the socioeconomic impact of the entrepreneurial university goes much beyond spin-offs and patents. The entrepreneurial university's impact is more or less visible, more or less diffuse in the region, as it is created by formal or informal activities. For example, the impact of entrepreneurship education is hard to measure quantitatively but can be assessed qualitatively (Lackéus, Lundqvist, & Middleton, 2015). Urbano and Guerrero (2013) define the entrepreneurial university's provision of human, social, knowledge and entrepreneurship capital as the determinants of its socioeconomic impact. The university's staff and graduates embody all these types of capital. Thus, human resources are crucial for the entrepreneurial university. The impact itself takes the form of 'productivity gains', 'competitive advantage', and 'regional dynamics, networks and identity' (Urbano & Guerrero, 2013, p. 43). However, research impact measurement is presently very much debated⁷, suggesting that research impact is not limited to 'productivity gains' and 'competitive advantage'. The traditional research impact measurement through 'citations and visibility of knowledge' is being revised to be more comprehensive and

⁷ See, for instance, the work conducted by the ENRESSH project: "Societal impact and relevance of the SSH research". <https://enressh.eu/working-group-2/objectives/>

more reliable as well: the implementation of the Research Excellence Framework⁸ in the UK is an example of such a change.

Many papers and policy advice have been written on how to develop into an entrepreneurial university (Bikse, Lusena-Ezera, Rivza, & Volkova, 2016; Clark, 1998; Fernández-Nogueira, Arruti, Markuerkiaga, & Sáenz, 2018; Jacob, Lundqvist, & Hellsmark, 2003). The entrepreneurial university's positive socioeconomic impact seems to be taken-for-granted as in general, a positive economic impact (observed in spin-off creation or successful UI collaboration in particular) is expected to trigger positive societal impact later on (Klofsten et al., 2019). Thus, often, the emphasis is made on having an economic impact before all, although increasing attention has been brought to societal impact as well, with broader understandings of what the entrepreneurial university is (Centobelli, Cerchione, Esposito, & Shashi, 2019; Heinnovate, 2015). However, less has been written about how to make the entrepreneurial university evolve. Most studies of entrepreneurial universities consider this model as an end in itself: they are snapshots of cases, or studies about the transformation into entrepreneurial universities. However, by definition, the entrepreneurial university is dynamic, as it keeps on adapting to its ever-changing environment (Clark, 1998); more studies are needed to explore how entrepreneurial universities reinvent their own models or whether they evolve into other models of universities over time.

Thus, the model of the entrepreneurial university has not been entirely explored (Centobelli et al., 2019; Klofsten et al., 2019). Two main research gaps have been identified: on the one hand, regarding entrepreneurial universities' socioeconomic impact; on the other hand, regarding a possible evolution of the model of the entrepreneurial university. While the entrepreneurial university's impact is expected and taken-for-granted, research needs to explore how the entrepreneurial university exploits its own model or evolves towards another model in order to increase such an expected impact. Consequently, the first research question of this dissertation aims at contributing in filling these research gaps by exploring evolutions of entrepreneurial universities towards more regional socioeconomic impact:

<i>(RQ1) How does the entrepreneurial university increase its socioeconomic impact?</i>

Studying successful cases of entrepreneurial universities is helpful to explore the efforts to increase its regional socioeconomic impact, in different ways. Papers 1, 2 and 3 study the

⁸ For more information, see <https://www.ref.ac.uk/about/what-is-the-ref/>

successful cases of Linköping University and Stanford University and their respective ecosystems related to issues of diversification of activities, broader support to entrepreneurship, talent development and attraction, which all participate in increasing the entrepreneurial university's socioeconomic impact.

2.2. Doctorate holders' job mismatches

Literature on doctoral students and doctorate holders focus mainly on their individual trajectories and career preferences (Mangematin, 2000; Roach & Sauermann, 2017). They rarely discuss doctoral students in the context of the university model or strategy. Nevertheless, doctoral students are both providers of resources to the university (as researchers and teachers) and receivers of university's activities (as students). Thus, doctoral students are potentially an important resource to exploit in order to increase the entrepreneurial university's impact. Despite being a minor category of the university population in terms of number (the undergraduate population is much more important for example), doctoral students represent a large share of the university's research workforce (Enders, 2002). They also have a transversal position in the university, across teaching, research and research valorisation; and a lot of them work at the interface of university-industry relations (Thune, 2009).

There has been increasing attention given to the relevance of doctoral education (Nyquist, 2010; Thune et al., 2012). Usually, recommendations are formulated towards universities to better adapt their curriculum, in order to prepare doctoral students to a possible career outside academia (LERU, 2016, 2018). However, literature on doctorate holders' integration to the labour market mainly deal with unemployment issues, i.e. quantitative aspects of employment (Andalib et al., 2018; Calmand, Prieur, & Wolber, 2017; Larson et al., 2014). Studies rarely focus on the quality of employment of doctorate holders, i.e. if the obtained positions fit their profiles and expectations, or if doctorate holders experience job mismatches (Di Paolo & Mañé, 2016). This kind of literature is instead more focused on the population of university graduates at master's level (Allen & van der Velden, 2001; Corcoran & Faggian, 2017). The employability of university graduates is a priority for the entrepreneurial university (Culkin & Mallick, 2011), as well as the retention of graduates within the region (Corcoran & Faggian, 2017).

Therefore, there are two more knowledge gaps: on the one hand, about the quality of doctorate holders' employment, or more specifically the experience of job mismatches by doctorate holders; on the other hand, about the population of doctoral students and doctorate holders as

significant actors in the entrepreneurial university. The second research question aims at linking these two gaps by exploring the population of doctorate holders in relation to the entrepreneurial university's model and impact, in particular through the qualitative aspects of their employment:

(RQ2) Why and how is doctorate holders' employability key in the entrepreneurial university's impact?

Studying the case of a region economically and academically very active in the EU, enables us to get a better understanding of the integration of doctorate holders in a regional labour market, showing that the employability of doctorate holders is a crucial issue for the entrepreneurial university. This is done in Papers 4 and 5.

2.3. Mechanisms and commitment to enhance doctorate holders' employability

The main attempts to enhance the employability have been to start a necessary reform of doctoral education (Nyquist, 2010). The general trend is a standardisation of doctoral education (Djelic, 2008), with the harmonisation of content and form of courses, as well as requirements to get the doctoral degree. For example, a strong emphasis has been made on generic skills, to enhance the employability of doctorate holders outside academia (Kyvik & Olsen, 2012; LERU, 2016; Sinche et al., 2017; Vitae, 2010). Programs providing opportunities of mobility to doctoral students have also been implemented in many places (Albouy & Martinet, 2017; Metcalfe, 2006; Neumann & Tan, 2011; Wallgren & Dahlgren, 2007): industrial doctoral programs such as in the UK, in Scandinavia or in France (thèses CIFRE: see figure 1). However, what stands out is that these efforts are mainly initiated and implemented by universities, often with the support of national authorities. Too little has been published about regional specificities. The efficiency of one-size-fits-all policies on doctoral education has not been assessed. In addition, initiatives may rise from other types of stakeholders, such as doctoral students and doctorate holders themselves: that has not been much covered in the literature (Nyquist, 2010).

Eventually, there are many beneficiaries of the enhancement of doctorate holders' employability, beyond the entrepreneurial university: in particular doctorate holders, employers and regions. As evoked earlier the most discussed initiatives are those from universities and

national government. However, one might wonder about the issue of whose responsibility it is to actually get involved and concretely act for a change. If it is a shared responsibility, then the question of how to share it has to be posed. Other stakeholders are also involved in doctoral education and the employment of doctorate holders (Nyquist, 2010). Entrepreneurial universities are embedded in regional ecosystems with various stakeholders (Rice, Feters, & Greene, 2010). Each stakeholder has its own position (or role) in the ecosystem, its own ambition, its own limitations, its own actions that influence and are influenced by those of other stakeholders (Nyquist, 2010). Among them, regional governmental agencies, which observe the labour market and its quality and ensure the implementation of national or regional policies (e.g. Mälardalsrådet (2018)); employers, who hire university graduates (e.g. Guardia (2017)); and doctorate holders, who are actually the first to be affected, can be mentioned (Mangematin, 2000).

The third research question thus considers the surrounding environment of the entrepreneurial university, to address this knowledge gap about the commitment of regional stakeholders in enhancing doctorate holders' employability, and consequently the entrepreneurial university's socioeconomic impact:

<p><i>(RQ3) What roles can regional stakeholders play in increasing doctorate holders' employability?</i></p>

Studying interactions between universities and the local employers and cases of doctorate holders' employment outside academia enables to highlight initiatives that can complement the entrepreneurial university's actions for socioeconomic impact, through the enhancement of its doctoral students' employability. This is done in Papers 3, 4 and 5.

CIFRE: An example of doctoral education aimed at enhancing the employability of doctorate holders

The following example is translated and adapted from ANRT (2019). In the early 1980s, in reaction to the gap existing between academia and the private sector, the French Ministry of Research and Technology (today Ministry of Higher Education, Research and Innovation) implemented a new form of doctoral programme called CIFRE (Conventions Industrielles de Formation par la Recherche: Industrial research training agreements). Nowadays this programme is coordinated by a governmental agency called ANRT (Association Nationale Recherche Technologie: National Association for Research and Technology). The principle consists in a company hiring a doctoral student to conduct research on a project that is considered as strategic for its socio-economic development. A minimal threshold for the salary is set by law as well as the employment contract status. The doctoral student has to be enrolled at a research laboratory, that supervises his/her research; and has to spend 100% of his/her working time to the research project, academic and professional training. The company and the research laboratory sign an agreement on the research of the doctoral student, for example on methodology, work conditions or intellectual property. The governmental agency (ANRT) provides subsidies to compensate for the costs for the company to hire a doctoral student, and part of those are exempt of taxes.

CIFRE cover all disciplines (cf. Figure 1) and have so far been quite successful: in 2016, the completion rate was of 98%. More than 85% of doctorate holders having used a CIFRE were employed at that time, and they tended to have higher salaries than the rest of the doctoral population (ANRT, 2016).

CIFRE present recognized advantages, such as the role of intermediary played by the doctoral student between industry and academia (Levy, 2005); and drawbacks, such as a potential lock-in effect (Mangematin, Mandran, & Crozet, 2000). CIFRE are very particular doctoral programmes and are not the norm in doctoral education, neither in France (they represent only 10% of funded doctoral studies (Campus France, 2019)) nor elsewhere; however, they are of particular interest for this dissertation. Indeed, they are actually an outside-in initiative: they started from the public sector to bring academia and industry closer.

Figure 1. Proportion of scientific disciplines of accepted Cifre in 2017. Translated by the author, from ANRT (2018, p. 6).

3. Introduction to key concepts

The following concepts are key to the dissertation as they are used in the title of the dissertation and in the research questions. They are introduced in this section, but are further developed in Chapter 2.

3.1. The entrepreneurial university

The term “universities” is used in the dissertation to name higher education institutions that are designated by governments to grant doctoral degrees. The term can generically designate types of higher education institutions other than universities as well, for instance engineering schools or business schools, as long as these institutions provide doctoral education.

Criticized to be isolated in their “ivory tower” (Mowery, Nelson, Sampat, & Ziedonis, 2015), universities have been receiving increasing expectations from their various stakeholders: in particular, the addition to their two main roles – education and research – of a third one: to valorise their activities outside the borders of academia, through spreading or commercialization of research results for example (Fayolle & Redford, 2014). A consensus on the definition of this third mission is still hard to reach, and on how to implement this mission as well (Heinnowate, 2015); but the general idea implies the support of innovation and entrepreneurship for economic and social development. In particular, regional development is called for since universities are first and foremost anchored in a specific territory, even though this regional involvement can be debated depending on the features and strategic choices of the university considered (some universities can be more internationally than locally oriented). Many regional roles of universities have been conceptualized, such as the knowledge factory (Uyarra, 2010), the civic university (Goddard, Kempton, & Vallance, 2012), the entrepreneurial university (Gibb & Hannon, 2003) or the engaged university (Breznitz & Feldman, 2012).

Entrepreneurial universities have been a much-debated subject in the past decades (Klofsten et al., 2019). On the one hand, supporters claim that universities should be entrepreneurial so that they can take part in economic development in the knowledge-based economy (Urbano & Guerrero, 2013). On the other hand, detractors assess that universities should stay separate from economic stakes and power holders (Blumenthal, Causino, Campbell, & Louis, 1996; Toole & Czarnitzki, 2010), but instead should serve the public good, and beyond economic profits, as engaged or civic universities (Uyarra, 2010). Moreover, there is no real consensus on what an entrepreneurial university is and should be; mainly because each and every university is unique,

and so are the contexts in which they are respectively embedded (Clark, 2004; Guerrero, Cunningham, & Urbano, 2015). OECD's guiding framework to entrepreneurial universities lists no fewer than 13 definitions from the literature (OECD and European Commission, 2012). However, what mostly distinguishes an entrepreneurial university from other types of universities is its strategy and its efforts put into commercializing research results (Urbano & Guerrero, 2013; Uyarra, 2010) and into providing a favourable context for academic entrepreneurship initiatives (Heinnovate, 2015; Perkmann et al., 2013). Such an institutional support can take many forms, from entrepreneurship education (Bischoff, Volkmann, & Audretsch, 2018; Guenther & Wagner, 2008; Heinonen & Hytti, 2010) to coaching and physical support in incubators, through patent expert advice in TTOs (Technology Transfer Offices) (Fuster, Padilla-Meléndez, Lockett, & Del-Águila-Obra, 2019; Klofsten, Jones-Evans, & Schärberg, 1999). In addition, the university can provide a framework for more informal support, through networking and informal knowledge transfer for instance (Albats, Alexander, Cunningham, & Miller, 2018; Bischoff et al., 2018; Perkmann et al., 2013; Perkmann & Walsh, 2007).

Despite these debates, the model of the entrepreneurial university developed by Guerrero and Urbano (2013; 2014) is used as the main theoretical lens in this dissertation because this model no longer discusses universities as isolated organisations but discusses instead their roles in terms of regional development, as interacting and evolving organisations. Besides, some elements of this model, such as its impact and its doctoral workforce, still need further exploration. This model is also interesting to study because it is currently supported by policymakers within the European Union, although it has not entirely been theoretically and empirically covered yet: HEInnovate has been developing a self-assessment tool to encourage higher education institutions to develop towards this model (Heinnovate, 2019).

3.2. Doctoral education

The term “doctoral education” is also used, to label the education of a doctoral student towards the graduation and the doctoral degree, considering both the formal education in the form of courses or programmes but also the informal education in the form of networking or self-learning. Besides, the term “doctoral-level of skills” describes the skills that are acquired during the time of doctoral studies and the skills that are expected to be mastered at graduation. These skills are both those dealing with the scientific expertise of the doctoral student and transversal

skills, that can be applied in different contexts and not specifically to the topic of the doctoral studies, such as communication skills.

For entrepreneurial universities, doctoral education might be of prime importance to take part in regional development, through the improvement of the quality of employment for highly-educated workers in the regions for example. Indeed, doctoral education is a key mission for universities among their numerous activities. Doctoral students represent a large and crucial share of a university workforce (Enders, 2002). They take part in all missions of the university – higher education, research and the third mission. They are in many cases at the interface of university-industry collaboration (Bienkowska & Klofsten, 2012; Thune, 2009) and are potential entrepreneurs (Bienkowska, Klofsten, & Rasmussen, 2016). The example of the AgoraLink program in Sweden (Bienkowska & Klofsten, 2012) shows the importance of university-industry collaboration to enhance the employability of doctoral students, but also for research opportunities for the university. To survive, universities need to train doctoral students, because they represent the future of the university, regarding both education and research. Universities which can deliver doctoral degrees thus need to attract and retain doctoral graduates.

This dissertation explores the issue of the employability of doctorate holders through the theoretical lens of the entrepreneurial university, thus participating in the body of knowledge of organization and regional studies. Research question 1 calls for an organizational unit of analysis; research question 2 for an individual unit of analysis; and research question 3 for a combination of both. For what regards individuals, it should be reminded that the population of doctoral students and graduates is very heterogenous, not only between nations (Djelic, 2008) but also between faculties and disciplines (Bienkowska & Klofsten, 2012). For example, distinctions are often made between Social Science and Humanities disciplines (SSH) and Science, Technology, Engineering and Mathematics disciplines (STEM). Such distinction can deal with epistemology (Ingthorsson, 2013) but also with relations towards the society outside academia: for example, STEM researchers will tend to interact more with industry than SSH researchers, and SSH researchers will tend to interact more with public organisations (Bienkowska & Klofsten, 2012).

3.3. Regional socioeconomic impact

The region is defined in this dissertation as the administrative region within a nation-state corresponding to the NUTS2⁹ level of classification of the European Commission (Eurostat, 2018), i.e. administrative units with a total population of 800,000 to 3,000,000 inhabitants. In the dissertation, the use of the term “socioeconomic impact” implies the regional dimension of the impact. Besides, this impact is considered as positive by default.

The model of the entrepreneurial university developed by Guerrero and Urbano (2014) define the regional socioeconomic impact of the entrepreneurial university as determined by human, social, knowledge and entrepreneurship capital. The impact itself can take many forms (workforce, creation of companies, etc.), but the most discussed and observable impact is what directly comes out of the university, in other words the provision of human and social capital to the region.

Human and social capital

Human capital is defined by the OECD as: “the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being” (OECD, 2007, p. 29). The “accumulation of human capital is one of the main sources of economic growth and development” (Maldonado, 2017, p. 173), as in entrepreneurial ventures (De Cleyn, Braet, & Klofsten, 2015). As the dissertation focuses on higher education graduates and in particular doctorate holders, when used, the term “human capital” refers to this highly-educated workforce.

Social capital is defined by the OECD as: “networks together with shared norms, values and understandings that facilitate co-operation within or among groups” (OECD, 2007, p. 103). Social capital has been shown to be of prime importance for the coherence of the society (Granovetter, 1973) and for economic activity, in particular entrepreneurial ventures (Davidsson & Honig, 2003), and through different types of proximities, in particular the cognitive one (Boschma, 2005). As the dissertation focuses on higher education graduates and in particular doctorate holders, when used, the term “social capital” refers to personal networks

⁹ “NUTS” stands for Nomenclature of Territorial Units for Statistics. NUTS2 is the second of the three levels of the NUTS classification.

of individuals, in particular doctoral students and doctorate holders, encompassing both academic and industrial networks.

