

# **TOWARDS A MODEL FOR UNDERSTANDING ENTREPRENEURIAL INTENTIONS IN AN ACADEMIC CONTEXT**

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**2014**

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Submitted at Ghent University Faculty of Economics and Business Administration  
in partial fulfillment of the requirements for the Degree of Doctor in Applied Economics

Funded by Research Foundation-Flanders (FWO Vlaanderen)

PhD Series – Ghent University 2014

Faculty of Economics & Business Administration

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## ACKNOWLEDGEMENTS

*It is good to have an end to journey toward; but it is the journey that matters, in the end.*

*(Ernest Hemingway)*

And what a memorable doctoral journey it has been to me. Not only because of its intellectual and emotional highs and lows, or the many places around the world I got to visit, but mostly thanks to the remarkable people that have been supporters, guardians and friends along the way. Before embarking on a new adventurous journey, I would like to express my gratitude to those people who have enabled me to reach the destination of this one.

First of all, I would like to thank my advisor prof. Mirjam Knockaert for stimulating me to pursue a PhD and for guiding me throughout the process, while at the same time giving me the freedom to discover and follow my own research interests. Mirjam, I deeply appreciate the time and energy you have invested in offering in-depth feedback, as well as your constant encouragements to develop high-quality papers. In addition, thank you for providing me the opportunity to present at many international conferences and for introducing me to a vibrant community of entrepreneurship scholars. I truly feel privileged to be your first graduating doctoral student and I sincerely hope that more collaboration (and ice cream!) may follow in the future.

I am greatly indebted to the members of my doctoral guidance committee – prof. Maw Der Foo, prof. Truls Erikson and prof. Evila Piva – whose constructive comments played an important role in shaping my dissertation. Maw Der, thank you for our lively discussions during your research visits to Ghent (typically followed by delightful dinners). I feel honored to have been able to benefit from your expertise. Truls, thanks for providing novel insights on my research on many occasions, and for inviting me to research workshops at the Centre for Entrepreneurship in Oslo. Evila, I have genuinely enjoyed our collaboration towards publication of my first dissertation paper. Thank you for your critical reflections (and even welcoming me in your Italian home to present them) which have considerably improved the quality of my doctoral research.

In addition, I would like to address a word of gratitude to the other members of my examination committee – prof. Magnus Klofsten, prof. Nola Hewitt-Dundas and prof. Herman Van den Broeck. Despite their busy schedules, they thoroughly reviewed my dissertation and provided me with detailed and valuable recommendations. Their passion for and knowledge in the field of entrepreneurship and management made them devoted committee members, and their positive comments made me feel proud of my own work. I also want to thank my co-authors, prof. Mike Wright and Martin Obschonka, as our cooperation inspired me and enriched both my theoretical insights and practical knowledge.

This doctoral research would not have been feasible without the financial support of Research Foundation-Flanders (FWO Vlaanderen). I also would like to express my appreciation to all respondents within Ghent University (UGent) who contributed to the qualitative data collection process, and UGent Tech Transfer in particular. Without their interest in and enthusiasm for my research, conducting this dissertation would have been impossible. Further, I gratefully acknowledge the invaluable input of the technology transfer officers of all participating universities in Belgium, Sweden, Germany, Spain and Slovenia, as well as the research scientists who completed the online survey.

I warmly thank my current and former colleagues at the department of Management, Innovation and Entrepreneurship. Elien, you deserve a special word of thanks. Who could have predicted us – after our first encounter at De Kastart – turning into much more than just colleagues? From being stuck in Oslo (and an elevator!) just before Christmas, over our ‘special’ hotel and piano bar in New York, to discovering alligators and vocal ‘talent’ during our Florida road trip: I cherish the funny and unforgettable moments we experienced together both at and after work. In addition, thank you to our cheerful “office mommies” – Sofie, Kim and Ann-Sophie – and “PhD bowl manager” Vanja for the shared laughter and motivational talks, inside and outside UGent walls. I am also grateful to prof. Bart Larivière as his door was always open for methodological insights and personal support, and to Ann and Sofie for their administrative assistance. Other members of “Team Belgium” – in particular David, Ine,

Sophie, Tom and Veroniek – deserve an explicit thank you note, as this team reference used at conferences surely did not come out of the blue.

I also would like to thank everyone who played a part in making my stay at Cass Business School the truly amazing experience it turned out to be. A heartfelt word of thank goes to prof. Vangelis Souitaris, not only for accepting me as a visiting doctoral student, but also for his enthusiasm, advice, and faith in my academic capabilities, thereby inspiring me to strive to become a better researcher. I am also grateful to prof. Scott Shane and prof. Andre Spicer for welcoming me in their classes on entrepreneurship and organizational theory. The group discussions with fellow PhD students allowed me to reflect on important methodological and theoretical issues and to expand my analytical and critical thinking skills. Thank you Camilla, Charlotte, Chris, Elena, Katharina, Kevin, Manolis, (Super)Mario, Marjolein, Olivier, Stéphanie, Yasmin, Zahra, and many others for your friendship and for contributing to my incredible time in London. Special thanks to Marjolein, for my “home away from home”, the late evening talks on London’s best couch and the shared (love for) cocktails – the Nightjar is calling us for another round! – and to Charlotte, for being the best London buddy I could wish for – I keep fond memories of our weekly reunions while discovering “our” city. Although it took us almost one hour to travel to one another, team Pauwels-Huyghe has definitely left its mark as the two Belgian ladies who brunch until late evening, dance until early morning and talk all day long.

Furthermore, I am blessed to be surrounded with many pretty, talented friends. Thank you for sharing happiness and tears. Thank you for making tough times bearable and good times extraordinary. Thank you for celebrating little victories with me. Thanks to Alexander, Arne, Brecht, Deborah, Eline, Evert, Fien, Jolies, Kim C., Kim D., Len, Lien D., Lien P., Lotte, Lynn, Marieke, Mathias, Sabien, Sebastien, Sanne and Tom. In particular, I am extremely grateful for the numerous memorable brunches, (dinner) parties and (weekend) trips that I had with my awesome roommates and many guests that soon regarded “het huisje” as their second home. Special thanks also goes out to Len, the master in funny post-it notes and inspirational

quotes, and to Kim(mie), who has become my sister at heart and my partner in crime: I am absolutely sure we will always be friends because you simply match my level of crazy.

Finally, I would like to express my deepest gratitude to my family, for the (adventurous) life they have rendered possible for me through their unconditional love, support and generosity. Dieter, thank you for your encouragements and for cheering me up with your humorous side – anyplace, anywhere, anytime. Papa, you have taught me to put things into perspective, and that hard work always pays off in the end. Mama, thanks for acting as the greatest listener and adviser, for not letting the “what-ifs” and “should-haves” eat my brain, and for being the always-present emotional force behind me. I would not be who I am today if it wasn’t for you.

Annelore Huyghe

August 2014

# **LIST OF PUBLICATIONS AND CONFERENCE PRESENTATIONS BASED ON THIS DOCTORAL RESEARCH**

## **Articles**

Huyghe, A., Knockaert, M., Wright, M., & Piva, E. 2014. Technology transfer offices as boundary spanners in the pre-spin-off process: The case of a hybrid model. *Small Business Economics*, 43(2): 289-307, DOI: 10.1007/s11187-013-9537-1.

Huyghe, A., & Knockaert, M. (forthcoming). The influence of organizational culture and climate on entrepreneurial intentions among research scientists. *The Journal of Technology Transfer*, DOI: 10.1007/s10961-014-9333-3.

## **Book chapter**

Huyghe, A., & Knockaert, M. (forthcoming). The relationship between university culture and climate and research scientists' entrepreneurial intentions. In D. Audretsch, E. Lehmann, S. Vismara, & M. Meoli (Eds.), *University Evolution, Entrepreneurial Activity and Regional Competitiveness*. New York: Springer.

## **Working papers**

Huyghe, A., Knockaert, M., & Obschonka, M.. Unraveling the “passion orchestra” in academia.

Huyghe, A., Souitaris, V., & Knockaert, M.. Academic entrepreneurship: A multilevel examination of individual, subunit and organization effects.

## **Conference presentations**

Huyghe, A., Knockaert, M., Wright, M., & Piva, E. 2011. Boundary spanners in ambidextrous organizations. The case of a hybrid technology transfer office in academia. ZEW Workshop on Spin-Off Entrepreneurship, Mannheim (Germany), November 10-11.

Huyghe, A., Knockaert, M., Wright, M., & Piva, E. 2012. Technology transfer offices as boundary spanners in the pre-spin-off process: the case of a hybrid model. Academic Policy & Knowledge Theory of Entrepreneurship Conference, Augsburg (Germany), August 20-21.

Huyghe, A., & Knockaert, M. 2013. The influence of organizational culture and climate on entrepreneurial intentions among research scientists. Belgian Entrepreneurship Research Day, Brussels (Belgium), May 6.

Huyghe, A., & Knockaert, M. 2013. The influence of organizational culture and climate on entrepreneurial intentions among research scientists. Babson College Entrepreneurship Research Conference, Lyon (France), June 5-8.