Regional stakeholders

Universities have an increasing number of stakeholders, in particular entrepreneurial universities because one of their characteristics is the diversification of their funding base (Clark, 1998). Regional stakeholders are those organizations or individuals who interact with the university, and are concerned with its activities and its impact (T. Clauss, Moussa, & Kesting, 2018). Nyquist (2010) lists stakeholders of the university involved in a way or another in doctoral education. If we narrow this list to regional actors, we can define regional stakeholders in this dissertation as: doctoral students and doctorate holders, regional non-academic employers, regional organizations of the public and the private sectors such as regional authorities or Science Parks.

3.4. Job mismatches and employability

In this dissertation, employment matching refers to the process of finding an alignment between the requirements of a job and its functions and the education and skills of the employee (OECD, 2016). Employment matching is important both for workers, in terms of salary and interest in employment; and for companies, nations and regions especially in the context of a knowledge-based economy, because it implies an optimal use of human capital: negative relations have been found between job mismatches and labour productivity (McGowan & Andrews, 2015; McGowan & Andrews, 2017; OECD, 2016). Employment match (or job match) is the successful result of employment matching. Employment mismatch (or job mismatch) is the unsuccessful result of employment matching, but nevertheless deals with employed population, since employment has been achieved. A job mismatch occurs when the employment situation of a worker is incoherent with the worker's profile. Different types of mismatches can be identified (Corcoran & Faggian, 2017). They can be observed at all levels of education, but are "more likely among (...) those with higher levels of educational attainment" (McGowan & Andrews, 2015, p. 8).

Employability is defined in this dissertation as: "the collection of worker characteristics, including attitudes towards work, expectations regarding employment and wages, and behaviours both in the labour market and on the job, that are increasingly seen as *determinants*

of employment chances” (Peck & Theodore, 2000, p. 731). An increased employability is considered as a solution to both unemployment and job mismatches.

4. Research questions and appended papers

Table 1 shows the links existing between the appended papers and the research questions formulated. Each appended paper was written with the objective to build an answer to one or several research questions.

Table 1. How publications help answering the research questions.

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5
RQ1 How does the entrepreneurial university increase its socioeconomic impact?	X	X	X		
RQ2 Why and how is doctorate holders’ employability key in the entrepreneurial university’s impact?				X	X
RQ3 What roles can regional stakeholders play in increasing doctorate holders’ employability?			X	X	X

Paper 1. Germain-Alamartine, E. (accepted) Transitioning from an economic to a broader social impact: the case of a Swedish university. (accepted for publication in forthcoming Springer book)

Paper 2. Etzkowitz, H., Germain-Alamartine, E., Keel, J., Kumar, C., Smith, K. N., Albats, E. (2019) Entrepreneurial university dynamics: Structured ambivalence, relative deprivation and institution-formation in the Stanford innovation system. *Technological Forecasting and Social Change*, 141, 159-171.

Paper 3. Cadorin, E., Germain-Alamartine, E., Bienkowska, D., & Klofsten, M. (2019). Universities and Science Parks: Engagements and Interactions in Developing and Attracting Talent. In *Developing Engaged and Entrepreneurial Universities* (pp. 151-169). Springer, Singapore.

Paper 4. Germain-Alamartine, E. (2019) Doctoral education and employment in the regions: the case of Catalonia. *Regional Studies Regional Science*, 6(1), 299-318.

Paper 5. Germain-Alamartine E. & Moghadam-Saman S. (2020) Aligning doctoral education with local industrial employers’ needs: a comparative case study. *European Planning Studies*, 28(2), 234-254.

The first research question (RQ1) aims at exploring how the entrepreneurial university can increase its socioeconomic impact. Paper 1 provides insights to answer RQ1 by exploring the case of Linköping University as a successful entrepreneurial university transitioning towards the model of the engaged university for a broader social impact. Paper 2 explores how even the most successful entrepreneurial university (Stanford University) deals with its challenges, in this case an innovation gap. Initiatives from internal stakeholders aimed at solving this issue have been developed and are analysed in this paper, emphasizing the dynamic characteristics of the entrepreneurial university. Finally, Paper 3 shows how the entrepreneurial university interacts with its environment to attract and develop talent to the region, thus increasing more or less directly its regional socioeconomic impact. This broader engagement with regional stakeholders highlights close collaborations that enable a constant evolution of the entrepreneurial university towards more socioeconomic impact.

The second research question (RQ2) aims at determining why and how doctorate holders' employability is key in the entrepreneurial university's socioeconomic impact. Paper 4 explores a database on the integration of doctorate holders in the non-academic labour market in Catalonia. It highlights a significant rate of doctorate holders retained in the region but also experiencing job mismatches, showing a sub-optimal use of human capital provided by the university in the region, which hinders its socioeconomic impact. Paper 5, exploring two cases of university – Science Park relations and the alignment of doctoral education to the needs of non-academic employers, provides additional qualitative insights into the mismatches observed in paper 4. Combining paper 4 and paper 5 suggests the entrepreneurial university's environment could be more and better used during doctoral education in order to improve doctorate holders' employability, which could in turn increase the university's socioeconomic impact by reducing the observed job mismatches.

Finally, the third research question (RQ3) aims at identifying the roles that regional stakeholders can play to complement the entrepreneurial university's activities in enhancing the employability of its doctorate holders. Papers 4 and 5 identify doctorate holders and employers as the actors having first-hand opportunities of action to reduce job mismatches. Papers 3 and 5 also introduce Science Parks as interesting partners in this issue, playing an indirect but facilitating role for the entrepreneurial university, doctorate holders and non-academic employers to meet and act.

Compiling the results of all the appended papers and personal experiences during doctoral studies enables to suggest implications and recommendations to universities, regional stakeholders and doctoral students to enhance their regional employability. This is done in Chapter 5 of this dissertation.

5. Dissertation overview

Following the introduction, the theoretical framework for the thesis will be developed in chapter 2. In chapter 3, the methodology adopted to conduct the research will be described and justified, and the participation in the writing of publications will be detailed. In chapter 4, major findings of the research project will be highlighted and discussed. Chapter 5 concludes the thesis by synthesizing it and discussing the limits and suggestions for future research. Finally, a bibliography is available at the end of the dissertation and publications in their most recent version in Part II.

CHAPTER 2. Frame of reference

This chapter presents the frame of reference for the dissertation. It starts with a brief history of higher education institutions in Europe, which leads to the different conceptual models of universities and an introduction to the model of the entrepreneurial university. Characteristics, challenges and impact of the entrepreneurial university are then discussed, giving way to the issues of doctorate holders' employment, job mismatches and employability.

1. The entrepreneurial university

1.1. Models of universities

a. An overview of European higher education institutions' history

To better grasp why the entrepreneurial university is a model of university much discussed and debated in theory as well as used in policy nowadays, it seems relevant to turn to history and get an understanding of the creation and evolution of universities over the centuries. The purpose of this overview is also to remind that although models of universities are discussed in this dissertation, and in particular the model of the entrepreneurial university, one should not forget that each university is unique because of the different conditions of its creation, and thus might react differently to its environment, in particular to policies.

Since the very beginning of their existence, universities have differed a lot in terms of organization and subjects of study. The first universities in Northern Europe (Paris, Oxford and Montpellier), created as early as in the 11th century, resulted from the gathering of schools, or bodies of teachers mainly studying theology, and were strongly influenced by the Church (Charle & Verger, 2012). In Southern Europe (Bologna), universities were in fact formed by nations of students (students grouped in function of their region of origin), mainly studying law (the rector was a student also) (Charle & Verger, 2012; Strassel, 2018). Nevertheless, in both cases, universities were associations, formalized by charts and other norms and codes, such as the election of rectors (Charle & Verger, 2012). Later on, in the 18th and 19th centuries, three main university models exist in Europe: the German, French and Anglo-Saxon models (Sam & van der Sijde, 2014) (see Appendix 1). The German (or Humboldtian) model, with a strong emphasis on research, is the dominant for three main reasons: the increasing importance given to education by administration and political classes, the non-selective system (in comparison to

France and part of Britain) and the relatively low cost of life in Germany at that time (Charle & Verger, 2012; Strassel, 2018). In France, the system is almost entirely rebuilt after the Revolution by Napoleon, to become mainly vocational; it was also spread in Italy (Strassel, 2018), through the implementation of *grandes écoles* such as Scuola Normale de Pisa for instance. In Great Britain, English universities are highly selective while Scottish universities are far more democratic (Charle & Verger, 2012). In the rest of Europe, e.g. Scandinavia, universities' evolution is slow, because of the still slow industrial development and high emigration rate: the few universities remain traditional, but a need for vocational education emerges, witness the creation of a *högskola* in Stockholm (Charle & Verger, 2012).

Despite their differences, higher education institutions have increasingly faced similar challenges, such as the massification of education after the world wars (Strassel, 2018). As the number of students rise dramatically, universities gradually see themselves placed at the heart of political and social stakes as well as social movements (cf. May-68 events), and at the crossroads of conflicts of interest between their states, their nations, their students, the demand of companies and the broader economy (Charle & Verger, 2012). Higher education institutions have received new expectations from varied stakeholders (Benneworth & Jongbloed, 2010). Thus, universities newly created in the 1960s and 1970s in a radically changing social context, such as two of the universities used as cases in the dissertation (Linköping University, Autonomous University of Barcelona), are very different in many regards from those created much earlier such as the University of Uppsala for instance, because they have put from their very beginnings a special emphasis on a certain openness towards the society (Svensson, Klofsten, & Etzkowitz, 2012).

b. Different models of universities

Each university remains unique because of its history, its settings and its environment: universities are

“social spaces that we cannot assimilate to a market like others nor a mere administration, nor a real company, nor merely to a public pedagogic space or a finalised research organism, less even to a pacified cultural location to live and meet. Actually, higher education is all of that at the same time, in varied degrees and according to different combinations in function of countries, regions, cities, disciplinary fields, but also strategies of the institutions” (translated by the author, from Charle and Verger (2012, p. 277–78)).

However, this brief overview of the history of universities in Europe since the Middle Age enables us to better grasp the different models of universities that can be found in the literature. It actually highlights the diversity shifting from national specificities to organisational differentiations. Several classifications can be found in the literature, depending on the focus: for example, the organization (Pinheiro & Stensaker, 2014), the missions (Sam & van der Sijde, 2014) or the impact of the university (Uyarra, 2010). The type of funding (public or private) of higher education institutions will not be discussed explicitly for all models, but it has an influence on the activities of a university and its freedom to operate (Benneworth & Jongbloed, 2010; Bikse et al., 2016; Bridger & Alter, 2006; Thomas Clauss, Kesting, & Moussa, 2018; Whitmer et al., 2010). Different funders might have different expectations: tax-payers might want more societal impact than industry, which might want economic impact instead (Bridger & Alter, 2006; Thomas Clauss et al., 2018).

Sam and van der Sijde (2014) compare the Humboldtian (i.e. German), the Napoleonic (i.e. French), the Anglo-Saxon and the Anglo-American models from an educational perspective (see Appendix 1). The authors argue that even before the academic revolutions (Etzkowitz, 2003), which added research and later socio-economic impact in universities' main missions, this socio-economic impact was already present in different ways in the discussed models. Elements of the model of the entrepreneurial university can actually be considered as originating from these different national models. In the entrepreneurial university, knowledge exchange and collaboration are of prime importance, in particular with industry, but also with the civil society (cf. the model of the Quadruple Helix (Carayannis & Campbell, 2009)). This can be linked to the characteristic of the German model in which research is closely linked to engagement with the society. In the French model, vocational education is enhanced, which can be linked to the emphasis of entrepreneurial universities on involving practitioners in education, through teaching in classes or internship and apprenticeship programmes for example. In the Anglo-Saxon model, the emphasis on generic skills and life-long learning make university graduates equipped to adapt to the changing needs of the labour market: this is in line with the particular ability to adapt to its changing environment being a distinctive feature of the entrepreneurial university (Clark, 1998).

Uyarra (2010) synthesizes the main conceptualizations of university models in the literature, considering their three missions of research, teaching and socioeconomic impact. She comes up with five models, differing mainly in terms of relation to the world outside academia – industry and the wider society (see Appendix 2). The main models discussed nowadays are the

entrepreneurial and the engaged models (Sánchez-Barrioluengo & Benneworth, 2019). Literature on the entrepreneurial university has been focusing more on the economic impact of the university (Uyarra, 2010), while literature on the engaged university insisted more on the societal impact that adds up to or results from the economic impact (Breznitz & Feldman, 2012). However, boundaries between these two models can be quite blurry (Heinnovate, 2015); a compromise between the two can be the one of the “university as a social entrepreneur” (Henricson, Faxheden, Williams-Middleton, & Lundqvist, 2009, p. 1). The following section will discuss the model of the entrepreneurial university, chosen as focus in this dissertation.

c. What is the entrepreneurial university?

Figure 2. An analytical model of the entrepreneurial university in its region. Source: author, inspired from Guerrero, Urbano, and Salamzadeh’s Figure 7.1 (2014, p. 165) and Centobelli et al.’s Figure 3 (2019, p. 181).

The discussion that follows on the entrepreneurial university is based on the analytical model depicted in Figure 2, created by the author but based on the analytical models of Guerrero, Urbano, and Salamzadeh’s Figure 7.1 (2014, p. 165) and Centobelli et al.’s Figure 3 (2019, p. 181). This model was built by combining elements from these two models, in order to present a model coherent with this literature review, especially in terms of concepts and vocabulary. The overall structure and relations between the boxes, as well as socio-economic impacts, come

from Guerrero et al (2014). Missions / activities were slightly modified: for simplification, only the three main missions were kept, and “valorisation of research” is used instead of “entrepreneurial activities” because it corresponds better to the chosen definition of ‘third mission’ (Caggiano, Bellezza, & Piccione, 2017). Internal factors used are from Centobelli et al. (2019) because they correspond to Clark’s theory (1998), and seem to be the most exhaustive. External factors are also from Centobelli et al. (2019) because they holistically present the influences the university gets from its environment, on the contrary to Guerrero et al.’s (2014) “environmental factors” which seem to deal with the university as an environment instead, and as such are closer to internal factors; which is also why the box of external factors is placed partially inside and partially outside the region. The place and roles played by PhDs in the entrepreneurial university is also highlighted in this model, between the university’s activities and its types of impact.

There are many definitions of the entrepreneurial university, because each and every university is unique, and so are the contexts in which they are respectively embedded (Clark, 2004; Guerrero, Urbano, Cunningham, & Organ, 2014), and because of the multiple theoretical approaches highlighted by Centobelli et al. (2019). 13 definitions from the literature are listed in HEInnovate’s guiding framework for the entrepreneurial university (OECD and European Commission, 2012); they are more or less wide in terms of scope. The theoretical approach of the model of development of the entrepreneurial university developed by Guerrero and Urbano mainly (2012; 2013; 2014) is chosen for the discussion, as it deals with developing the model within a regional setting, and holistically (at all levels of the institutions, and in varied ways, beyond the mere technology transfer). The definition of the entrepreneurial university will be suggested by discussing its missions and activities, its internal and external factors, as well as its socioeconomic impact in the region (see Figure 2).

To begin with, the entrepreneurial university is before all a university, which means that its main missions are education and research for the large majority of them. But what has come in addition to these two missions is the so-called ‘Third Mission’ (Pinheiro & Stensaker, 2014), mainly defined as the valorisation of research results outside academia (Caggiano et al., 2017), for the economy and the society. What characterizes the entrepreneurial university is the spreading of an entrepreneurial culture into these three missions (D’Este & Patel, 2007; Klofsten & Jones-Evans, 2000; Laine, van der Sijde, Lähdeniemi, & Tarkkanen, 2008; Perkmann & Walsh, 2007): entrepreneurship education (Bischoff et al., 2018; Guenther & Wagner, 2008; Heinonen & Hytti, 2010; van der Sijde & Ridder, 2008), spin-off creation

(Albats et al., 2018; Harrison & Leitch, 2010), support to faculty and student entrepreneurship through incubators and TTOs (Fuster et al., 2019; Klofsten et al., 1999). This can also take the form of synergies, formal or informal, between the three missions (OECD and European Commission, 2012): for example, involving students in research projects, industrial professionals in teaching, or conducting multi-sectoral collaborative projects (Dooley & Kirk, 2007).

1.2. Characteristics and challenges of the entrepreneurial university

a. External factors: Why developing into an entrepreneurial university?

The majority of studies on the entrepreneurial university highlight commercialization of research and technology transfer as the main reasons why traditional universities should develop as entrepreneurial universities: to create economic value and jobs (Bikse et al., 2016; Fernández-Nogueira et al., 2018). However, this gives only a partial picture of why the model of the entrepreneurial university is supported nowadays.

Clark (1998) identified the entrepreneurial university as “the solution to the problems facing contemporary higher education systems” (Pinheiro & Stensaker, 2014, p. 497), because of its ability to react to the imbalance (Clark, 1998) resulting from increasing expectations of the traditional stakeholders (funders, students, faculty) – whose number and variety increase as the university turns entrepreneurial – and its inner capabilities (Benneworth & Jongbloed, 2010; Leih & Teece, 2016), and from an increasingly complex and uncertain environment (Gibb & Haskins, 2014; Meissner, Erdil, & Chataway, 2018). In the knowledge-based economy, universities play a key role (Audretsch, 2014; Klofsten et al., 2019; Peterka, 2011): they need to provide relevant educated workforce but also knowledge and innovation for the economy and the society (Urbano & Guerrero, 2013); thus the importance of knowledge and technology transfer in studies of entrepreneurial universities (O’Shea, Allen, Morse, O’Gorman, & Roche, 2007). However, the knowledge-based economy has been developing along with the massification of education, globalization and digitalization (Charle & Verger, 2012). These major trends make universities face dilemmas and make them find it often difficult to prioritize between competing on the global and national education markets, competing for research funding, and having a regional impact (Gibb, Haskins, & Robertson, 2013). The characteristics of the entrepreneurial university, presented later on, make it complex but more flexible and more adaptable to change, thanks to, for example, its diversified funding base and its openness towards industry and society (Clark, 1998).

The university – and especially the entrepreneurial university – is not an isolated organization in the economic and societal landscape: it is rooted in a region, a nation and some also have a place on the global stage (Charle & Verger, 2012). Thus, universities are set in different institutional settings (formal and informal) that influence them (Salamzadeh, Farsi, Motavaseli, Markovic, & Kesim, 2015). They interact with different organisations; whose types differ depending on the chosen definition of the entrepreneurial university. Narrow definitions focusing merely on knowledge transfer consider that the entrepreneurial university interacts with large manufacturing firms and spin-offs only (Uyarra, 2010). However, in this dissertation, the entrepreneurial university is considered as having many more types of stakeholders, even within its region: in particular, the public sector and the civil society. Indeed, formal institutions such as European, national or regional policies in higher education, innovation and entrepreneurship are of prime importance for universities: witness for instance the Bayh-Dole Act in the U.S. (Atkinson & Pelfrey, 2010), which allowed publicly-funded organizations to patent research results, thus changing the rules of the games in terms of innovation and commercialization of research results (Mowery et al., 2015). Informal institutions such as informal knowledge transfer are also important (Abreu & Grinevich, 2013; Albats et al., 2018) as they can for example set the stage for more formal relations. At the local scale, informal and formal institutions favourable to the development of an entrepreneurial university can take the form of an entrepreneurial ecosystem (Bischoff et al., 2018), characterized by an integration with industry conditions, networks and strategic alliances, and interactions with the civil society and the media (Centobelli et al., 2019). For instance, industry conditions can be the rhythm of the market, which has a strong influence on the entrepreneurial university: to commercialize research results, the university has to keep up with the pace of the market (Unger & Polt, 2017).

b. Internal factors: How to develop towards an entrepreneurial university?

Universities are actually institutions themselves and can adapt their internal institutional setting to strategically develop towards an entrepreneurial university (Kirby, 2006). External factors just discussed as being formal and informal institutions are thus also valid as internal factors in the case of universities: governance structures are key for a more flexible organization, with less bureaucracy (Guerrero, Urbano, & Salamzadeh, 2014) and a better ability to interact with other stakeholders of the entrepreneurial ecosystem (McClure, 2016). A favourable attitude towards entrepreneurship can be enhanced for instance through role models and rewards, and the development of education programmes and institutional support to entrepreneurship within

the university (Albats et al., 2018; Guerrero, Urbano, & Salamzadeh, 2014; McClure, 2016; van der Sijde & Ridder, 2008).

Centobelli et al. (2019) introduce several classifications of the literature on entrepreneurial universities in their exhaustive literature review. Their table 4 (pp. 179-180) highlights eight theoretical approaches to the concept of entrepreneurial university, with groups of researchers focusing on different objects of investigation, namely internal and external factors of entrepreneurial universities. Although using different terms and differing slightly in scope, almost all approaches cover Clark's (1998) five organizational pathways, which can be summarized as follows:

- A “strengthened steering core” (p. 5): a top-down approach to entrepreneurial orientation of the university, with university management setting strategic goals along this line, in complement to a “stimulated academic heartland”.
- An “expanded developmental periphery” (p. 6): the development of varied types of collaborations with varied stakeholders.
- A “diversified funding base” (p. 6): getting funding not only from the government, but also from research councils, industry, students.
- A “stimulated academic heartland” (p. 7): a bottom-up approach complementing the “strengthened steering core”, with university faculty and staff sticking to the strategic orientation towards the entrepreneurial model.
- An “integrated entrepreneurial culture” (p. 7): the spreading of a positive mindset towards entrepreneurship in a broad sense, at all levels of the university (including administration and students), with the corresponding institutional support.

For some internal factors, the boundary with the entrepreneurial university's activities can be quite blurred: i.e. in the case of entrepreneurship teaching programmes, which are concrete activities but which support the development of an entrepreneurial mindset and institutional support to entrepreneurship (Klofsten & Jones-Evans, 2013). HEInnovate dimensions are also quite close to Clark's model, complementing it with maybe more recent concerns of the scientific community and policymakers: digitalisation (Bouncken, 2018) and impact measurement (Guerrero et al., 2015; Klofsten et al., 2019).

c. Challenges

All the above-discussed factors can potentially challenge universities to develop entrepreneurially, depending on their context and history: there is no recipe to do so (Heinnovate, 2015). HEInnovate conducts country reviews to identify good practices and challenges in the development of entrepreneurial universities in different national educational systems, and to suggest recommendations to policymakers (i.e. governments) as well as higher education institutions. One can see that the challenges differ depending on the contexts. For example, in the Netherlands, some challenges are on raising awareness of entrepreneurship earlier and more broadly in the education process, and on increasing the participation of students in research valorisation activities (OECD/EU, 2018). However, the efforts in measuring the impact of entrepreneurship and innovation in higher education in the Netherlands are often cited as a good practice; while they are, on the contrary, a challenge identified in the case of Ireland (OECD/EU, 2017), along with developing entrepreneurship education in all disciplines.

A recent special issue in *Technological Forecasting and Social Change* aimed at identifying strategic challenges for entrepreneurial universities (Klofsten et al., 2019). Authors discuss the different meaning and interpretations of entrepreneurship depending on the cultural, organizational and cognitive contexts, making it difficult to find a consensus to start orienting towards an entrepreneurial model (Klofsten et al., 2019). Most of the time, entrepreneurship is interpreted as technology commercialization in the university context (Meissner et al., 2018). Barriers exist to the development of entrepreneurship that have to be overcome (Kirby, 2006), for instance academic tensions (Ahmad, Abdul Halim, & Ramayah, 2016), in order to institutionalise support to entrepreneurship (Reyes, 2016). Thus, leadership is key to efficiently manage the time, trust and engagement of varied stakeholders (Klofsten et al., 2019), and to spread a “broader thinking” about entrepreneurship and a revised paradigm of the entrepreneurial university (Meissner et al., 2018, p. 53). Besides, during the transition, Centobelli et al. (2019) highlights the necessity for the university to develop a so-called ‘ambidexterity’, to be able to manage and use external and internal factors differently and iteratively during the exploration or exploitation phases of knowledge production. Finally, once the transition is done, a main challenge remain: measuring impact of the university on the economy and society (Klofsten et al., 2019; Meissner et al., 2018; Sánchez-Barrioluengo & Benneworth, 2019).

1.3. Regional socio-economic impact

Even though impact measurement has just been discussed as challenging for universities in general – and entrepreneurial universities in particular, to show the relevance of the model – some authors have argued that entrepreneurial universities are driving forces for economic and social development (Etzkowitz & Klofsten, 2005; Klofsten et al., 2019; Svensson et al., 2012). Indeed, “a thriving knowledge economy depends upon its universities in three critical dimensions: the application and exploitation of research capability; the enterprise and entrepreneurial culture that is developed amongst its students; and the applicability of the knowledge and skills of all its graduates” (Wilson, 2012, p. 13). Wilson’s assertion is in line with Urbano and Guerrero’s (2013) conceptualization of the determinants for entrepreneurial universities’ socioeconomic impact, in terms of human, social, knowledge and entrepreneurship capital (see Figure 3).

Activities	Inputs	Outcomes	Socioeconomic impacts	
			Determinants	Impacts
Teaching	<ul style="list-style-type: none"> • Support measures (entrepreneurship education) • Attitudes toward entrepreneurship • Resources (human, physical, and financial) 	<ul style="list-style-type: none"> • Job seekers • Potential entrepreneurs 	<ul style="list-style-type: none"> • Human capital 	<ul style="list-style-type: none"> • <i>Productivity gains</i> • Mobility (attraction of foreign students and exchange of locals) • Employment (labor insertion)
Research	<ul style="list-style-type: none"> • Support measures (knowledge and technology transfer) • Attitudes toward entrepreneurship • University reward system • Resources (human, physical, and financial) • Capabilities (alliances and networks, status and prestige) 	<ul style="list-style-type: none"> • Research talent • Academic entrepreneurs • Knowledge generation (scientific papers) • Knowledge transfer (patents, licenses, contracts) 	<ul style="list-style-type: none"> • Human capital • Knowledge capital • Social capital 	<ul style="list-style-type: none"> • <i>Productivity gains and Competitive advantage</i> • Mobility (attraction of foreign researchers and exchange of locals) • Citations and visibility of knowledge • Spillover effects with the local industries and economic agents
Entrepreneurial	<ul style="list-style-type: none"> • Organizational structure • Governance structure • Support measures (start-ups) • Role models • Resources (human, physical, and financial) • Capabilities (alliances and networks, status and prestige) 	<ul style="list-style-type: none"> • Entrepreneurial university culture • Intrapreneurs at all university levels 	<ul style="list-style-type: none"> • Entrepreneurship capital • Social capital 	<ul style="list-style-type: none"> • <i>Regional dynamics, networks, identity</i> • Attract inversion • Increase the number of enterprises • GDP • Social benefits

Figure 3. Socioeconomic impacts of entrepreneurial university and academic entrepreneurship. Source: Urbano & Guerrero (2013, p. 43).

As discussed previously, entrepreneurial universities differ in configuration and contextual settings; thus, entrepreneurial universities might have different roles and impacts in their respective environments (Uyarra, 2010). Audretsch, Lehmann, and Warning (2005) found a positive relation between the choice of firms to locate and the presence of a university. Lester (2005) highlights the access to human capital, knowledge capital, and financial resources

universities can attract. However, although the socioeconomic impact of entrepreneurial universities is presented as quite varied (Urbano & Guerrero, 2013), human and social capital remain the most often discussed in the literature in relation to socioeconomic impact (Culkin & Mallick, 2011; Davidsson & Honig, 2003; Isenberg, 2010; Klofsten et al., 2019).

Human capital is a priority for the entrepreneurial university, as it has to provide “ready-to-work” graduates to the labour market (Culkin & Mallick, 2011, p. 347), in particular its entrepreneurial ecosystem (Isenberg, 2010), making it necessary to adapt its education to the changing requirements of employers (Meissner et al., 2018). The provision of human capital is obviously done through education, as in each and every university; but in the case of entrepreneurial universities, it is done through entrepreneurship education (Martin, McNally, & Kay, 2013; van der Sijde & Ridder, 2008) and synergies between education, research and collaboration with stakeholders outside academia through for instance geographical and/or inter-sectoral mobility (Urbano & Guerrero, 2013).

Social capital is closely linked to human capital: it is a social construct consisting of networks, shared norms and a cognitive proximity (OECD, 2007). Social capital can be provided by entrepreneurial universities through their three missions: entrepreneurship education, by building a stronger alumni community (Culkin & Mallick, 2011); formal or informal collaborations, especially with non-academic partners and preferably long-term (Kitagawa, 2005); and research valorisation through the creation of spin-offs for instance (Davidsson & Honig, 2003).

2. Doctorate holders' employability

2.1. *Employability and structuration theory*

We have seen that the entrepreneurial university can be defined by a panel of activities determined by external factors and made possible because of internal factors (see Figure 2). These activities have socioeconomic impacts, especially in the region in which the university is embedded, and in particular through the provision of human and social capital (Urbano & Guerrero, 2013). Doctoral students are key resources of the entrepreneurial university (Bienkowska et al., 2016). They are the workforce possibly meant to replace the current faculty, thus to carry on and develop the various activities of the entrepreneurial university (Dunne, 2016; Fumasoli, Goastellec, & Kehm, 2015). They conduct a large share of university research (Enders, 2002), and are often at the interface of university-industry interactions (Thune, 2009). As students and later alumni of the university, they also develop a long-term relationship with the university that can be translated into recruiting other university graduates (Drejer & Østergaard, 2017). In terms of education, doctorate holders can be considered as holding the highest human capital, being the highest educated workers (EHEA, 2018). Doctorate holders might also hold a high social capital, because of their entrepreneurial culture and mindset developed in the environment provided by the entrepreneurial university, and because of acquired skills such as networking capacities, communication and collaboration skills (Durette, Fournier, & Lafon, 2016). All these abilities are potentially assets for their employability, both inside and outside academia (Durette et al., 2016; Hayter & Parker, 2019; Roberts, 2018).

Definitions of the concept of employability differ mainly in terms of scope: some authors keep it to the ability of a worker to perform the tasks implied in a job; others integrate environmental factors that can prevent or enhance the use of the employability (Forrier & Sels, 2003). The chosen definition focuses on both abilities and preferences of an individual: “the collection of worker characteristics, including attitudes towards work, expectations regarding employment and wages, and behaviours both in the labour market and on the job, that are increasingly seen as *determinants* of employment chances” (Peck & Theodore, 2000, p.731). If both abilities and personal preferences on the employment are considered, attention given to employability can be seen as a solution to reduce job mismatches, improving the employment situations of doctorate holders, especially outside academia.

There are many labour market theories in macroeconomics dealing with matching (Fedorets, Lottmann, & Stops, 2019) or human capital sorting (Ahlin, Andersson, & Thulin, 2018), which aim at improving employment rates and quality of employment. However, individuals' free will always plays a role in employment issues, such as a personal preference in the choice of a geographical location to work and live (Sumell, Stephan, & Adams, 2009), suggesting the importance of a microeconomic approach through the agency theory (Lam, 2010; Lam & de Campos, 2015). The structuration theory is thus chosen as a background for this dissertation, as it reconciles both approaches, enabling us to consider both personal preferences and actions, and environmental structures such as formal and informal institutions in the analysis (Giddens, 1991). Giddens's structuration theory indeed argues that structures and individuals influence each other (Giddens, 1991). In this dissertation, this can be interpreted as: doctoral education and employers' demand influence doctorate holders' employability, and doctorate holders themselves also influence education and the labour market, through self-employment for example.

2.2. Doctorate holders' employment and job mismatches

Doctoral education was designed in the first place to educate university graduates and train them to become teachers and researchers (Charle & Verger, 2012): in other words, for an academic career. With the massification of education, and the orientation towards a knowledge-based economy, doctoral education has become increasingly popular (Bloch, Graversen, & Pedersen, 2015; Neumann & Tan, 2011). However, the number of doctoral students tend to exceed the number of available positions in academia, especially in Western Europe and the United States, where research systems are more developed than in other regions of the world (Auriol et al., 2013; Larson et al., 2014) – even though in some regions of the very same countries, it can be difficult to retain academic workforce too (Dunne, 2016). There is a bottleneck in the academic labour market, as career progress is very pyramidal; recent doctorate holders can accept postdoctoral positions, one after another, without being assured to finally get a tenure track position (Andalib et al., 2018; Auriol et al., 2013; Brechelmacher, Park, & Ates, 2015; Hayter & Parker, 2019; Recotillet, 2007). Finding a job outside academia is also possible for doctorate holders, both from STEM and SSH disciplines (Drejer, Holm, & Østergaard, 2016; Fritsch & Krabel, 2012; Neumann & Tan, 2011; Stephan, Sumell, Black, & Adams, 2004). Actually, it is sometimes a first choice for them: research is not conducted by universities only, but also by research institutes and companies (Cañibano et al., 2018). It also happens that scientists are employed part time by a university and part time by another

organization: it is the case of hybrid careers (Cañibano et al., 2018), which can result from university-industry overlapping labour markets (Lam, 2007). So, all in all, there are many career possibilities for doctorate holders (Enders, 2002). Cañibano et al. (2018) have built a typology of research careers, depending on the employer(s) and types of missions. Trajectories inside and outside academia are determined by both external factors and internal factors. On the one hand, external factors can be the state of the labour market, the policies in place, the employment conditions offered, or the types of skills looked for (Bloch et al., 2015; Garcia-Quevedo, Mas-Verdú, & Polo-Otero, 2012). On the other hand, internal factors can be personal preferences of doctorate holders regarding the missions, the employment conditions, the geographical location, the importance given to the different aspects of the job compared to his/her familial situation (Bloch et al., 2015; Hayter & Parker, 2019; Mangematin, 2000; Roach & Sauermann, 2010; Sumell et al., 2009).

However, employment outside academia can mean job mismatch for some doctorate holders. Corcoran & Faggian (2017, p.5) distinguish three types of mismatches:

“Qualification mismatches occur when a graduate holds a higher qualification than is required for their job (Green & McIntosh, 2007). A field-of-study mismatch occurs when a graduate is employed in a field that does not align with their area of tertiary study (McGuinness & Byrne, 2015). A skills mismatch occurs when graduates do not employ the skills that they learnt during the course of their studies in their occupation [...] (McGowan & Andrews, 2015).”

Job mismatches are important subjects of study from both societal and economical perspectives: studies have shown that they have effects on individuals' earnings and on their job satisfaction (Allen & van der Velden, 2001; García-Aracil & Van Der Velden, 2008), even for self-employed individuals (Bender & Roche, 2013); as well as on labour productivity (McGowan & Andrews, 2015; McGowan & Andrews, 2017; OECD, 2016). For highly-educated workers, over-education and over-skilling are the most studied mismatches (Canal-Domínguez & Wall, 2014; Di Pietro & Urwin, 2006; Groot & Maassen van den Brink, 1999; McGuinness & Bennett, 2007). A major challenge in such studies on mismatches is that they can be based on individuals' perceptions instead of verifiable facts (Canal-Domínguez & Wall, 2014). Some researchers introduce geographical mobility as a solution to a skills mismatch in particular (Hensen, De Vries, & Cörvers, 2009; L'Horty & Sari, 2019).

2.3. Doctoral education and doctorate holders' employability

The heterogeneity of higher education institutions was discussed in the first part of this literature review. Doctoral education, which is a key mission for the higher education institutions which are entitled to deliver doctoral degrees, is no exception: there is actually not one doctoral education but a myriad of types, depending on the culture, or country, on the institution, on the discipline, or on the research project and associated funding for example (Usher, 2002). Despite a quite recent trend of standardisation at the European scale, starting with the Bologna process, doctoral education remains by essence very individualised: the informal aspect of doctoral education can vary substantially from one institutional setting to another, or even from one doctoral student to another (Djelic, 2008; Durette et al., 2016). Examples of such differences can be: the supervisor-student relationship (Platow, 2012; Salminen-Karlsson & Wallgren, 2008); the proportion of mandatory courses and ECTS requirements; the proportion of teaching and/or administrative duties. Besides, in the past decades, with the increasing awareness of doctorate holders' rising employment rates outside academia, researchers and practitioners have called for an evolution of doctoral education (Boud & Tennant, 2006; Cuthbert & Molla, 2015; Metcalfe, 2006; Nyquist, 2010), to enhance the employability of doctorate holders, thus increasing the relevance of doctoral education for the labour market (Manathunga, Pitt, & Critchley, 2009; Thune et al., 2012). New forms of doctoral education have been implemented, such as industrial Ph.Ds. (Enders, 2002; Metcalfe, 2006; Neumann, 2005). Two main aspects of doctoral education have been focused on: the development of transferable skills, and experiences of mobility (Bienkowska et al., 2015; Vitae, 2010).