Huyghe, A., & Knockaert, M. 2013. The influence of organizational culture and climate on entrepreneurial intentions among research scientists. Technology Transfer Society Conference, Bergamo (Italy), November 8-9.

Huyghe, A., Knockaert, M., & Obschonka, M. 2014. Spin-off versus start-up intentions: A tale of two passions. Babson College Entrepreneurship Research Conference, London, (Canada), June 4-7.

Huyghe, A., Souitaris, V., & Knockaert, M. 2014. Academic entrepreneurship: A multilevel examination of individual, subunit and organization effects. Belgian Entrepreneurship Research Day, Ghent (Belgium), May 13.

Huyghe, A., Knockaert, M., & Obschonka, M. 2014. Spin-off versus start-up intentions: A tale of two passions. Academy of Management Annual Meeting, Philadelphia (US), August 1-5.

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# **1. GENERAL INTRODUCTION**

## **1.1. SETTING THE SCENE: ACADEMIC ENTREPRENEURSHIP**

Universities figure prominently in regional and national innovation systems as producers and disseminators of knowledge (Etzkowitz & Klofsten, 2005). Historically, academic institutions operated under Mertonian norms that emphasized wide dissemination of research discoveries, mainly through publications, and discouraged involvement in commercial activities (Bercovitz & Feldman, 2008; Etzkowitz, 1998). Over the past decades, however, there has been growing interest to convert university-based research into economic development through entrepreneurship (Clark, 1998; Wright et al., 2008). Universities have become increasingly entrepreneurial, assuming a mandate for the realization of commercial value from research and encompassing a “third mission” in addition to their traditional tasks of education and research (Etzkowitz, 2000; Rothaermel et al., 2007). A number of interrelated events have precipitated this changing nature of university missions. First, reduced public research budgets have exerted pressure on universities to develop alternative and complementary strategies to raise funds (Ambos et al., 2008; Shane, 2004a). Furthermore, a public debate has emerged on the role which universities are expected to play in society (Wright et al., 2007). Driven by the recognition that research commercialization is a key source of innovation and national competitiveness (Ambos et al., 2008; Lam, 2011; Mansfield, 1998), policy makers have set up a range of initiatives to support collaboration between universities and industry and to stimulate academic entrepreneurship (Markman et al., 2008; Rasmussen et al., 2006; Van Looy et al., 2003). Finally, the passage of the US Bayh-Dole Act in 1980 (Mowery et al., 2002; Shane, 2004b), followed by similar changes in the legislative framework in most European countries (OECD, 2003; Wright et al., 2008), contributed to more rapid exploitation and diffusion of knowledge and technologies developed in academia. In sum, these drivers have resulted in an “academic revolution” towards entrepreneurial universities, where commercial outputs have turned into the norm, rather than an optional side activity (Etzkowitz, 2000; Thursby & Thursby, 2002). The

increased level of academic entrepreneurial activities has been epitomized by a rise in patenting, licensing, generation of spin-off companies, consulting and contract research (Shane, 2004a; Wright et al., 2007; 2008).

The growing importance of academic entrepreneurship is illustrated by the following figures relating to different commercialization mechanisms. According to the Association of University Technology Managers (AUTM), US universities created 705 spin-offs in 2012, whilst in the 1980s they spun out fewer than 100 companies a year. Some prominent examples of university spin-offs in the US are Google in internet search engines, Cirrus Logic in semiconductors, and Genentech in biotechnology. Patent activity in academia has also seen exceptional growth in the US, for instance rising from 1,584 patent applications in 1991 to 14,224 in 2012. Over the same period, AUTM reports an increase in US university licensing revenues by 1,082%, from \$220 million to \$2.6 billion. Similar trends can be observed in Europe, the research setting of this dissertation, as depicted in Table 1.1. However, the entrepreneurial transformation of academia in Europe has commenced later in comparison with the US.

**Table 1.1: Indicators of academic entrepreneurship in Europe**

	2004	2005	2006	2007	2008	2009	2010	2011
Invention disclosures	2,373	4,475	5,261	5,982	5,841	6,039	5,243	6,337
Patent applications	943	2,162	2,496	3,303	2,951	3,227	2,571	3,358
Licenses executed	423	295	3,174	3,768	3,574	4,872	4,326	5,477
Licensing revenues	€22.2mio	€82.7mio	€73.3mio	€62.3mio	€70.4mio	€70.6mio	€66.9mio	€90.0mio
Spin-offs created	108	435	473	549	480	473	579	549

Source: ProTon Europe

Survey respondents were TTOs in UK, Spain, Italy, Ireland, Denmark, Belgium, Portugal and Germany.