Transferable, or generic skills, are skills that the doctoral student acquires during the doctoral studies, but that (s)he is able to use in contexts other than in his/her research expertise. In OECD countries, "there appears to be no consensus regarding which transferable skills are most needed at different career stages" (OECD, 2012, p.34). In spite of that, several organizations have worked on defining what kind of transferable skills a doctorate holder should master. Among these, the League of European Research Universities, arguing in 2016 that "it is talent more than technology that society or business needs from universities" (LERU, 2016, p.2), defines 25 skills divided into three categories: intellectual skills, academic and technical skills, and personal and professional management skills. The Careers Research and Advisory Centre, in the UK, presents an even more comprehensive set of skills to develop for a researcher, and phases of development for each skill: 63 skills that are divided into four domains, where we

find again intellectual abilities, personal effectiveness, professional conduct but where engagement and impact can also be found (Vitae, 2010). This Vitae framework has been used as a reference for developing Universitat Autònoma de Barcelona's Professional Competencies Framework for instance. Durette, Fournier, and Lafon (2016) suggest a slightly different approach, arguing that there are transferable skills that can be formalized, such as communication, IT, project management or networking skills; and others that cannot be formalized, such as leadership skills or innovation capacity. Despite all these typologies of skills, some are still not integrated into most of doctoral programmes: for example, business skills such as managing people and finance (Lean, 2012).

Mobility experiences can either be geographical or inter-sectoral, or even both. Inter-sectoral mobility experiences consist in spending a period in an organization outside academia: typically, it is the case of industrial doctoral programmes, but it can also be in the form of internship, or other types of collaborative programmes (Bienkowska et al., 2015; Bienkowska & Klofsten, 2012; Roberts, 2018; Thune, 2009, 2010). Geographical mobility experiences consist in spending a period abroad, most of the time in another academic institution, to get to know other cultures and practices, and have the possibility to conduct research in other institutional settings: Innovative Training Networks of Marie Skłodowska-Curie actions of the European Commission are examples of such geographical mobility requirements in doctoral education (European Commission, 2014). Such mobility experiences enable the development of transferable skills, in particular networking skills (Bienkowska & Klofsten, 2012).

3. Summary

This chapter detailed the frame of reference for the dissertation on the following topics: the entrepreneurial university, doctoral education and doctorate holders' employability. A brief insight on the history of higher education institutions in Europe reveals the origins of the different models of universities conceptualised in the literature (Charle & Verger, 2012; Sam & van der Sijde, 2014; Uyarra, 2010). Among these, the model of the entrepreneurial university corresponds to the recent European universities, mostly created in a radically changing societal context at the end of the 1960s and in the 1970s (Clark, 1998). This model is nowadays supported by European policies (Heinnovate, 2019). The entrepreneurial university is characterized by its activities: teaching, research, and in particular the so-called 'third mission', or valorisation of research results (Caggiano et al., 2017). These activities are performed because of and influenced by external factors, such as the regional context and the expectations of its stakeholders (Centobelli et al., 2019; Davey, Rossano, & van der Sijde, 2016); and made possible because of internal factors, such as a diversified funding base or an integrated entrepreneurial culture (Clark, 1998) (see Figure 2). These activities generate socio-economic impacts, in particular in the region, and in particular in the form of human and social capital (Guerrero, Urbano, & Salamzadeh, 2014). Doctoral students are key actors of the entrepreneurial university (Enders, 2002; Thune, 2009). They are involved in its three main missions – teaching, research and third mission – and they largely participate in ensuring the proper functioning of the university (Enders, 2002). They also represent a significant part of the human and social capital that the entrepreneurial university provides to its region, as the most highly educated workforce (EHEA, 2018), although their share is less important in quantity than the share of other types of graduates (master's and bachelor's). However, career perspectives for doctoral students are not always ideal: there is a bottleneck in the academic labour market (Andalib et al., 2018; Hayter & Parker, 2019; Larson et al., 2014), and in the non-academic labour market, important mismatches of different types (in particular over-education) are observed (Canal-Domínguez & Wall, 2014; McGuinness & Bennett, 2007). This raises the issue of the employability of doctorate holders outside academia (Roberts, 2018); thus, the issue of adapting doctoral education to new expectations, especially of non-academic employers (Nyquist, 2010; Thune et al., 2012). The development of mobility experiences (Bienkowska et al., 2015; Wallgren & Dahlgren, 2007) and the teaching of transferable skills (Durette et al., 2016; LERU, 2016; Vitae, 2010) are recent developments in this direction.

CHAPTER 3. Methodological considerations

This chapter discusses elements of methodology used in the dissertation. It starts with explaining the personal and professional background of the doctoral studies, continues with a discussion around the philosophical stance of the researcher and goes on with detailing the methods used in the writing of the dissertation and of the appended papers, before discussing the limits of the presented research.

1. Personal path to the Ph.D. and development as a researcher

After two years of intensive courses to prepare the competitive entrance to a business school in France (*classes préparatoires*), I studied business administration, project management, innovation and entrepreneurship and got a master's degree in business administration at Grenoble Ecole de Management (France). My interest for organizational strategy, human capital and knowledge management started then: my master's thesis was on strategic intelligence in companies (scientific intelligence and lobbying). At that time, I wanted to know more about the technical aspects of innovative projects; that is why I decided to pursue my studies in an engineering school to learn about information systems and in particular tools for decision-making at the strategical level of organizations, and got a master's degree in engineering at Telecom Bretagne (France). My experience in industry consists in two 6-month end-of-studies internships as a project manager assistant in different departments of the French national electricity company (EDF); and after graduation, an engineer position as a consultant in business intelligence for the same company, from which I turned to academia by engaging in doctoral studies.

This path to academia might not, at first sight, seem very logical or smooth. Actually, my higher education was first of all vocational, in the sense that I was purposefully trained to work in a company. However, some elements are worth mentioning to clarify my move to academia. Firstly, I did my studies in business and engineering schools, that are – I can say it now – quite entrepreneurial, by teaching entrepreneurship, and by involving both researchers and students to work with companies, among other activities. I also was employed during my studies as a

part-time research assistant to collect and prepare data for researchers, on several projects. This gave me a first insight, interest and taste for research, that never completely left me. Secondly, I have a multi-disciplinary profile. However, more than collecting master's degrees, my real aim in pursuing both business and engineering studies was to learn the culture and language of both professions, to be able to create bridges between the two communities, and become a sort of boundary-spanner within an organization. Finally, one of the things I realized when working in industry was, each time, how much what I brought from my studies in terms of methodology or new knowledge was looked for and appreciated by my bosses and colleagues, especially outside the capital region where, maybe, this was scarcer. That actually made me realize the importance of human capital and knowledge in industry. Thus, my interests in academia and industry, innovative projects and human capital of all sorts led me to engage in a dissertation on universities, human and social capital for innovation and regional development.

An open position for a dissertation on these topics was actually open at Linköping University at the time when I was looking for a Ph.D. This position was funded by a Marie Skłodowska-Curie scholarship, in the framework of the RUNIN project (see paragraph 2.1 below). Working in a European research team and having the possibility to experience the Marie Skłodowska-Curie doctoral programme seemed like very good conditions to enter academia. These were the main factors that decided me to move to Sweden to do my Ph.D. Being a Marie Skłodowska-Curie doctoral student is quite special. It differs from traditional doctoral studies in Sweden where the Ph.D. has research, teaching and administrative duties, which makes him/her take four years or more to complete his/her dissertation, with the middle step (usually around the second year) of the licentiate degree. In my case, my working time was 100% dedicated to research during the three years of the project funding (March 2017-February 2020); without teaching, administrative duties and licentiate thesis, but with a lot of travelling (in particular for the secondment and the training weeks) and collaboration outside my host university.

To my mind, this experience has made me grow quickly as a researcher and in a very rich manner: developing multi-disciplinary and multi-cultural collaborations; getting to know foreign academic contexts (and overall contexts as well) in particular because of my move to Sweden, and my secondments in Spain; getting to know different methodological approaches in practice by meeting and attending lectures of experts from different disciplines especially during the training weeks; trying to disseminate research results and have an impact outside academia as a research group and individually by meeting outside stakeholders such as policymakers.

2. Research project

2.1. The RUNIN project

The thesis is part of the research project RUNIN: The Role of Universities in Innovation and Regional Development, funded by the European Commission under grant agreement no. 722295, in the framework of Horizon 2020 and Marie Skłodowska-Curie actions (Innovative Training Networks). Through these actions, scholarships are provided to early-stage researchers to train them in multicultural environments and innovative fields. The aim of the project was to create a multi-disciplinary body of knowledge on “how universities contribute to innovation and economic growth in their regions” (RUNIN, 2017). The RUNIN research is conducted by 14 doctoral students affiliated to seven universities across Europe¹⁰, in the period 2017-2020. In order to broadly cover the role of universities in innovation and regional development, RUNIN research was divided into four work packages: People and Networks; Places and Territories; Practices and Governance; Policies and Interventions. In particular, the work package “People and Networks” explores the role played by individuals and their networks in the transfer of knowledge between universities and the private sector. The present dissertation on the entrepreneurial university, doctoral education and regional development is part of this work package.

As a group of researchers working on different aspects of the same research topic, the RUNIN network created many opportunities to disseminate research results. In particular can be mentioned: a special issue in the journal *Regional studies, Regional science*; special sessions and RUNIN booths at conferences, e.g. 12th Triple Helix Conference in Manchester (2018) and Geoinno Conference in Stavanger (2020); a policy report written for the Board of the Twente region in the Netherlands (2018); poster sessions with policy-makers, e.g. at the Think Tank DEA in Copenhagen (2018).

2.2. HELIX Competence Centre

The present research has also been partly funded by HELIX Competence Centre based in Linköping University. HELIX Competence Centre is a research program funded by the Swedish innovation agency Vinnova, on sustainable development in organizations. The Centre aims at

¹⁰ University of Stavanger, Norway (coordinating the project); University of Linköping, Sweden; University of Aalborg, Denmark; University of Twente, the Netherlands; University of Lincoln, the United Kingdom; Autonomous University of Barcelona, Spain; University of Aveiro, Portugal.

involving the public and private sector, trade unions, civil society organisations, in the form of a partnership. Researchers at HELIX Competence Centre use an interactive research approach, characterized by a continuous joint learning process between the researcher and the participants (Ellström et al., 1999). It is an iterative collaborative process that aims at making sure that the research is as close to the practice as possible, but also at trying to keep a certain distance to avoid too much bias. Interactive research was used to produce some of the appended papers: after the writing process and before publication, interviewees were asked their advice on the use of their quotes as well as on the analysis of the data. Moreover, paper 5 was presented at the 2018 HELIX day, in which HELIX partners took part, and gave feedback on the paper before submission to the journal.

3. Philosophical stance

This dissertation is an inter-disciplinary work in social sciences, but mainly in organization, innovation, entrepreneurship and regional studies. I am studying the employment of doctorate holders outside academia, and initiatives that could support the matching between supply (the doctorate holder) and demand (the job market), for productivity and performance, and socioeconomic growth and development. I am looking for what is working and what is not working, and attempting to find solutions for what does not work so well. My philosophical stance is pragmatic in the sense that I consider “knowledge as “an instrument [...] of successful action” (Dewey, 1908 [1977]: 180)” (Elkjaer & Simpson, 2011, p. 56). In other words, as the objective of my research is to improve the observed social constructions (for example, labour market matching), my research results needs to lead to action and be socially useful. It translated into the methodology adopted as explained in section 5.2.

This work implies working with observable facts, such as the employment rate of doctorate holders and the characteristics of employment and education. But also, with non-observable material such as the personal preferences of doctorate holders: the choice to stay in a certain city or region because of family or whatever attachment to the place in question; to give up working as a doctorate holder because of better employment conditions, or because of personal convictions such as a disbelief in science, or bad experiences during doctoral studies. This non-observable material can sometimes be observed, during interviews for instance if the interviewee is willing and open enough to share, or even conscious of all this. Otherwise, it needs to be interpreted. I am thus empiricist in the sense that I always start from data and theory, not theory alone, to conduct my research; and in the sense that I believe that all that we know

should be based on experience, whether observable or not (Okasha, 2016). This is translated in my methodology in the form of quasi-inductive approaches, starting from collected data, in particular in the use of the Gioia methodology (Gioia, Corley, & Hamilton, 2013) in paper 5. The term “quasi-inductive” is used to highlight the fact that a purely inductive approach was very difficult for me to implement. As I was looking for something specific in my studies, I was more or less consciously influenced by theory, or by other empirical studies even before collecting my data. However, the analysis of the collected data greatly enabled the re-shaping of the research questions and the formalisation of results.

However, the pragmatic philosophical stance highlighted earlier is valid in the context of a specific paradigm. Kuhn’s concept of paradigm can be defined as “an entire scientific outlook – a constellation of shared assumptions, beliefs, and values that unite a scientific community” (Okasha, 2016, p. 86). This dissertation is framed by the paradigm of the knowledge-based economy for the competitiveness of the European Union on the global scale. This means that economic growth and development are no longer driven by agricultural and industrial production alone, but by innovation, which is based on knowledge production and utilization. In this context, universities play a key role in innovation by supporting the entrepreneurial mindset of both students and faculty. There does not seem to be other paradigms competing with this one of the knowledge-based economy, but there are different views in innovation theory on the driving force for such knowledge-based economy: the one adopted in this dissertation is that entrepreneurship – or more generally an entrepreneurial mindset – is identified as driving innovation, thus human and social capital are of prime importance. For other researchers, the driving force can be the technology itself, or the market. There are also researchers who are more realistic and positivist, conducting quantitative research exclusively; others are navigating in-between, using a mixed-methods approach.

The goals and means of my research are in theory decided externally: it is quite explicit that the European Commission agreed to provide funding based on the promises made by the applicants on research results and benefit for the European Commission. My research corresponds to the ‘extreme externalism’ model of technology defined by Nordin (2017): indeed, the European Commission granted funding to the research project, this way handling a task to us to solve some problems. One of the objectives of this research is to provide recommendation to policy makers – that is actually one of the main promises made in the application to get the grant. However, in the end, we will not be the ones deciding to implement these recommendations or

not, it will be the policy makers themselves, or the stakeholders involved in the recommendations.

4. Literature review

4.1. The entrepreneurial university

As I chose to focus on the model of the entrepreneurial university, I explored methodically the scientific literature to get an overview of the theoretical approaches to this concept as well as empirical analyses. I collected all the journal articles, book chapters and conference proceeding that the requests shown in Table 2 provided me.

Table 2. Queries to look for literature on the entrepreneurial university.

Keyword in title	Database
“entrepreneurial+university”	Linköping University Library
“entrepreneurial+university”	Google Scholar
“entrepreneurial+universities”	Linköping University Library
“entrepreneurial+universities”	Google Scholar

I stopped the collection of papers when I found redundancy in the request results (around the 20th page of results in each database) (Booth, Sutton, & Papaioannou, 2016). In total, I collected 205 documents, published between 1990 and 2019. In this collection of references, I then looked for analytical models of the entrepreneurial university and chose among the half-dozen found the most relevant for the dissertation in terms of chosen concepts and relation to the region. References on other models of universities (such as the engaged university) concepts similar to the entrepreneurial university (such as academic entrepreneurship) were also included in the literature review when relevant. These were collected in a less systematic manner: most of the time, they were found as references in other papers.

To write the frame of reference on the entrepreneurial university, I chose two of the analytical models found in the collected literature (Centobelli et al., 2019; Guerrero, Urbano, & Salamzadeh, 2014) and combined them into one model. In each model, I chose the features that seemed the most relevant to the terms and concepts used in the dissertation (for instance: internal and external factors, human and social capital). I then used the combined model to discuss the characteristics, challenges and impact of the entrepreneurial university, using the

most relevant papers in terms of terminology and coherence with the presented model among the 205 documents collected. In total, approximately 80 references on the entrepreneurial university are used in this dissertation.

4.2. Employability of doctorate holders

Finding a frame of reference on the issues of doctorate holders' employment, job mismatches, employability and doctoral education was more complex in terms of broadness of scope. Thus, the core of the literature was found using different queries in Google Scholar, focusing on job market, employability and doctoral education, and considering the different possible writings of doctorate holder (for instance: PhD or Ph.D.). Literature on the related issues (job mismatches, labour market issues in general) were found as references in the collected papers. Around 150 papers were collected in total, among which approximately 90 were referred to in the frame of reference. The frame of reference was structured thematically: firstly, doctorate holders' employability both inside and outside academia is discussed, logically leading to a discussion of job mismatches, which are observed on the non-academic labour market. After that comes a discussion on the issue of doctorate holders' employability that could be a solution to these job mismatches. The review ends with a discussion on doctoral education and in particular how it can enhance doctorate holders' employability.

5. Methodological approaches

5.1. Overview of the methods and data used in the appended papers

Table 3. Summary of methods and data used in the appended papers.

	Title	Authors	Purpose of the study	Data sources	Methodology
1	Transitioning from an economic to a broader social impact: the case of a Swedish university	Germain- Alamartine, E.	Study a case of entrepreneurial university and its role in its region	Literature, 3 interviews of key personnel of the university, 20 online resources	Case study
2	Entrepreneurial university dynamics: Structured ambivalence, relative deprivation and institution-formation in the Stanford innovation system	Etzkowitz, H., Germain- Alamartine, E., Keel, J., Kumar, C., Smith, K. N., Albats, E.	Study a failure of the most successful entrepreneurial university and how it is dealt with	Literature, interviews of initiators of different projects aiming at filling the innovation gap	Case study
3	Universities and Science Parks: engagements and interactions in developing and attracting talent	Cadorin, E., Germain- Alamartine, E., Bienkowska, D., Klofsten, M.	Study Science-Park university interactions	Literature, 7 interviews of personnel responsible for the illustrative cases	Case study
4	Doctoral education and employment in the regions: the case of Catalonia	Germain- Alamartine, E.	Study the integration of doctorate holders in the labour market at the scale of a region	Databases from the Catalan Agency for the Quality of the University System (1,358 doctorate holders; 1,325 non-academic employers)	Descriptive statistics
5	Aligning doctoral education with local employers' needs: a comparative case study	Germain- Alamartine, E., Moghadam- Saman, S.	Study the need of local non-academic employers for doctorate holders and how they deal with it	17 interviews of employers in Science Parks and key personnel in universities	Comparative case study

5.2. Qualitative approaches

Research can be conducted using a purely qualitative, purely quantitative or a mixed-method approach (including both qualitative and quantitative analyses) (Tashakkori & Teddlie, 2010). Choosing one approach or the other can depend on the philosophical stance of the researcher

(and of its research group), but also on the research questions (Gavard-Perret, Gotteland, & Haon, 2012).

My pragmatic stance presented earlier translates into the use of a mainly qualitative approach: qualitative research enables me to learn more about the informal aspect of the social constructions that I am studying. The research questions for this dissertation are of “how”, “why” and “what” types, suggesting mainly qualitative approaches (Yin, 2003). The first research question is a “how” type of interrogation, with the aim to explore success cases of entrepreneurial universities and their roles and evolutions, in particular regarding regional socioeconomic impact. The second research question is both a “why” and “how” type of interrogation; it aims at exploring the issue of doctorate holders’ employability in the lens of the entrepreneurial university’s model and socioeconomic impact. The third research question uses a “what” type of interrogation, with the objective to explore initiatives from other regional stakeholders that can complement the entrepreneurial university’s actions in enhancing the employability of doctorate holders, and in turn the socioeconomic impact of the entrepreneurial university.

Still in relation with my philosophical stance and the research questions that make the dissertation an exploratory work, the qualitative approach is the main one used in the dissertation, in particular through different case studies; but it is complemented by a quantitative paper using descriptive statistics. Case studies can be used to describe, test or generate a theory (Eisenhardt, 1989; Gioia et al., 2013): this dissertation is both about testing the model of the entrepreneurial university especially with regards to labour market issues, and developing it. The main advantages of the case study method are that it enables the researcher to focus on a single phenomenon and thus study it in depth, using a limited but varied dataset (Gavard-Perret et al., 2012; Yin, 2003): in this dissertation, both semi-structured interviews and descriptive statistics on a database are used. However, the other side of the coin is the issue of generalizability (Yin, 2003), which will be discussed as the main limit of this dissertation. The use of the comparative case study approach in Paper 5 is an attempt in increasing the generalizability of case study research results.

The case studies of Papers 1, 2, 3 and 5 look at organizational initiatives, whether from the university or from another type of organization (e.g. a company), or at university-industry interactions. This is explained by the chosen focus on the entrepreneurial university and its role in its region, especially for what regards the production of human and social capital. Analysing

the actions, roles, ambitions and challenges of the different stakeholders in this issue was thus of prime importance, to explore the setting; and a first step was to focus on the organizations: universities and industrial companies, for example. However, paper 4 rather focuses on doctorate holders in regions, i.e. the individual level, as they are the first concerned with the issue. This shift in the unit of analysis is necessary in this paper to better grasp the issue of job mismatches since it happens at the individual level, not at the organizational level, and since individual initiatives in particular from doctorate holders themselves are stakeholders of the entrepreneurial university.

The case studies of Papers 1, 2, 3 answer RQ1. The aim of the research question is to explore the entrepreneurial university's impact in its region particularly through the provision of human and social capital. The chosen cases are Linköping University and Stanford University and their respective environments. Linköping University was chosen as a case for the following reasons: it had previously been identified as an entrepreneurial university which had had a strong regional impact (Svensson et al., 2012); access to data was convenient; Linköping University is also member of the RUNIN project, the ECIU¹¹ and the YERUN¹² network, making it a relevant representative of a young, innovative and entrepreneurial university, and making research results potentially applicable in other similar contexts, such as other members of these networks (e.g. the University of Twente). Stanford University was also chosen as a case for two main reasons: because it is the most successful case of the entrepreneurial university (Colyvas & Powell, 2007), and because of the availability of data. In each case, the primary source of data was first-hand semi-structured interviews from key personnel of universities and staff responsible for the organizational initiatives used as illustrative cases, which enabled to get a quite broad overview of the universities' activities and interactions with external stakeholders, with special regards to human and social capital. The Stanford case study deals with a major challenge for the entrepreneurial university, which introduces barriers to the entrepreneurial university's impact in its region, in other words the concern of the following RQ2.

The comparative case study of Paper 5, along with the descriptive statistics of Paper 4, answer RQ2. The aim of RQ2 is to get an understanding of why the employability of doctorate holders is key in the entrepreneurial university's socioeconomic impact. Papers 4 and 5 introduce the issue of doctorate holders' employment in the region. Paper 5 deals with organizational initiatives but also brings insight on individual situations to answer the research question. Paper

¹¹ ECIU is the European Consortium of Innovative Universities, created in 1997: see <https://www.eciu.org/>

¹² YERUN is the Young European Research Universities Network, created in 2015: see <https://www.yerun.eu/>

5 is a comparative case study of university-Science Park relations regarding doctoral education. First-hand semi-structured interviews from both key personnel from the universities and non-academic employers in the Science Parks – most of them being doctorate holders themselves, thus providing elements of analysis on doctorate holders' employment outside academia – are the main source of data for this study (the interview guide is available in Appendix 3). The chosen cases are KTH and Södertälje Science Park, and UAB and Parc de Recerca de la UAB. These two universities were not only chosen because they are entrepreneurial universities, especially with regards to their respectively neighbour Science and Research Park, and because of the accessibility of data; but also because they differ in scope (one is an engineering school, the other a comprehensive university) and in context (two radically different countries with different institutional settings). The comparative case study shows the validity of the identified problem (job mismatches) in different settings and participates in suggesting explanations based on these two different settings, along with the descriptive statistics of a regional non-academic labour market for doctorate holders.

Finally, the case studies of Paper 3 and 5 answer RQ3. The aim of RQ3 is to identify initiatives that could complement those of the entrepreneurial university in the provision of human and social capital to the region. Papers 3 and 5 help identifying initiatives from stakeholders other than the university in three different contexts, by interviewing regional stakeholders outside the university.

5.3. *Quantitative data*

Although this dissertation presents a mainly qualitative approach, quantitative data were used in Paper 4. Thus, it is possible to label this dissertation as using mixed-method approach (Tashakkori & Teddlie, 2010), but these descriptive statistics can be considered as qualitative to the extent that they are explorative and aim at formulating hypotheses, instead of testing hypotheses on large databases. Indeed, quantitative data can be used in qualitative research (Gavard-Perret et al., 2012; Yin, 2003). These descriptive statistics were used mainly to shift from the viewpoint of the university (used in Papers 1, 2 and 3) to the viewpoint of doctorate holders in a whole region. Using regional data was relevant in Paper 4 to identify limits of the impact of the entrepreneurial university in its region, and to start focusing on the regional employability of doctorate holders, which is the core subject of this dissertation, by analysing observable facts at the scale of a region.

The descriptive statistics of Paper 4, along with the comparative case study of Paper 5, answer RQ2. RQ2 raises the issue of limitations in the impact that the entrepreneurial university can have in terms of human and social capital. Paper 4 explores doctorate holders' integration in the non-academic regional labour market. The descriptive statistics of Paper 4 help to identify job mismatches whose existence had been observed in the literature on doctorate holders' employment, and formulate hypotheses regarding the reasons for such mismatches. Secondary data collected from a regional agency are the main source of data for this study, with units of analysis being the doctorate holder and the non-academic employer. Paper 4 represents the shift in unit of analysis of the dissertation, from organizational initiatives to the doctorate holder him/herself.

6. Contributions to papers

6.1. Paper 1

Paper 1 was written in the very first months of the doctoral studies, first as an exercise to know more about my host institution, Linköping University, but also to get to know the different schools of thoughts on universities and their implication in their regions. I chose to use Uyarra (2010) as the main reference because I found the different models of universities explained very clearly and quite exhaustively; thus, I could use it to explore the case of Linköping University. Indeed, my aim in this paper is to analyse the case through the different conceptual models explained in Uyarra (2010) to see to what it corresponds the most. I gathered elements on the case using mainly the literature that had been published on it, especially by my Ph.D. supervisors. I then complemented these elements by reading a book on the history of Linköping University, and by interviewing key personnel at that time to get more recent insights on the institution and its role in region Östergötland. Thus, I am the sole author of Paper 1: I collected and analysed the data, I wrote the paper and made the corrections asked for during the review process. Paper 1 was presented and peer-reviewed by junior and senior researchers at the PhD Academy in Linköping University in May 2017, and at the Regional Innovation Policies Conference in October 2017 in Santiago de Compostela (Spain). It was published in the RUNIN Working Paper Series in 2018. Paper 1 was also accepted to be part of a book to be published by Springer, and was peer-reviewed by the guest editor of the book.

6.2. Paper 2

Paper 2 was written in collaboration with researchers from the United States and Finland. This collaboration happened at the time when I got quite familiar with the concept of the entrepreneurial university, its different features and several cases of entrepreneurial universities. Henry Etzkowitz had gathered some data from Stanford University – the most recognized example of entrepreneurial university – in the past years, and had identified an innovation gap he wanted to explore and write about. I accepted to take part in this paper, as I was then looking to know more about the challenges of the model of the entrepreneurial university, and how they could be dealt with. The other authors are Ekaterina Albats from Lahti University of Technology, Lappeenranta (Finland) and Henry Etzkowitz's master's students who collected the data from the different cases. I had a significant contribution in the paper as I gathered and synthesized literature on the entrepreneurial university, wrote the literature review part, synthesized the cases and produced Table 3. I was also corresponding author for the paper for some months during the review process. Paper 2 was peer-reviewed by anonymous reviewers as part of the publication process in *Technological Forecasting and Social Change*.

6.3. Paper 3

Paper 3 was written in collaboration with colleagues from Linköping University: Eduardo Cadarin, Ph.D. student in the same division as myself, studying talent attraction in Science Parks; Magnus Klostén and Dżamila Bienkowska, my Ph.D. supervisors, from the same division. Paper 3 was also written in the beginning of my doctoral studies, when I tried to better grasp the difference between the models of the entrepreneurial and the engaged university, and when I wanted to get more insight on concrete activities of entrepreneurial universities in the creation of human and social capital for the region. Thus, this collaboration was very timely for me, as it enabled me to broaden my theoretical knowledge, expanding it from literature focusing mainly on the university to literature on Science Parks and university-industry collaboration. My contribution in this paper was: the collection and analysis of literature on universities and university-industry collaboration; and writing of the corresponding part of the literature review; the writing of the Method part; the finding of the dimension “degree of formalism” in the analytical model; the writing of the corresponding parts of the chapter; the improvement of the chapter at each iteration of writing and revising. Paper 3 was published in the Springer book *Developing Engaged and Entrepreneurial Universities*, and was peer-reviewed by the guest editors of the book.

6.4. Paper 4

Paper 4 was written during a secondment at the Autonomous University of Barcelona in 2017. I had the opportunity to get access to data collected by the Catalan Agency for the Quality of the University System (AQU), so I applied to get the databases in which I was interested and signed agreements with AQU. At that time, I was getting interested in observing the labour market of doctorate holders outside academia at the scale of a region. I was wondering if I could find major differences with studies that had focused on the national scale. AQU reports are available online but I chose to focus on the part of the population employed outside academia, comparing those who used their doctoral degree in the recruitment process vs. those who did not. The thing is that data was only about doctorate holders with a Spanish nationality, having graduated from a Catalan university; I am thus lacking the population of doctorate holders from abroad. That is why I chose to do descriptive statistics: this way, I could suggest characteristics of the non-academic labour market at the regional scale, that can be re-formulated in the form of hypotheses to be further tested. I am the sole author of Paper 4: I collected and analysed the data, I wrote the paper and made the corrections asked for during the review process. This paper was presented and peer reviewed at the International PhD course in Economic Geography at Utrecht University (2018), and was peer-reviewed by anonymous reviewers as part of the publication process in *Regional studies*, *Regional science*.

6.5. Paper 5

Paper 5 was initiated just before the secondment at the Autonomous University of Barcelona, giving the possibility to collect data both in Sweden and in Spain. Paper 5 can be considered as the continuity of Paper 3, as it deepens the analysis of the interactions of Science Park tenants with the university regarding human capital (in this case, doctorate holders), and of Paper 4, as it explores more qualitatively a sample of the non-academic labour market for doctorate holders in Catalonia (in a Research Park). The aim with this study was really to get a grasp of the needs of non-academic employers in Science or Research Parks for skills held by doctorate holders, and the challenges in finding such skills. It was also to explore if these employers had interactions with the nearby university regarding this issue, and if not, why it was not the case. I am the corresponding author of this article written in collaboration with Saeed Moghadam-Saman (part of the RUNIN project, University of Stavanger). I sketched the research design and conducted the data collection in Sweden and in Spain. I also prepared the data for analysis, by transcribing the interviews. Saeed joined for the literature review, the analysis, the

development of the model and the writing of the article. We agreed on being responsible of one case each: I was responsible for the case of Södertälje Science Park. I was also in charge of asking for validation to all interviewees. In the writing, I was particularly in charge of the Method Section, the Findings section (part on SSCP case: 4.2), the first part of the Discussion (5.1) and the Implications part in the Conclusion. I presented Paper 5 at the Triple Helix Conference in Manchester (2018), at the PhD Academy in Linköping University (2018) (where it was peer-reviewed by junior and senior researchers) and at the HELIX Day in Linköping University (2018); Saeed Moghadam-Saman presented it at the Regional Innovation Policies Conference in Bergen (2018). Paper 5 was also peer-reviewed by anonymous reviewers as part of the submission process in *European Planning Studies*.

7. Summary

In this chapter, the personal path of the researcher towards doctoral studies is described, as well as the project framing this research. Both influenced the philosophical stance, and thus the methodological choices detailed in this chapter. In a nutshell, the pragmatic stance to the research topic led the researcher to adopt mainly a qualitative approach, while using both qualitative and quantitative data. Case studies are frequently used in social sciences, and in particular in studies on entrepreneurial universities. The use of case studies is all the more relevant as research on both doctoral education and the entrepreneurial university needs to be explorative. However, studies on doctoral education and on the employment of doctorate holders are mostly quantitative. The use of quantitative data in paper 4 enables to make up for this difference in approaches between the two trends of research: qualitative on the entrepreneurial university, quantitative on doctorate holders' employment. Thus, this dissertation is a collection of case studies, which are all respectively relevant to the four research questions. RQ1, calling for an exploration of the activities and impact of the entrepreneurial university in its region, is answered using case studies of two entrepreneurial universities and its relations to regional stakeholders. RQ2, calling for an exploration of doctorate holders' employability in the light of the entrepreneurial university's impact, is answered using the case study of a region, focusing on the integration of doctorate holders in the labour market in this region. Finally, RQ3, calling for an exploration of initiatives to complement the activities and impact of the entrepreneurial university in its region with regard to doctorate holders' employability, is answered using the case studies of regional employers in three different regions.

CHAPTER 4. Findings and discussion

This chapter summarizes the findings of the appended papers and relate them to the research questions presented in chapter 1 as well as to the literature highlighted in chapter 2.

Table 4 below highlights the main findings, and their links with the research questions and the frame of reference.

Table 4. Links between the RQs, frame of reference and findings.

RQ	Frame of reference		Findings
	The entrepreneurial university	Doctorate holders' employability	
1) How does the entrepreneurial university increase its socioeconomic impact?	1.2.a. External factors		Alignment among regional stakeholders
	1.2.b. Internal factors		Retention of human and social capital within the entrepreneurial university
2) Why and how is doctorate holders' employability key in the entrepreneurial university's impact?	1.1.c. Missions and activities		Broadening of scope of activities and regional stakeholders
		2.3. Doctoral education and doctorate holders' employability	Doctorate holders' lack of added value on the non-academic labour market
		2.2. Doctorate holders' employment and job mismatches	Doctorate holders' experience job mismatches outside academia
		2.2. Doctorate holders' employment and job mismatches	Non-academic employers' and doctorate holders' lack of knowledge about each other
3) What roles can regional stakeholders play in enhancing doctorate holders' employability?	1.1.c. Missions and activities	2.3. Doctoral education and doctorate holders' employability	Increased UI collaborations for better communication between university and employers
	1.2.b. Internal factors	2.3. Doctoral education and doctorate holders' employability	Doctorate holders: network exploitation, interactions with employers, self-employment
	1.2.a. External factors	2.3. Doctoral education and doctorate holders' employability	Intermediaries: creation of meeting opportunities

1. Increasing the entrepreneurial university's socioeconomic impact

The two cases of Linköping University and Stanford University provide complementary insight on the entrepreneurial university's socioeconomic impact in their regions, and the challenges it can encounter. These cases both put a strong emphasis on the support of entrepreneurship, but they differ in age and they are embedded in totally different socio-economic contexts. Thus, they encounter different challenges, especially in the development of human and social capital: in the one case, making the most of the scarce resources in the region; in the other, avoid to waste an important entrepreneurial potential. Their respective reactions provide lessons to be learnt to other entrepreneurial universities.

The case of Linköping University (LiU) shows that the entrepreneurial university's support to the development of human and social capital in the region is done through an alignment among the regional stakeholders, in particular the public and private sectors and the university. The case witnesses the importance of the entrepreneurial university in the economic development of its region, as well as the importance of the region for the university to keep adapting its activities so that they remain relevant to its stakeholders. It also shows the variety of university stakeholders (both internal and external) and how flexible enough the university is to deal with all of their expectations, confirming other studies of the entrepreneurial university which identify internal and external stakeholders as crucial actors in the internal and external factors giving way to the model of the entrepreneurial university (Centobelli et al., 2019; Clark, 1998). The LiU case particularly highlights the major role of a sense of consensus existing between regional stakeholders, which is a regional specificity of the case of Linköping, and which has been built by long-term collaborations in the past decades (Svensson et al., 2012). This is in line with Bischoff, Volkmann, & Audretsch's (2018) stakeholder approach to entrepreneurship education: the authors indeed identified a need "for more extensive and well-coordinated stakeholder involvement to address the demands and expectations of key stakeholder groups" (p. 39). Linköping University has actually been very close to Linköping and Norrköping municipalities, Region Östergötland and companies such as Saab since its creation. For instance, the university is involved in the design of the regional development strategy. In addition, the choices to locate Science Park Mjärdevi and Norrköping Science Park adjacent to two main campuses of the university demonstrate strategic choices of the municipalities and the role played by the university in them. Discussion platforms are the main ways through

which consensus can be found in the Östergötland regional context. The university is often at the centre of discussions or at the initiative of collaborations, especially because of its political neutrality. Indeed, Growlink, and later on the East Sweden Business Region, was chaired by the university for a substantial period. This is coherent with Klofsten et al.'s (2019) statement that leadership is essential to manage the engagement of varied stakeholders. Human and social capital are indeed crucial in these long-term relationships and stakeholders' alignment, which enable the building of a regional ecosystem: individuals are key in the history of the region, and their personal networks as well, especially considering the relatively small size of the region in terms of number of inhabitants. It is frequent that same individuals are involved in the boards of several organizations. For instance, the boards of LiU Relation and of Saab Ventures have been identically composed in the recent years. Thus, the alignment with regional stakeholders is very characteristic of the case of LiU. To increase its regional socioeconomic impact and more specifically the societal aspect of this impact, the university tends to evolve towards the model of the engaged university by diversifying the nature of its collaborations and extending the variety of its stakeholders. However, working with new types of stakeholders such as the civil society takes some time to implement, which means that the transition towards the engaged model is still ongoing, because the large majority of the university's interactions still happen with traditional stakeholders which are industrial partners and the public sector.