For instance, the number of patent applications per year has augmented progressively, from 943 in 2004 to 3,358 in 2011. Likewise, the number of licenses executed and revenues generated exhibit a constant and progressive growth trend over this period, growing by 1,195% and 305% respectively. These European figures are still far from US outputs, but nonetheless represent a positive signal of the rising involvement of universities in intellectual

property and licensing management. Furthermore, in 2011, the total number of spin-off companies founded was 549, a rise of 408% as compared to 2004 (108). These figures indicate that European universities are performing increasingly well in terms of fostering patenting, licensing and spin-off creation. For instance, Ghent University (UGent) has cumulatively launched about 65 spin-off companies<sup>1</sup>, both technology-oriented spin-offs such as ActoGenix (development/commercialization of new generation of biological drugs) or Calioipa (development/marketing of high speed fiber optic transceivers), and service-oriented spin-offs such as Möbius (consulting for supply chain/business process management) or Biogazelle (transcriptome analysis services). Further, a remarkable example in Belgium is the royalty income acquired by professor Désiré Collen, cumulatively about \$144 million, through patent protection of the molecule Tissue plasminogen activator and a license agreement with Genentech. In addition, he is founder and chairman of biotech company ThromboGenics, publicly listed spin-off of KULeuven.

Numerical data on informal or “soft” commercialization mechanisms, such as consulting and contract research (Link et al., 2007), are to a lesser extent publicly available. Yet, the Higher Education Funding Council for England (HEFCE) provides evidence of upward trends in the UK. For instance, the number of consultancy contracts in the UK has evolved from 64,292 (total value £335 million) in 2008 to 85,748 (total value £398 million) in 2012. Correspondingly, over the same period, HEFCE points to an increase in revenues from contract research by 32% at UK universities, from £835 million to £1.1 billion.

## **1.2. FOCUS OF THE DISSERTATION**

As a result of the coalescing of the worlds of science and commerce, in recent years, there has been a burgeoning empirical literature on universities’ involvement in their third mission and the entrepreneurial behavior of research scientists. Nevertheless, a number of important gaps still exist in the current understanding of (nascent) academic entrepreneurship. Bridging these gaps is the main purpose of this dissertation.

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<sup>1</sup> An overview of UGent spin-offs is listed on [www.techtransfer.ugent.be/en/spin-offs/UGent-spin-offs](http://www.techtransfer.ugent.be/en/spin-offs/UGent-spin-offs).

First, extant literature has predominantly devoted attention to entrepreneurial *productivity or output* measures. For instance, extensive scholarly inquiry has concentrated on universities' performance in terms of patent count (e.g., Coupe, 2003), number of licenses executed and generated income (e.g., Friedman & Silberman, 2003), number of consulting contracts (e.g., Gulbrandsen & Smeby, 2005), number of spin-offs (e.g., Di Gregorio & Shane, 2003), or equity investments in spin-offs (e.g., Lockett & Wright, 2005). There remains, however, a lack of clarity regarding the *processes* that lead to the realization of these outputs (Markman et al., 2008; Rothaermel et al., 2007). Only a handful of studies have investigated the process of university spin-off formation and evolution (Clarysse & Moray, 2004; Ndonzuau et al., 2002; Rasmussen & Borch, 2010; Vohora et al., 2004). Accordingly, since entrepreneurship is a complex process that unfolds over time (Zahra & Wright, 2011), this dissertation aims to provide new insights into the early part of the process of commercializing university research.

Second, and closely related to the first knowledge gap, academic entrepreneurship researchers have largely focused on *behavior* in the area of patenting, licensing, consulting or contract research, and spin-off creation. Here again, this dissertation aims at looking at earlier phases in the entrepreneurial process. Specifically, we study research scientists' entrepreneurial *intentions*, which represent a crucial part of the early commercialization process, as they form the first in a series of actions to organizational founding (Bird, 1988), and are the single best predictor of subsequent entrepreneurial behavior (Fishbein & Ajzen, 1975; Kolvereid & Isaksen, 2006). Additionally, in contrast to entrepreneurial behavior, entrepreneurial intentions are measurable without unpredictable time lag, potential survival bias, ex-post rationalization by the respondents, nor the risk of identifying consequences instead of determinants (Dohse & Walter, 2012). Recently, entrepreneurial intentions have been introduced as an outcome variable of interest in a university context (Goethner et al., 2012; Mosey et al., 2012; Obschonka et al., 2012; Prodan & Drnovsek, 2010). However, the scarce prior research that has analyzed determinants of entrepreneurial intentions in academia has *only concentrated on the individual level*. Given the relevance of understanding how contextual factors can either trigger or restrain entrepreneurial intentions, both from a research and policy perspective (Dohse & Walter, 2012; Lee et al., 2011), this dissertation

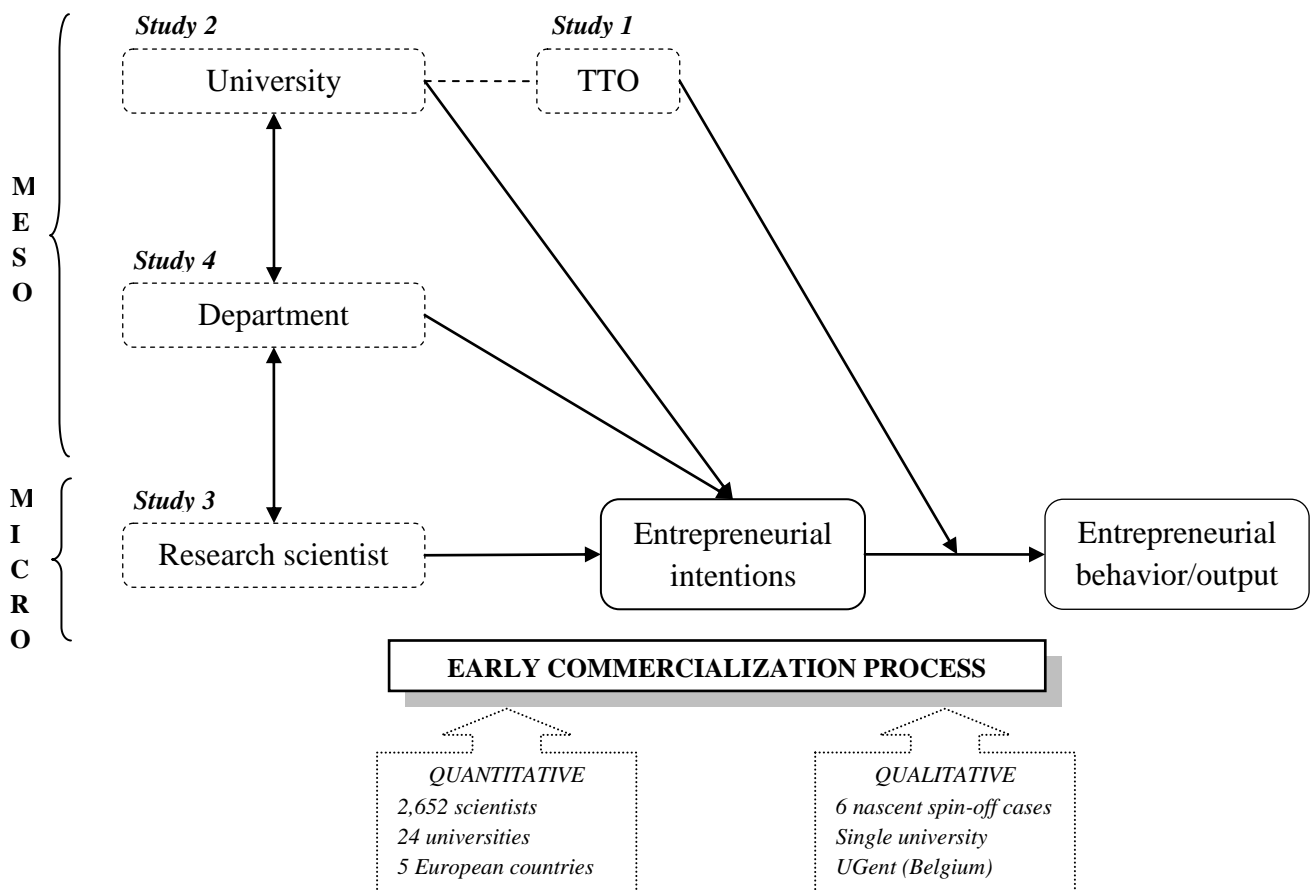
*simultaneously accounts for individual and organizational drivers* of research scientists' inclination to engage in commercialization activities. In doing so, we also elucidate the existence of *distinct types of academic entrepreneurial intentions*, as well as differences in their antecedents.