Once a stakeholder alignment is reached, and collaborations have stemmed out of the implemented discussion platforms, tangible activities can be implemented. The development of human capital in the region seems quite obvious in the form of the supply of graduates by the university to regional employers (Urbano & Guerrero, 2013). The added value of the entrepreneurial university is to provide relevant skills, really adapted to the needs of employers, and graduates who are ready to work (Culkin & Mallick, 2011). Human and social capital are indeed developed through students, graduates, researchers, university staff, who are involved in external collaboration and knowledge exchange (Perkmann et al., 2013; Roberts, 2018), and who develop entrepreneurial mindsets by studying or working in an entrepreneurial university (Clark, 1998). One of the consensus in the Östergötland region is to retain workforce within the region, and prevent an excessive brain-drain occurring in particular towards the two largest Swedish cities that are Stockholm and Göteborg: witness the Östgötamorgon initiative, which aims at gathering LiU alumni in Stockholm during breakfast meetings and attempting to attract them back to Östergötland. Studying the issue of talent attraction and development for the Science Park Mjärdevi shows that the entrepreneurial university's support to the development

of human and social capital in the region is thus also done through concrete interactions with local organisations, in particular local businesses. These interactions can be classified: they are more or less formal (and initiated by the university as an institution, or by students through student associations), and occur with companies which have different levels of maturity (small, young companies or larger, older companies). They complement the comprehensive lists of activities of the entrepreneurial university which can be found in the literature on the entrepreneurial university and on academic entrepreneurship (D'Este & Patel, 2007; Perkmann et al., 2013). These interactions really show the importance of retaining talent from the university for local employers. This can be done either by encouraging the development of new ideas and/or firms, or by identifying adequate human resources within the university, either inside or outside the university. While the InGenious course, Spetsa AB and the Sommarmatchen initiative of LiU Innovation enable employers to do so within the university by temporarily using the services of bachelor's, master's and doctoral students (as well as faculty), events such as the Hackathon and Game Awards enable them to do so as well, but closer to them: inside the Science Park. Such interactions also show the indirect but essential role played by the Science Park in this issue, by its creation of meeting places and opportunities for local employers and potential human resources, in particular (but not exclusively) university students and graduates. LARM is a job fair held at the university and organised by a student association in close collaboration with Science Park Mjärdevi, which gives the opportunity to both employers and students to get to know each other and for demand and supply to match. What needs to be highlighted is the indirect support that the entrepreneurial university provides to its regional stakeholders. In particular, it allows its internal stakeholders some freedom to operate; for example, students who directly interact with the Science Park, using the framework of student associations instead of involving the university's administrative level.

Finally, the entrepreneurial university's support to the development of human and social capital in the region is done by considering varied types of potential human and social capital, and including a large spectrum of initiatives for regional economic and social development in their support system. The case of Stanford University shows that even in successful entrepreneurial universities, challenges are still there and successes can sometimes hide failures, such as the lack of support to neophyte entrepreneurs. This means that the entrepreneurial university does not necessarily make the most of a very high potential of developing human and social capital in the region, as it supports almost exclusively the commercialization of technology ready to be transferred. However, being educated in an entrepreneurial university, graduates develop an

entrepreneurial mindset and can benefit from the pool of resources available on campus. Thus, they can launch initiatives by themselves to make up for this gap, either on campus (such as the translational research programmes Biodesign and SPARK) or at the interface between the campus and the Silicon Valley (such as Radicand and StartX Accelerator). Even if the entrepreneurial university has not directly developed the support, its ‘offspring’ has been doing it. The case of LiU Innovation at Linköping University shows that having a broad understanding of entrepreneurship within the entrepreneurial university is also key in avoiding this innovation gap. Indeed, what is characteristic of the entrepreneurial university is the so-called ‘third mission’, which goes beyond the mere commercialisation of research results through the creation of patents or spin-offs: it is instead the valorisation of the university’s activities (Caggiano et al., 2017). The entrepreneurial university also creates synergies between its three missions (OECD and European Commission, 2012). Linköping University’s innovation office gives advice and support freely to all faculty and students for the development of their ideas, no matter whether these are profit-oriented or not, research- or studies-inspired or not, neither whether they will be implemented in the region, in the country or abroad. Such a broad scope of support is a good practice which is regularly recommended for the development of entrepreneurial universities: for example, in the HEInnovate country review of Ireland, one of the recommendations was to extend the understanding and culture of entrepreneurship to all disciplines (OECD/EU, 2017), not only to Science, Technology, Engineering and Mathematics (STEM) disciplines where the majority of commercialization of research results comes from.

In summary, the appended papers highlight the importance of long-term and consensus-based relations between the university and its regional stakeholders. While the entrepreneurial university has been discussed extensively in the literature as a producer of patents and spin-offs, and very focused on the commercialisation of research results, these papers put more emphasis on softer initiatives, which are mainly combined efforts with regional stakeholders to retain human and social capital in the region. Indeed, stakeholders’ alignment enables the entrepreneurial university to initiate or take part in collaborations and concrete interactions aiming at developing human and social capital, such as the creation of meeting places and opportunities between employers and potential human resources within the university, thus providing a more or less direct support to regional stakeholders’ initiatives. Besides, while most papers focus on how to develop into the model of the entrepreneurial university, the appended papers highlight how entrepreneurial universities maintain and improve their own model, or attempt to evolve towards another model of university (in this case, the model of the engaged

university) to increase their regional socioeconomic impact. Finally, supporting a large spectrum of ideas and firm creations from a large panel of individuals is also key in developing the potential found in the region into real human and social capital.

2. The importance of doctorate holders' employability for the entrepreneurial university's impact

We have observed different ways through which the entrepreneurial university acts in attempting to increase its regional socioeconomic impact, namely: reaching a stable alignment with its regional stakeholders, expanding the scope of its actions and stakeholders, and supporting varied types of initiatives, more or less directly. A straightforward example of the entrepreneurial university's socioeconomic impact is the provision of university graduates to the regional labour market, because they hold human and social capital. Doctorate holders are the most highly educated workforce and consequently hold the highest level of human capital. As they are increasingly employed outside academia, they might be of prime importance in the entrepreneurial university's impact. The case of Catalonia enables to explore the integration of doctorate holders having graduated from Catalan universities in the regional labour market, through the analysis of a database. Beyond the quantitative aspect of this employment (related to the unemployment rate), exploring qualitative aspects of doctorate holders' employment is relevant to assess the entrepreneurial university's impact through the provision of doctorate holders to regional employers. Complementing the study of the database with interviews conducted in the region enables to provide insight on employers' mindsets related to hiring doctorate holders.

Quantitative data from 2017¹³ on the integration of Spanish doctorate holders in the Catalan non-academic labour market show that the majority of these doctorate holders live in Catalonia after their PhD graduation. A large part of them is also employed in Catalonia. However, two-thirds of the employed doctorate holders did not use their doctoral degree in the recruitment process outside academia, suggesting an important education mismatch. This result is coherent with McGowan & Andrews's (2015) observation that highly educated employed population is likely to be affected by job mismatches. Different types of mismatches are defined (Corcoran & Faggian, 2017), in particular qualification mismatch (Green & McIntosh, 2007) and skills

¹³ This quantitative data was collected by the Agency for the Quality of the University System in Catalonia. See chapter 3 and appended Paper 4 for more information about the databases.

mismatch (McGowan & Andrews, 2017). However, surveyed doctorate holders have an overall very high satisfaction towards their doctoral studies and would even re-iterate them, even though they might not use their doctoral degree to find a job outside academia. This suggests that the observed education mismatch is out of universities' scope of influence and responsibilities, but is instead a result of choices made by doctorate holders which are constrained by other factors, such as a will to stay in the region despite potential macroeconomic constraints.

Job mismatches mean that human resources are not exploited optimally (McGowan & Andrews, 2015): thus, job mismatches can be seen as a limit of the entrepreneurial university's impact on regional human and social capital.

Comparing features of the doctoral studies of doctorate holders who used their doctoral degree in the recruitment process and those who did not use it aimed at identifying significant differences between the two groups. No striking distinction was observed, but slight differences suggest that some features of doctoral studies develop skills that might seem valuable to non-academic employers. For example, there are more doctorate holders having written their dissertation in English, or having worked in a research team during their doctoral studies, who got a job requiring a doctoral degree than a job where the doctoral degree was not required. It is also the case for those who had a mobility experience abroad during their doctoral studies, in line with L'Horty & Sari (2019) who identified geographical mobility as a potential solution to job mismatches. The results of this comparison thus also suggest that skills could be part of the reasons why some doctorate holders do not get jobs which do not require a doctoral degree. Qualitative data from 2017¹⁴ complement the quantitative data: when employers from the UAB Research Park share their experiences in recruiting doctoral students or doctorate holders, they highlight a lack of knowledge of what a business is, and how to work in a company. This actually confirms the potential existing of a skills mismatch in addition to an education mismatch, and enables us to start identifying what types of skills might be the main problems in such a skills mismatch.

As the university is not directly involved in the recruitment process, decision-making of both employers and doctorate holders are the main limits to the entrepreneurial university's impact.

¹⁴ This qualitative data was collected by the author through face-to-face interviews at the Autonomous University of Barcelona (UAB) and its adjacent Research Park (PRUAB). See chapter 3 and appended Paper 5 for more information about the interviews.

It is worth looking into the data gathered from the decision makers in the recruitment process to get a deeper understanding of this.

In the Catalan databases, there is no outstanding difference in the reasons why regional non-academic employers valorise more a specific non-doctoral degree (such as an engineering degree) than the doctoral degree. In the interviews recorded in the same region (Catalonia), employers of R&D companies made it clear that they would rather hire a master's graduate over a doctorate holder, for financial reasons but also because master's graduate appear more adaptable to them. Some employers recognize the doctoral degree as a certificate of quality. However, both quantitative and qualitative studies show that non-academic employers might not know a lot about doctorate holders and what they can bring them, in other words doctoral studies might not be of any added value compared to a master's degree or equivalent, despite the investment made in doctoral studies by the doctorate holder. This heavy investment might actually be an issue, as it might make the doctoral student too specialized in the eyes of an industrial employer, and consequently too expensive. Interviewed employers state that they generally look for some sort of entrepreneurial behaviour and transferable skills rather than scientific expertise and excellence, and they tend to already find it in master's graduates' profiles. This need for transferable skills is known to entrepreneurial universities: the development of teaching of transferable skills and of industrial or collaborative doctoral programmes are examples of the entrepreneurial university's initiatives to develop relevant human and social capital, thus trying to reduce the job mismatches (Bienkowska et al., 2015; Durette et al., 2016; Roberts, 2018). This initiative shows the efforts made by universities to consider the needs of non-academic employers for more relevance of doctoral education outside academia. However, it seems that it does not really add any added value to doctoral education: instead, it brings doctoral education at the same level as master's education in terms of generic or transferable skills. In addition, some employers highlighted a lack of knowledge of the corporate world and practices by doctorate holders they had hired, which sometimes resulted in problematic behaviours, misunderstandings and conflicts of interest. This can be especially dramatic for the employer and the whole company when it happens in front of customers. Interviewed employers express a will to communicate their needs to the university and regret that there is no formal procedure for them to influence the curriculum of doctoral programmes, for different reasons, such as the complexity of university organisation. This could indeed enable them to find the human capital they need more easily. However, it seems that the lack of interaction between employers of the PRUAB and the university can be explained because

of issues on both sides. On the one hand, even though employers claim to be willing to interact with the university regarding doctoral education, it clearly does not seem a priority for them and they also lack resources, both in time and personnel, to do so, especially small and medium-sized enterprises (SMEs). In addition, they have not necessarily thought about the issues of doctoral education and doctoral-level skills before being interviewed about them. On the other hand, it is a real challenge for the university to consult a large panel of non-academic employers considering their number and variety. However, the entrepreneurial university is supposed to provide 'ready-to-work' graduates (Culkin & Mallick, 2011): through its interaction with its surrounding environment, it should be more aware of the needs of local employers and try to adapt its curriculum. Thus, the decision-making of employers in the recruitment process is a limit to the entrepreneurial university's impact on the development of human and social capital in the region, especially if there is a lack of interaction with regional non-academic employers on their needs for doctoral-level skills and the adaptation of doctoral education to consider them.

Although the Catalan database provides a lot of first-hand information from doctorate holders themselves, it is harder to understand the education mismatch and their choices to accept a job which does not require a doctoral degree. Some features of the chosen position outside academia might provide a partial explanation to this: doctorate holders who did not use their doctoral degree in the recruitment process tend to have more stable and/or better-paid jobs. However, the database lack contextual and personal information on these specific choices, which could enable us to verify hypotheses explaining them, such as familial constraints or any similar specific attachment to the region. Trajectories of doctorate holders have already been studied (Cañibano et al., 2018; Cruz-Castro & Sanz-Menéndez, 2005; Mangematin, 2000), but not necessarily with the lens of job mismatches. A declining interest in a research career, observed by Roach & Sauermann (2017), does not however seem very plausible as the surveyed doctorate holders are very positive towards their doctoral studies. Qualitative data from employers of the PRUAB give complementary information on this, as some of them are doctorate holders themselves. The main reasons they express for their career choice to leave academia after graduation are a need for more certainty and stability in their employment conditions (which is coherent with the observations made from the database); and to get engaged in entrepreneurial ventures to commercialize research results or to create tailor-made jobs for themselves, which is in line with the identification of self-employment as a solution to job mismatches (Stenard & Sauermann, 2016). Thus, the decision-making of doctorate holders

in the recruitment process is also limiting the entrepreneurial university's impact on the development of human and social capital in the region, to the extent that doctorate holders might choose not to fully use the education and skills acquired despite the heavy investment it took on their part.

In summary, the appended papers discuss job mismatches of doctorate holders as a limit to the impact of the entrepreneurial university in its region, because it implies a non-optimal use of human and social capital whose development is mainly supported by the university. Thus, the employability of doctorate holders is key in the entrepreneurial university's socioeconomic impact. However, the decision-making of employers and of doctorate holders in the recruitment process is out of the scope of the entrepreneurial university's influence and responsibilities. The large majority of non-academic employers might not really understand what doctoral education entails, what it is worth, and how it can be useful to them, and this population of non-academic employers is so varied that it is challenging for the entrepreneurial university to consult all of them to revise its doctoral education curriculum. Finally, the final decision-making of individuals can make a doctorate holder renounce his/her doctoral degree to find employment, because of personal or external constraints such as a low demand for his/her profile on the labour market.

3. Regional stakeholders' roles to enhance doctorate holders' employability

We have seen that job mismatches are limits to the entrepreneurial university's impact on the development of human and social capital in its region, mainly because of the two main decision-makers in the recruitment process, who are doctorate holders themselves and employers. This calls for a need for an evolution of doctoral programmes, for more relevance and more consideration of non-academic employers' needs, and for an enhanced employability of doctorate holders outside academia, which has already been discussed in the literature (Metcalf, 2006; Nyquist, 2010; Thune et al., 2012).

A first objection against such an evolution is that it implies an increased involvement of third parties, in particular industry, in both research and education, possibly limiting the researchers' autonomy *vis-à-vis* political or funding stakes (Blumenthal et al., 1996). However, this autonomy has become more theoretical than real, since funding diversity is one characteristic of the model of the entrepreneurial university (Clark, 1998), although autonomy remains in

accepting funding – and the implied responsibilities – from a particular stakeholder or not. Thus, the partiality of funding seems more relevantly debated on its use than on its acceptance or not. Another objection can be that the over-production of doctorate holders is not happening everywhere in the E.U. (Santos, Horta, & Heitor, 2016), thus implementing an evolution of doctoral education is not necessary at the moment. However, Roach and Sauermann (2017; 2012) have shown that it frequently happens that doctoral students change their minds during their studies on whether they would like to continue working in academia or not. Besides, it is quite likely that these countries follow the same trend as other European countries, but only a little bit later. Considering a revision of doctoral education would help them anticipating issues of job mismatches and be as competitive as other countries in terms of labour market. Enhancing the employability of the graduates seems a good option in this context.

Non-academic employers and doctorate holders can play a role in enhancing the employability of doctorate holders. Nyquist (2010) introduces a list of varied stakeholders who play a role in doctoral education and have an interest and capacity to take part in its evolution, in particular government agencies (i.e. policymakers). The appended papers 3 and 5 enable us to consider additional stakeholders which are intermediaries such as Science Parks, and which can play an indirect but facilitating role in doctoral education and employment.

Non-academic employers can make the difference in enhancing the employability of doctorate holders outside academia. The case studies of interactions between Linköping University, KTH and UAB and local non-academic employers show that increased university-industry collaboration is key, especially when it deals with education and/or training to enhance employability. Interviews of some non-academic employers who are doctorate holders themselves, show that collaborative doctoral programmes can be decisive in their transition from academia to industry, and to find a suitable position outside academia. Such programmes, involving external funding and supervision of the doctoral student, have indeed been recognised in the literature as ways to enhance the employability of doctorate holders outside academia (Roberts, 2018; Wallgren & Dahlgren, 2007). In particular, industrial doctoral programmes, through which companies actually hire doctoral students, have been implemented in an increasing number of countries (ANRT-Cifre, 2010; Metcalfe, 2006). Nevertheless, there are other types of initiatives that non-academic employers can take on. The case of SSCP shows that they can directly take part in education by being involved in teaching, or by funding professorships. The case of UAB shows that non-academic employers can be consulted with regards to the curriculum design, as happened when designing the ‘Professional Competence

Model for UAB Researchers' by UAB doctoral school, which entails a programme to teach transferable skills across the university. Finally, the interactions between Linköping University and Science Park Mjärdevi and its tenants, although they are not focused on doctoral students and doctorate holders, suggest two other initiatives which could be relevant for them also. Non-academic employers can temporarily hire students, thus supporting inter-sectoral mobility experience without getting involved in the three years or more needed to complete a PhD: this can be done through internship, or consultancy missions (as through Sommarkampen, or Spetsa). Employers can also more generally take part in events or meetings with the university and/or students, both formally or informally, to get to know the students and their abilities, and potentially spot the human resources they could need: for example, in job fairs (such as LARM) or in other events such as hackathons. Finally, employers can also take part in entrepreneurship events, to discover and support the development of students' ideas which could be interesting for their companies, for instance in business plan competitions such as the Venture Cup. Non-academic employers thus have many opportunities to influence doctoral education to fulfil their needs.