Finally, while the phenomenon of academic entrepreneurship has been studied from different points of view, researchers have typically used *either* the micro-level (i.e. individual, team and firm), *or* the meso-level (i.e. university and technology transfer office), *or* the macro-level (i.e. government and industry) as unit of analysis (Djokovic & Souitaris, 2008; Rothaermel et al., 2007). As these levels are intimately entwined, several scholars have recommended an integrated approach in order to shift from a fairly fragmented to a unifying view on academic entrepreneurship (Djokovic & Souitaris, 2008; Lockett et al., 2005; Markman et al., 2008; Rothaermel et al., 2007). Consequently, this dissertation focuses on the *intersection between the micro- and meso-level*, i.e. the research scientist or team and the organizational context. Moreover, we further *untangle the meso-level* by analyzing the largely neglected department level, which is embedded within the university level. Ultimately, the goal of this doctoral research is to capture the multilevel nature of academic entrepreneurship and to understand the interplay between micro- and meso-level determinants of research scientists' entrepreneurial intentions.

In conducting this dissertation, we deliberately target (junior) research scientists, as opposed to (tenured) professors, for multiple reasons. First, while a great deal has been written about the entrepreneurial role of professors (e.g., Etzkowitz, 2003; Lam, 2010), surprisingly, little is known about the growing number of (post-)doctoral researchers who produce a substantial share of university knowledge (Enders, 2002) and contribute to professors' scientific and technical human capital (Bozeman & Corely, 2004). Moreover, research scientists constitute an important channel for knowledge transfer because of their frequent interactions with industry (Bienkowska & Klofsten, 2012; Thune, 2009). Second, (post-)doctoral researchers are more likely to expand their capabilities due to uncertainty about which future career path will be the most favorable to them (Krabel & Mueller, 2009).

Conversely, professors are generally more focused on establishing their reputation in the scientific community, and may lack the skills and abilities needed for pursuing commercial outputs (Lockett et al., 2003; Shane, 2002). Finally, since the beginning of their career, research scientists are more familiar with universities' "third mission", and may therefore be more receptive to entrepreneurial activities. (Post-)doctoral researchers also deserve closer scrutiny because they represent the new generation of academics that will shape universities in the future.

**Figure 1.1: Dissertation framework**



### 1.3. OVERVIEW OF THE FOUR DISSERTATION STUDIES

The aim of this doctoral dissertation is to gain a better understanding of the early commercialization process, and the micro- and meso-level conditions under which research scientists display intentions to engage in entrepreneurial activities. Figure 1.1 provides a

graphical representation of the four dissertation papers, that each have a specific actor or unit as focal point of examination: the university (*study 2*) and its technology transfer office (*study 1*), the individual research scientist (*study 3*), and the department (*study 4*). A combination of longitudinal in-depth case studies and a cross-sectional dataset of 2,652 research scientists at 24 universities in five European countries (Sweden, Germany, Slovenia, Spain and Belgium) is used to cover the specific research questions outlined below.

### **1.3.1. Study 1: Technology transfer offices as boundary spanners in the pre-spin-off process: The case of a hybrid model**

In order to manage organizational ambidexterity, i.e. reconcile their traditional and entrepreneurial mission, most universities have set up dual structures through the formation of dedicated technology transfer offices (TTOs) (Ambos et al., 2008; Debackere & Veugelers, 2005; Siegel et al., 2007). Following the emergence of these units, TTO characteristics (e.g., systems, staff, structure), challenges (e.g., stakeholders with conflicting interests), and productivity (e.g., patents, licensing revenues, spin-off creation) have been well documented in the literature (Rothaermel et al., 2007; Siegel et al., 2007). However, prior studies have overlooked the role of TTOs in the pre-spin-off process. This is surprising as the impact of institutional context upon the development of university spin-offs, the key route to research commercialization (Debackere & Veugelers, 2005; Wright et al., 2008), is particularly critical at early stages (Rasmussen et al., 2014). Additionally, although more decentralized models are increasingly prevalent in practice (Bercovitz et al., 2001), the bulk of research has focused on centralized and hierarchical TTO structures. Hence, for the first paper, we identified and scrutinized six teams of research scientists with entrepreneurial intentions at Ghent University, which has implemented a hybrid TTO model uniting centralized and decentralized levels. The longitudinal qualitative research design in the first study enables us to obtain an in-depth appreciation of *how (i.e. through which activities) the two levels in a hybrid TTO structure help pre-founding teams to advance throughout the pre-spin-off process, and to trace why they precisely perform these activities.*

### **1.3.2. Study 2: The influence of organizational culture and climate on entrepreneurial intentions among research scientists**

Both academic institutions and individual scientists have a responsibility to leverage research results for commercial purposes and broader economic growth. Yet, due to the ongoing transformation, significant variation exists between universities in terms of support for and participation in entrepreneurial activities. Strikingly, while it is vital to comprehend the organizational conditions where individuals' entrepreneurial intentions stem from, this remains an unexplored area (Dohse & Walter, 2012; Lee et al., 2011). Therefore, the second paper attempts to reveal whether university culture and climate, as key aspects of organizational context, can foster entrepreneurial intentions in academia. In so doing, we also expand entrepreneurial intentions in academia beyond the restrictive focus on spin-off creation, by including a broader canvas of commercialization mechanisms (Abreu & Grinewich, 2013; Wright et al., 2008). Accordingly, the second study adopts an institutional perspective and explores *the extent to which university culture (i.e. mission and role models) and climate (i.e. reward systems) shape research scientists' intentions to engage in different forms of academic entrepreneurship (i.e. spin-off creation, patenting and licensing, consulting and contract research)*.

### **1.3.3. Study 3: Spin-off versus start-up intentions: A tale of two passions**

A growing body of entrepreneurship literature has pointed to passion as a central driver in the venture creation process (Baum et al., 2001; Cardon et al., 2005). However, while prior studies have elucidated the multifaceted nature of entrepreneurial passion (i.e. for inventing, founding and developing) (Cardon et al., 2013), the “passion orchestra” or the coexistence and interrelation of entrepreneurial passion and passion for other non-entrepreneurial roles within the person, remains a neglected topic. In the third paper, we recognize that individuals may hold different types of passion that simultaneously affect entrepreneurial intentions, especially in universities where research scientists are increasingly expected to reconcile scientific and entrepreneurial roles. In addition, we differentiate between two types of entrepreneurial intentions. While one research scientist may aspire to spin off a firm based

upon research results (i.e. spin-off intentions), another may hold intentions to found any type of company, for instance a new venture which is independent from his or her academic research (i.e. start-up intentions). Thus, building upon passion literature and role identity theory, the third study extends the literature on the individual-level determinants of entrepreneurial intentions in academia by unraveling *the “passion orchestra”, i.e. entrepreneurial and scientific passion, underlying research scientists’ spin-off and start-up intentions.*

#### **1.3.4. Study 4: Academic entrepreneurship: A multilevel examination of individual, subunit and organization effects**

The academic entrepreneurship literature suffers from the need for a multilevel understanding, of entrepreneurship in general, and entrepreneurial intentions specifically (Lockett et al., 2005; Rothaermel et al., 2007). Additionally, the vast majority of studies has examined the role of the university as a whole, thereby neglecting that departments within the same university may demonstrate great heterogeneity in terms of entrepreneurial activity (Grimaldi et al., 2011). Therefore, the purpose of the fourth study is to disentangle *whether and how the departmental context affects entrepreneurial intentions in academia, above and in conjunction with university and individual factors.* Drawing upon organizational culture literature and trait activation theory, the multilevel analysis treats department culture as an independent variable that accounts, in part, for observed individual differences in entrepreneurial intentions. This analytical lens permits a sharpened focus for examining variation which others have alluded to, but which has not been systematically studied, and allows to scrutinize the interplay between micro-and meso-level determinants.

In sum, this doctoral research is embedded in the growing interest in academic entrepreneurship worldwide, and in Europe specifically. Focusing on a number of knowledge gaps in the literature, the following chapters present the four studies outlined above. The concluding chapter of this dissertation provides a synopsis of the main findings, and highlights the implications for theory and practice.

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## **2. TECHNOLOGY TRANSFER OFFICES AS BOUNDARY SPANNERS IN THE PRE-SPIN-OFF PROCESS: THE CASE OF A HYBRID MODEL**

### **ABSTRACT**

Over the past decades, universities have increasingly become ambidextrous organizations reconciling scientific and commercial missions. In order to manage this ambidexterity, technology transfer offices (TTOs) were established in most universities. This paper studies a specific, often implemented, but rather understudied type of TTO, namely a hybrid TTO model uniting centralized and decentralized levels. Employing a qualitative research design, we examine how and why the two TTO levels engage in diverse boundary spanning activities to help nascent spin-off companies move through the pre-spin-off process. Our research identifies differences in the types of boundary spanning activities that centralized and decentralized TTOs perform and in the parties they engage with. We find geographical, technological and organizational proximity to be important antecedents of the TTOs' engagement in external and internal boundary spanning activities. These results have important implications for both academics and practitioners interested in university technology transfer through spin-off creation.