It is possible for doctorate holders to find a matching job outside academia, sometimes even tailor-made: this can for instance be seen when doctorate holders launch their own entrepreneurial ventures. Doctoral students can also get inspiration from master's students to initiate interactions with employers and enhance their employability: at Linköping University, they organise career fairs through student associations; or take part in the board of students in the nearby Science Park. Another solution for doctorate holders is to turn to self-employment: some interviewed employers of PRUAB are actually doctorate holders themselves, having chosen to engage in entrepreneurial ventures to commercialise their research results, and to escape an academic career in which they considered they had no perspective. Finally, if doctorate holders find it difficult to engage in an entrepreneurial venture because they feel they do not receive enough support from their university, they can actually complement the entrepreneurial university's support to entrepreneurship by creating themselves the organisations and activities dedicated to supporting neophyte entrepreneurs: this is what happened at Stanford University. Doctorate holders thus can prevent the job mismatches they might encounter by behaving entrepreneurially.

Finally, intermediaries such as Science or Research Parks play an indirect role in doctoral education and in the employment of doctorate holders (unless they are employers themselves). At first sight, this role can seem irrelevant, because Science Parks' main missions deal with real

estate, logistics and tenant membership, in other words far from doctoral education issues, they have been increasingly concerned with talent recruitment, not only for their tenants but also for their own success (Cadorin, Klofsten, & Löfsten, 2019). Doctorate holders, as highly-educated workers, can be considered as talent. In this context, one of Science Parks' roles can be to create meeting places and opportunities between its tenants and students of the university. Intermediaries can, for instance, organize entrepreneurship competitions, or other interesting initiatives to encourage students and local employers to get to know each other and find a potential matching, as the cases of Science Park Mjärdevi in Linköping show. But companies of the parks can be more directly involved in doctoral education by participating in boards for the design of curricula, or by training doctoral students through internships or industrial doctoral programmes: for example, large companies in the SSCP train quite a lot of doctoral students through industrial doctoral programmes. However, these kind of activities are most of the time ad-hoc initiatives which are not viable in the long-term; there are thus improvements to be made. In particular, there is a need for increased cognitive proximity between employers and university. This proximity can be facilitated by the park as intermediary, all the more when the park is actually a joint initiative of regional stakeholders, as in the case of the SSCP. The cases of PRUAB and SSCP differ in particular in terms of composition of the board (the university is majoritarian in the PRUAB but not in the SSCP) and types of tenants (there are two large companies in the SSCP, while the PRUAB is mainly composed of SMEs). Comparing the two cases shows that when the university is the major stakeholder of the park, it involves practitioners in the theoretical part of doctoral education; while when large companies are major stakeholders of the park, practitioners' engagement in doctoral education touches more upon practice. For example, PRUAB is involved in the entrepreneurship course held in the framework of the teaching of transferable skills for UAB researchers; while large companies in SSCP have the resources to complement PhDs' education through hands-on experiences such as industrial PhDs. Thus, although they might not have thought about it and considered it in their missions, intermediaries can actually play a role in doctoral education of their nearby university.

In summary, the appended papers show that the entrepreneurial university is not the only stakeholder working on the employability of doctorate holders: in particular, non-academic employers and doctoral students themselves are the main actors involved. Other stakeholders such as intermediaries can also play a role, however indirect. All of them can have initiatives

complementary to those of the entrepreneurial university; nevertheless, for now, most of them are informal or ad-hoc, calling for more formalization which could bring more sustainability.

4. Summary

The appended papers answer the research questions in several ways. Firstly, they highlight the importance of the development of human and social capital by the entrepreneurial university to its region, extending the image of the entrepreneurial university as a mere producer of patents and spin-offs. This is done by studying real interactions occurring between an entrepreneurial university and its environment in order to retain human capital in the region. Secondly, the papers also show that the socioeconomic impact of the entrepreneurial university is somewhat limited, and that the employability of doctorate holders is key in this issue. Job mismatches of doctorate holders are indeed observed, and interpreted as a non-optimal use of the human and social capital generated. Several hypotheses are formulated to attempt explaining these job mismatches: non-academic employers might not really understand how doctoral education could be useful to them; the variety of non-academic employers makes it difficult to collect all their needs and consider them when revising doctoral education curricula; and the free will of individuals can prevent a doctorate holder from using his/her doctoral degree to find employment suitable for his/her personal situation. Finally, doctoral students and non-academic employers, as well as intermediaries and policymakers, were identified as potentially able to complement the entrepreneurial university's activities to enhance the employability of doctorate holders, through for example the collaborative building of curricula.

CHAPTER 5. Conclusion, contributions and suggestions for future research

This final chapter generalizes the research results presented in the previous sections. Then, both theoretical and practical implications of the dissertation are highlighted. The section ends with a discussion of the main limits of the dissertation, with suggestions for future research.

1. Generalisation of research results

1.1. RQ1: How does the entrepreneurial university increase its socioeconomic impact?

The findings presented in chapter 4 section 1 suggest the following propositions:

- an alignment among regional stakeholders, built over the years thanks to relations with key individuals, is essential to increase the entrepreneurial university's socioeconomic impact in the region;
- retaining human and social capital within the entrepreneurial university is necessary to be able to create and maintain these relations with regional stakeholders;
- the entrepreneurial university also increase its socioeconomic impact by broadening the scope of its actions and regional stakeholders, through more or less direct support of other stakeholders' initiatives.

The findings indeed show that it is the varied interactions between the entrepreneurial university and regional stakeholders which create both human and social capital, because they enable the stakeholders to reach an alignment of strategies, a consensus, or a shared vision: e.g., through the involvement of industrial partners in education and the involvement of students outside the university. In addition, the entrepreneurial university also needs such human and social capital itself, to be able to take or generate opportunities and create sustainable relations with regional stakeholders. This means that the entrepreneurial university also takes part in the retention of human capital in the region, both inside and outside itself. The entrepreneurial university is actually involved in interactions with regional stakeholders such as Science Parks and their tenants, which aim at retaining talent in the region. Such interactions can be classified by type depending on their degree of formalism and the maturity level of the interacting firm. In these

interactions, Science Parks and entrepreneurial universities are intermediaries between university students and local employers, but their roles are nevertheless indispensable, to create meeting places and to provide institutional support as well as a brand to students. The findings also emphasize that entrepreneurship does trigger an impact (human and social capital) in the region even though it is hard to measure quantitatively. Entrepreneurial mindsets are developed, leading to the creation of companies, but not necessarily immediately, sometimes this happens a few years later, sometimes in a different region, or sometimes within a company (in the form of intrapreneurship). The entrepreneurial university supports all kinds of entrepreneurial initiatives: a direct impact is the observable provision of human and social capital through graduates getting employed in the region. An indirect impact is for example the alumni who, educated in the entrepreneurial university, have developed an entrepreneurial mindset, and kept links with their university, sometimes thanks to intermediaries.

All in all, it is its openness and the interactions with its surrounding environment which enable the entrepreneurial university to attract human and social capital to the region: it is a virtuous circle of interactions between internal and external stakeholders of the entrepreneurial university, which enable them to get to know each other and to interact formally or informally, usually in the long-term (from a couple of years to decades).

1.2. RQ2: Why and how is doctorate holders' employability key in the entrepreneurial university's impact?

The findings presented in chapter 4 section 2 suggest the following propositions:

- doctorate holders' profiles are not necessarily competitive on the non-academic labour market compared with those of masters' graduates;
- doctorate holders are likely to experience education and skills mismatches when employed outside academia, which implies a non-optimal use of the provided human capital;
- non-academic employers and doctorate holders respectively lack knowledge about doctoral education and career possibilities outside academia, which can lead to job mismatches.

Many non-academic employers, including some being doctorate holders themselves, would rather hire masters' graduate over doctorate holders, because they see masters' graduates as more flexible. Moreover, many doctorate holders do not use their doctoral degree to find

employment outside academia, mainly to stay in the region and for family reasons: they experience an education mismatch. They also experience a skills mismatch, in particular a lack of knowledge of the business world and practices. The decision-making and personal preferences of individuals limit the impact of the entrepreneurial university. The entrepreneurial university does not really have any say in the final choices made by doctorate holders: indeed, doctorate holders might lose interest in their expertise, or in a research career, or might choose to prioritize their personal situation (for example, a place of living for familial reasons) over the use of their education or over their professional aspirations. It does not have a direct influence on the decision-making of employers in the recruitment process: for instance, employers do not necessarily want to collaborate with universities, and they often do not communicate their needs for skills to universities. They also do not necessarily wish to invest in expensive workforce such as doctorate holders, because they do not know what it could bring them, in particular if additional investment is needed to finalise the training for doctorate holders to be ready to work for their organisation. This is especially the case of SMEs which particularly lack of time and resources in comparison with larger companies.

To summarize, the employability of its graduates is a priority for the entrepreneurial university, witness all the initiatives implemented in particular for its masters' graduates such as career centres. However, it does not have the influence nor the authority to make the graduate find and accept a matching job. Job mismatches are limits to its regional impact since they represent a non-optimal use of the human and social capital it provides to the region. This impact is thus limited by the decision-making of individuals and organisations.

1.3. RQ3: What roles can regional stakeholders play in enhancing doctorate holders' employability?

The findings presented in chapter 4 section 3 suggest the following propositions:

- increased UI collaborations enable non-academic employers to communicate their needs for skills and influence education to improve the employability of graduates;
- doctorate holders have several means to improve their own employability, including the exploitation of their networks, interactions with employers and self-employment;
- intermediaries such as Science Parks also play an indirect but facilitating role in creating opportunities for employers and graduates to meet.

Initiatives from doctorate holders and non-academic employers complement those of the entrepreneurial university to enhance the employability of doctorate holders in terms of content and form. Doctorate holders and non-academic employers need to get to know each other better. On the one hand, doctorate holders need to learn about non-academic careers during their doctoral studies, how it is to work outside academia, and how they could fit in there, just as master's graduates do. Doctoral students make decisions during their doctoral studies to enrich their sets of skills that could make the difference in the recruitment process for a non-academic position: an increased focus on how to 'sell themselves' when searching for a non-academic job, i.e. present their profiles so that they are attractive to employers, is one initiative they can take. In other words, they can learn how to better promote the human and social capital they hold on the job market, for example by getting involved in collaborative projects during their studies and building their own inter-sectoral networks. This is indeed a way not only to develop generic skills applicable outside academia, but also to get an insight of whether a career outside academia could be interesting for them. It can also enable them to create relations which can lead to a targeted recruitment, i.e. a perfectly matching employment situation, at least in terms of skills, education and missions. On the other hand, non-academic employers need to understand how doctorate holders could be useful to their organisations, and collaborate with the university to enable doctoral students develop their high potential during their studies and be ready to work for them after graduation. By collaborating with entrepreneurial universities, they can have an overview of what graduates have to offer, they can meet them and test them in the framework of a course at the university or an internship at the company, and they can influence the education to fill their needs. Finally, intermediary organisations such as Science Parks can play an indirect role in providing meeting places for employers and doctorate holders, or interacting with the university to organize such meetings: the Science Park could represent employers while the university could represent doctoral students and doctorate holders.

In summary, the entrepreneurial university cannot solve by itself the issue of job mismatches for doctorate holders, as it is a matter involving mainly doctorate holders and employers themselves, and it is hard to interfere between them. Thus, doctorate holders and employers take initiatives themselves to complement the activities of the entrepreneurial university and enhance the employability of doctorate holders, both in terms of content and form. The entrepreneurial university and other organisations such as intermediaries indirectly support doctorate holders' and employers' initiatives.

2. Contribution to theory

The dissertation contributes to the body of knowledge on the entrepreneurial university. It is indeed based on this concept, and in particular on the theoretical approach called “model of development of an entrepreneurial university” by Centobelli et al. (2019, p.180), mainly developed by Guerrero and Urbano (2012; 2013; 2014; 2016). It focuses on the provision of human and social capital to its region, and thus uses a large part of this model. The dissertation also attempts to enrich this model by focusing on the population of doctoral students and doctorate holders from the entrepreneurial university and considering the viewpoint of internal and external stakeholders on the issue of provision of human and social capital to the region: doctorate holders, regional employers, and regional intermediaries such as Science Parks. Furthermore, it tackles the issue of job mismatches of doctorate holders, and assesses the extent of responsibility and influence the entrepreneurial university could have on them, in particular through the enhancement of doctorate holders’ employability outside academia.

As it focuses on doctoral students and doctorate holders in the entrepreneurial university, the dissertation also contributes to the literature on doctoral education, using the theoretical lens of the entrepreneurial university and suggesting that this model of university helps to increase the relevance of doctoral education and to enhance the employability of graduates. The research also examines how what happens after doctoral studies shapes the content of doctoral education, instead of tackling the process of studies and the ex-post-employment situation separately. Finally, it introduces the issue of branding doctoral education to employers outside academia, in other words the issues of communication and marketing, while the current literature on doctoral education tends to look mainly at the content of the curriculum.

Thus, the dissertation contributes to both bodies of literature on the entrepreneurial university and on doctoral education, by participating in filling the research gaps introduced in Chapter 1.

Regarding knowledge gaps on how the entrepreneurial university increases its socioeconomic impact: the dissertation suggests, based on two cases of entrepreneurial universities, that the entrepreneurial university develops its own model, either by expanding its scope of influence, or by developing towards a model which implies a broader impact, in particular the societal aspect of this impact. The dissertation thus contributes to the literature on the entrepreneurial university by discussing the evolution of this model. The transformation of traditional universities towards the model of the entrepreneurial university is already thoroughly explored

in the literature. The appended papers explore the next steps, beyond the creation of entrepreneurial universities: how to maintain the model of the entrepreneurial university, and improve it by increasing its impact, or how to evolve to a different model, with more societal impact.

Regarding knowledge gaps on the employability of doctorate holders, and their role in the entrepreneurial university's impact, the dissertation explores the issue of job mismatches of doctorate holders in the regional non-academic labour market. The dissertation complements the dominant view on the over-education of highly-educated workforce: it mainly highlights skills mismatches from the viewpoints of employers, but also a prominent regional dimension in doctorate holders' decision-making when looking for a job. This latter result is particularly interesting since doctorate holders are part of a worldwide community of researchers and theory has been so far examining their case in the framework of an international labour market.

Finally, regarding knowledge gaps on enhancing the employability of doctorate holders through a reduction of the observed mismatches: the dissertation highlights the characteristics of the entrepreneurial university which enable doctoral students to do it, more or less directly and more or less formally, mainly by applying the established theory on the entrepreneurial university to the case of doctorate holders. However, it also broadens the scope of analysis, and thus the theoretical insights, by including the initiatives of partners of the entrepreneurial university (such as industrial employers), as well as less institutionalized initiatives (those of students themselves for instance). As for the commitment in solving the issue of job mismatches, the dissertation identifies actors and their roles in adapting doctoral education to the needs of non-academic employers, such as employers themselves, and students, and intermediaries like Science Parks, to be included in the theoretical considerations on doctoral education and doctorate holders' employment. Finally, the dissertation explains the persistence of mismatches by the lack of coordination between actors and their respective initiatives, as well as the lack of proven positive impact of those activities on job mismatches.

3. Practical implications

The dissertation has practical implications for various stakeholders. In the literature, recommendations to enhance the employability of doctorate holders can be found. Roberts (2018) highlights the importance of inter-sectoral mobility. Thune et al. (2012) put an emphasis on generic skills and collaboration for more relevance of the Ph.D., as well as keeping track of the career of graduates. Frameworks listing the skills researchers should master have also been created, that universities can use to build their curricula (LERU, 2016; Vitae, 2010). Nevertheless, most of these recommendations are formulated to the entrepreneurial university and ministries of higher education. This dissertation identifies implications for the entrepreneurial university, doctoral students and external stakeholders. It is in line with, and complements, LERU's position paper on the careers of doctorate holders (LERU, 2018), which also formulate recommendations to universities, employers, doctoral students and governments.

The dissertation presents implications for the entrepreneurial university. It shows that the activities of the entrepreneurial university have already some impact, direct or indirect, in the provision of human and social capital to the region, and in the attempt to reduce job mismatches. However, it also shows that the entrepreneurial university cannot control everything and cannot really interfere in the employment of doctorate holders. One implication is thus that it should continue conducting its current activities, keep watching for initiatives created by its internal stakeholders (faculty, staff or students), in particular if they aim to enhance the employability of doctorate holders, and support or incorporate these initiatives to make them sustainable. Moreover, the entrepreneurial university can work on the branding of doctoral education, so that employers get interested in it and find it worth to invest in, both by hiring doctorate holders but also by getting involved in making doctoral education more relevant for their needs. Finally, previous results show the existence of diverse initiatives from various stakeholders (including the entrepreneurial university): a recommendation is to bring these initiatives to their highest potential by institutionalising them, which could avoid redundancy, and could make them sustainable. However, this should not prevent the initial steps to be informal as this might be necessary in the creation of the initiatives. Such an institution could take care of developing a proximity with non-academic employers, and a process of communication and feedback on their needs for skills. It could for example take the form of a career centre dedicated to doctorate holders, as it already exists in some universities, and as it already exists in almost all higher education institutes for bachelor's and master's students. It could be managed by doctorate

holders, who might suggest solutions to the gaps they could have experienced themselves during their doctoral studies and after graduation.

Then, the present research implies that doctoral students and doctorate holders should keep in mind that they are the prime actors in their career choices and employment situations. They should dedicate a substantial part of their studies, preferably from the very beginning, to learn about their career possibilities and how to enhance their employability, and acquire different experiences, for example by working in a company, to make up their own minds about this and to get a grasp of how they could find a job matching their abilities and preferences there. To do that, doctoral students should take advantage of what the entrepreneurial university, the employers and intermediaries make available to them. Finally, if something is lacking, they should take initiatives and behave entrepreneurially to make up for this identified lack. An example of this is the creation of organisations aimed at branding doctoral education and making employers and doctorate holders get to know and meet each other, such as PhD Talent, an online platform created by doctorate holders, and a company organizing the largest job fair for doctorate holders in Europe: the PhD Talent Career Fair.

As for non-academic employers, they should invest beforehand work on the quality of the human resources they would need and hire. One way to do that would be to work on their own ability to anticipate their needs for skills, and to then work hand in hand with their nearby university. They should not hesitate to ask the help of intermediaries such as Science Parks, to take the relevant contacts there, or use these intermediaries as delegates in this matter if they really lack of time and resources to dedicate to it.

Finally, this research has implications for policymakers, by showing that: (i) there is a potential in the model of the entrepreneurial university to attempt reducing job mismatches; (ii) the population of doctorate holders, even though they are the most highly educated, should not be neglected in employment and educational policies; (iii) there is a potential in working at the regional level as the geographical proximity of stakeholders can facilitate the development of other types of proximities and make the varied stakeholders collaborate and get involved in working for a better employability of doctorate holders.

Table 5. Summary of recommendations.

Implication for:	Recommendation:
Entrepreneurial university management	<p>Create career centres for doctorate holders, to support them in their transition to work after graduation, and to brand doctoral education to employers.</p> <p>Develop different types of proximities with regional employers and a process of collection of needs and feedback on the provided human and social capital.</p> <p>Create an institution dedicated to watch for ad-hoc or spontaneous initiatives and to provide support to them, or to institutionalise them.</p>
Regional employers	<p>Learn about doctoral education and its advantages for them, especially in terms of human and social capital.</p> <p>Develop different types of proximities with the nearby university and engage in a process of communication of needs and feedback on the provided human and social capital.</p> <p>Be willing to open their walls such as through temporary placements and to engage in initiatives to enhance the employability of doctorate holders.</p>
Doctoral students in the entrepreneurial university	<p>Enhance their employability and learn how to ‘sell’ their skills to employers.</p> <p>Learn about their different career possibilities.</p> <p>Start initiatives themselves to fill the gaps or lacks they might experience.</p>
Other regional stakeholders	<p>Implement policies supporting the recruitment of doctorate holders outside academia.</p> <p>Organize regional PhD career fairs.</p> <p>Create intermediaries dedicated to both SSH PhDs, to balance with the support existing for STEM PhDs.</p>

For more information, examples of initiatives illustrating these recommendations are available in Appendix 4.

4. Limits

Every research project has its limits, and each appended paper details their own limits. This section presents the main limits of the overall dissertation, in particular in terms of methods and content.

The limits of this dissertation are inherent to the use of case studies in research. In particular, the issue of generalizability of the results is much discussed. The relevance of the chosen cases for all papers can be justified, but there will always be a bias of convenience, because research can be conducted when data is accessible, which often depends on opportunities and availability. This dissertation aims at suggesting recommendations to universities, regional policy-makers and doctoral students in the E.U. However, some limits can be highlighted in such a task.

A first limit to this dissertation is that I have not studied all the regional settings within the E.U. Overall, in the six appended papers, four universities are used as cases, from four regions in three countries (Sweden, Spain, the U.S.). The whole sample is far from covering the 28 E.U. members and the more than 300 NUTS2 E.U. regions. One advantage to focus on such a small sample is the opportunity to analyse it more in depth, and more completely; however, it raises an issue of generalizability of the research results. For example, could recommendations formulated for Swedish regional stakeholders be valid for Polish regional stakeholders? It obviously depends, both on the recommendation itself and on the regions, if they share similar characteristics relevant for to apply the recommendation (Firestone, 1993). However, one of the cases in this dissertation is Stanford University: can this case be really valid for European stakeholders? American and European higher education systems and economic systems differ a lot; however, they also influence each other. The European system is often said tends to imitate the American one (Djelic, 2008). Knowing that Stanford University is the role model in terms of entrepreneurial universities, studying its challenges remains relevant to anticipate similar challenges in the European context. Besides, although this issue of generalizability of qualitative research results has been discussed a lot in the literature, case studies are still frequently used in social sciences (Gavard-Perret et al., 2012; Yin, 2003) and are often the starting point for research topics: explorative case studies are needed to discover new phenomena or solutions (Flyvbjerg, 2006). Using case studies can also be valuable for policy-makers, as it has already been shown that “one-size-fits-all” policies are not always relevant (Tödtling & Tripl, 2005).

Besides, the outcomes of this dissertation have not been verified: recommendations are formulated to various stakeholders, but their effective implementation has not been tested. For instance, the different examples cited to illustrate the recommendations do exist, but their actual impact on job mismatches has not been studied.

I chose to focus on doctoral education in STEM disciplines only (Science, Technology, Engineering and Mathematics) because of their higher propensity to leave academia for industry after graduation. This focus does not reflect the heterogeneity of disciplines within academia: major differences in doctoral education and in research in general have been observed between STEM and SSH disciplines (Social Sciences and Humanities) (Bienkowska et al., 2016). This focus also does not reflect the heterogeneity of doctoral education within the E.U., in other words the variation of the proportions of formal and informal education during doctoral studies (Djelic, 2008; Sam & van der Sijde, 2014) – witness for example the

differences in ECTS validation requirements to get a Ph.D. degree between different countries. Finally, this focus also does not reflect the variety of non-academic organizations that are potential employers for doctorate holders: in this dissertation a clear focus is made on industrial employers; but public services for example are important employers for doctorate holders (Drejer et al., 2016). However, all these mentioned heterogeneities make it harder to identify solutions for the whole system of doctoral education and doctorate holders' employment. The choice to focus on STEM and industrial employers make it a starting point to suggest solutions, which can be tested for other populations and settings later on.

In addition, the model of the entrepreneurial university is the main focus and framework for this research. The literature on this model was extensively studied, and examples of entrepreneurial universities were chosen as learning cases for the dissertation. The results thus apply to entrepreneurial universities; implications and recommendations are formulated for universities using this model or aspiring to it. Although other models of universities are mentioned in the frame of reference (chapter 2), this dissertation does not look into these other models, one could be more relevant or have more potential than the model of the entrepreneurial university for what regards the issue of employability and job mismatches of doctorate holders.

Another limit is classical in social sciences: personal preferences of doctorate holders and personal life trajectories (e.g. family) can sometimes be difficult to observe. Besides, influencing the free will of individuals is not necessarily desired in our European context of freedom and democracy. Suggesting recommendations on these issues brings to a discussion about how policy can influence personal lives, both in terms of whether it should do so, and whether it has the power to do so.

Finally, the topic of this dissertation is at the crossroads of disciplines (innovation, entrepreneurship, educational sciences, economics). Thus, sticking to one discipline or to one theory only was very difficult to conduct the research. Consequently, the results of the research do not contribute to one discipline or one theory only, which might make it difficult to use by other researchers and by practitioners.

5. Suggestions for future research

This dissertation explored the enhancement of the employability of doctorate holders by the entrepreneurial university, to support the development of human and social capital in its region. It has achieved an exploration of the activities of the entrepreneurial university as well as its challenges and limits, an identification of job mismatches of doctorate holders outside academia, and the identification of initiatives from doctorate holders, non-academic employers and intermediaries to complement the entrepreneurial university's activities, to reduce the job mismatches more or less directly. The above-mentioned limits to the dissertation suggest that there is still a fruitful research agenda around the employability and job mismatches of doctorate holders, and more generally around the role of universities in regional development. In the framework of the RUNIN project, several dissertations explore this research topic under different theoretical lenses.

Future research could help making up for the limits previously mentioned. Similar methods could be applied to other models of universities, in particular the model of the engaged university, to determine whether this model could be more suited to solving the issue of job mismatches for doctorate holders. In addition, conducting quantitative studies, using longitudinal data from the labour market for example, and complementing it with qualitative data on the regional contexts, could help to test the formulated hypotheses, identify good practices, and test the suggested recommendations. Another idea could be to study some initiatives already in place, such as PhD career centres, and explore whether such an initiative brought positive change, and if yes, how and why and if this could be useful for other contexts.

Future research could also explore how education and professional experience preceding the admission to the PhD influence doctoral education and employment after graduation. Indeed, most of the literature dealing with doctoral students and doctorate holders look at the process of doctoral education and the time after, but not really what happens before. We have seen that doctoral programmes are not homogeneous in terms of education within the European Union: average duration of the studies, proportions of formal and informal training, requirement of a monograph or compilation thesis, etc. Doctoral programmes are not homogenous in terms of admission criteria as well: for instance, some universities require a certain score at the GMAT and TOEFL examinations, while others do not require them at all. In some contexts, it is possible to start a PhD right after getting a bachelor's degree; in others, a master's degree is required, sometimes even with a research specialisation. This, for instance, might influence

greatly the extent to which there is a need for teaching transferable skills at doctoral level: students who got a vocational degree such as an engineering degree before pursuing a PhD as well as those who worked for some time might already master some transferable skills, while bachelor's graduates might not.

To conclude, this dissertation supports the entrepreneurial university as a relevant model to enhance the employability of doctorate holders both within and outside academia. The main reasons for this claim are the distinguishing capabilities of interaction and flexibility of the entrepreneurial university, in particular with its surrounding regional stakeholders. Indeed, these capabilities enable synergies to be created within the region, through the spreading of entrepreneurial mindsets, as well as increased collaboration opportunities and proximities. All this opens the possibility for employers, doctoral students and universities to communicate their expectations and offers to each other, and to better adapt to the quickly evolving labour market situations. Such alignment between the three main actors in the issue would ideally support the reduction of job mismatches, although this still needs to be proven.

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APPENDICES

Appendix 1: Higher education models, their basic features and impacts on transformation. Source:(Sam & van der Sijde, 2014, p. 896).

Higher Education Model	Basic features	Impacts
Humboldtian Model	Research-based learning Academic freedom of research and learning Centralized system of governance	Research becoming a central area of study in modern higher education
Napoleonic Model	High-level vocational training Professional education Centralized system of governance	Vocational and technical training becoming crucial to prepare students for the rapidly-changing labor markets
Anglo-Saxon Model	Personality development through liberal education Professionalism Institutional autonomy or self-governing institutions	Soft skills being emphasized in modern higher education to enable students to act flexibly and intelligently in a changing and challenging environment
Anglo-American Model	All the basic features of the European models integrated Decentralized system of governance Massification of higher education	Research, technical training and professionalism being incorporated in contemporary higher education worldwide Entrepreneurialism model of higher education institutions becoming critical for the competitive academic market place

Appendix 2: Highlight on scope of university partners in the different university models.
Source: author, based on (Uyarra, 2010)

Appendix 3: Interview guide

INTRODUCTION

- Present my research topic and investigations
- Explain why I chose to interview him/her
- Ask for reading and signature of paper on ethics
- Make a summary of what I know about his/her organization (goal, missions, difficulties) and ask for validation or correction
- Ask: what is your exact role in your organization?

IDENTIFICATION OF STAKEHOLDERS

- Are you involved (or is your organization involved) in PhD education and/or PhD candidates' or PhD holders' recruitment?
 - If yes:
 - How are you involved? (examples of concrete actions are expected)
 - What has your organization to gain from such an implication?
 - What are the issues encountered?
 - What could be improved?
 - Do you work in collaboration with other stakeholders?
 - If no:
 - Why?
 - Would you (or your organization) like to get involved? How? Why?
- Do you know if other stakeholders are involved in PhD education and/or PhD candidates' or PhD holders' recruitment?

DESCRIPTION OF PROCESSES OF NEEDS' ANTICIPATION AND PhD EDUCATION ADAPTATION

- According to you, do such processes exist today?
 - If yes:
 - How are they organized?
 - What are the steps?
 - Who is involved?

- How would you assess their relevance and their performance?
 - What could be improved?
- If no:
 - Why don't they exist?
 - Do you think that they should exist?
- What are the advantages and drawbacks to be a member of the Science Park regarding PhD education and PhD recruitment?
- If there is enough time: try to draw together the process with post-its > one colour for the step of process, another colour for stakeholders involved)

CONCLUSION

- Make a summary of the main points discussed
- Ask if he/she wants to add anything
- Ask if he/she could provide additional contacts to interview
- Thanks for his/her time and contribution
- Let him/her know that I will keep him/her updated with the research and send him/her my analysis for correction or validation of the information used

Appendix 4: Summary of formulated recommendations, and corresponding existing initiatives.

Stakeholder:	Recommendation:	Examples:	Description:
Entrepreneurial university management	Create career centres for doctorate holders, to support them in their transition to work after graduation, and to brand doctoral education to employers.	<i>AU Career PhD & JR</i>	This career centre at Aarhus University provides a panel of services for PhDs and young researchers: individual mentoring, job fair, online platform providing toolkits and statistics, etc. These activities are similar to other career centres, but are dedicated to doctoral instead of master's graduates. Source: http://talent.au.dk/career/
	Develop different types of proximities with regional employers and a process of collection of needs and feedback on the provided human and social capital.	<i>Industrial Advisory Boards (University of Leeds)</i>	With the main aim to inform the board dedicated to design programme curricula, industrial advisory boards are ideally composed of university representatives (management, teaching and research representatives), industry representatives ('from a range of sectors, reflecting subject relevance and graduate destinations' (p.22) and student representatives. Source: Pugh, S., & Grove, M. (2014). Establishing Industrial Advisory Boards Using a Practice Transfer Model. <i>The Higher Education Academy</i> , 10(1), 20-25.
	Create an institution dedicated to watch for ad-hoc or spontaneous initiatives and to provide support to them, or to institutionalise them.		

Stakeholder:	Recommendation:	Examples:	Description:
Regional employers	Learn about doctoral education and its advantages for them, especially in terms of human and social capital.	<i>DOCPro competence reference document</i>	DOCPro is an online platform where doctoral students, employers and academics can have an account. Doctoral students can create their profile, assess the skills they have developed and valorise them for a job application. They can also consult job advertisements published by employers. Employers can publish job advertisements, create a profile with the skills they are looking for, and consult doctoral students' profiles as well as doctoral programmes. Finally, academics can create a page describing the doctoral programmes or courses they offer to doctoral students. Source: http://www.mydocpro.org/en
	Develop different types of proximities with the nearby university and engage in a process of communication of needs and feedback on the provided human and social capital.	<i>Industrial Advisory Boards (University of Leeds)</i>	<i>See previous table</i>
	Be willing to open their walls such as through temporary placements and to engage in initiatives to enhance the employability of doctorate holders.	<i>Industrial PhD programmes</i>	Industrial PhD programmes consist of agreements signed between an industrial company and a university or a research lab, and a doctoral student. The company hires a doctoral student to conduct research. The doctoral student is also attached to an academic environment. The industrial doctoral student thus has two supervisors: one industrial and one academic. (S)he has to share his/her time between his research duties in the company and his/her academic obligations, which are in particular publications, attendance of courses and conferences and the writing and defence of his/her dissertation. Industrial PhD programmes have been successfully implemented in many European countries (France, Denmark, U.K., etc.) and continue to be implemented in other European countries (Spain: Catalonia, Italy, etc.). Source: http://www.amrt.asso.fr/sites/default/files/comparaison-europeenne_formation-doctorale_11.11.09.pdf
		<i>Agora Link</i>	In Sweden, the AgoraLink programme enables doctoral students to be mobile and experience working in a context different from the one they are used to: one in industry, one in another academic context. Source: Bienkowska, D., & Klofsten, M. (2012). Creating entrepreneurial networks : academic entrepreneurship, mobility and collaboration during PhD education. <i>Higher Education</i> , 64, 207–222.

Stakeholder:	Recommendation:	Examples:	Description:
Doctoral students in the entrepreneurial university	Enhance their employability and learn how to 'sell' their skills to employers.	<i>Ph.D. Career Seminar: "How to Sell Your Analytical Skills" to an Employer? (UiB Alumni Network, University of Bergen)</i>	Gathering PhD alumni, recruiters from different types of organisations (public and private sectors), the seminar aimed at making doctoral students aware of the different types of career possibilities, of what can be expected from them outside academia, and of how they can valorise their skills and knowledge. Source: https://www.uib.no/en/alumininetwork/114506/phd-career-seminar-how-sell-your-analytical-skills-employer#program
	Learn about their different career possibilities.	<i>PhD workshop 'Career prospects for young professionals' (Centre for Training and Development, University of Twente)</i>	This workshop aims at making doctoral students work on figuring out what they truly want to do after graduation, what kind of career they want to pursue and how they can articulate this with their personal life. Source: https://www.utwente.nl/en/ctd/courses/
	Start initiatives themselves to fill the gaps or lacks they might experience.	<i>PhDTalent</i>	The PhDTalent Career Fair, held in Paris every year, is the largest job fair dedicated to PhDs in Europe. Created by PhD graduates, it enables companies to meet doctoral students and doctorate holders and find the resources they need. Source: https://careerfair.phdtalent.org/en/home-2/
		<i>OkayDoc</i>	OkayDoc is the company behind the organization of the PhDTalent Career Fair. It is an online platform on which doctoral students and doctorate holders can offer their services to conduct expert missions for companies. Source (in French): https://okaydoc.fr/

Stakeholder:	Recommendation:	Examples:	Description:
Other regional stakeholders	Implement policies supporting the recruitment of doctorate holders outside academia.	<i>French decree of February 22 2019 (implementation of a national competence reference)</i> <i>PhD Talent Career Fair</i> <i>Bernard Gregory Association</i>	This decree details the 'competence blocs' that doctorate holders master, in order to support the recruitment of doctorate holders by non-academic employers. Source (in French): https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000038200990&categorieLien=id
	Organize regional PhD career fairs. Create intermediaries dedicated to both SSH PhDs, to balance with the support existing for STEM PhDs.		Since 1980, this association aims to promote doctorate holders' skills and employment outside academia and support innovation capacities of companies. It offers an online platform where information about training and events is available, as well as job and profile advertisement services. Source: https://www.abg.asso.fr/en/

PART II. PUBLICATIONS

Papers

The papers associated with this thesis have been removed for copyright reasons. For more details about these see:

<http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-164164>

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**The Role of
Universities in
Innovation and
Regional Development**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Marie Skłodowska-Curie grant agreement No. 722295.