## 2.1. INTRODUCTION

Universities are increasingly active in the commercialization of their research results, the so-called “third mission” related to entrepreneurship and economic development (Etzkowitz, 2003; Rasmussen et al., 2006). The commercialization of research results goes beyond the traditional, scientific dissemination mechanisms, such as publications, and includes university spin-offs, patents, licensing, collaborative research, contract research and consulting (Wright et al., 2008). Such mechanisms have received considerable attention over the past decades (Siegel et al., 2007; Van Looy et al., 2011). This entrepreneurial tendency of universities is inspired by decreasing university budgets and increasing pressure from policy makers who view the commercialization of academic research as a key driver of national competitiveness (Ambos et al., 2008). As such, universities have to become “entrepreneurial universities” which have the ability to generate a focused strategic direction, both in formulating academic goals and in translating knowledge produced within the university into economic and social utility (Clark, 1998). While many universities have taken initiatives to promote technology transfer between science and industry (Phan & Siegel, 2006), it is recognized that commercialization of research results poses major challenges. At the heart of the problem is the inherent tension between academic and commercial demands (Hackett, 2001; West, 2008). As the university’s third mission cannot be considered separately from the traditional academic remit of research and teaching (Van Looy et al., 2011), universities have to act as ambidextrous organizations pursuing research excellence while promoting research commercialization (Ambos et al., 2008; Raisch & Birkinshaw, 2008). One of the pathways to obtain organizational ambidexterity is so-called structural ambidexterity, or the use of “dual structures” and strategies to separate different types of activities, in which actors deal with one or the other activity (Andriopoulos & Lewis, 2009). In a university context, scholars have recommended the establishment of an autonomous unit, a technology transfer office (TTO), alongside traditional structures related to teaching and research (Ambos et al., 2008; Siegel et al., 2007; Tushman & O’Reilly, 1996). TTOs engage in various support services for the commercialization of academic research, most notably, partner search, management of intellectual property and business development. A growing number of studies have focused on

the commercialization of research results and technology transfer and, in particular, have analyzed the role of TTOs. However, this literature still suffers from two important gaps.

First, TTO activities have been widely studied (Siegel et al., 2007). Researchers have looked into the role of the TTO in licensing (Siegel et al., 2003b), patenting (Coupe, 2003) and the creation and performance of university spin-offs (Link & Scott, 2005; Lockett et al., 2003; Lockett & Wright, 2005). Quite surprisingly, little is known about the role of TTOs *during the pre-spin-off process*. While the creation of university spin-offs<sup>2</sup> typically represents the central route to public research commercialization (Debackere & Veugelers, 2005; Wright et al., 2008), little is known about the role of the TTO in this process. Hence, we study TTO activities and how these help nascent spin-offs during the pre-spin-off process.

Second, a large body of research has documented the activities performed by TTOs in the commercialization of university-based intellectual property. TTOs stimulate researchers to disclose their inventions and evaluate their patentability, technological validity and commercialization potential (Siegel et al., 2003a; Vohora et al., 2004). Further, TTOs alleviate the asymmetric information problem between industry and university (Macho-Stadler et al., 2007) and mitigate the uncertainty related to the profitability of new inventions (Hoppe & Ozdenoren, 2005). Strikingly, most studies have considered TTOs to be centralized and hierarchical structures, embedded at the central level of the university. By contrast, a number of studies have argued that TTOs can take different organizational forms. Markman et al. (2005) identified three TTO structures, which vary by the degree of autonomy granted to TTOs in their pursuit of technology commercialization opportunities. These three archetypes are a traditional university structure, a nonprofit research foundation, and a for-profit venture extension. Along the same lines, Bercovitz et al. (2001) classified four organizational forms for TTOs, the functional or unitary structure (U-form), the multidivisional form (M-form), the holding company (H-form), and the matrix structure (MX-form), while Debackere & Veugelers (2005) studied an example of a decentralized TTO.

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<sup>2</sup> University spin-offs are defined as new ventures initiated within a university setting and based on technology derived from university research (Rasmussen & Borch, 2010).

However, in general, limited attention has been given to the activities performed by *more decentralized organizational structures*, in which responsibilities for technology transfer activities are located close to research groups and individuals (Bercovitz et al., 2001), often in combination with a centralized TTO level. This is quite surprising, as centralized and hierarchical TTO models are not considered conducive to universities' spin-off activity (Apple, 2008). Accordingly, we address this gap in the literature by studying a largely neglected form of TTO, which we typify as a "hybrid TTO model". This is a combination of the traditional hierarchical structure, in which a TTO is established at the central level of the university, complemented by decentralized TTOs at the level of the research groups and departments. As TTOs are boundary spanners, serving as a bridge between academic and commercial contexts (Siegel et al., 2003a), a central concern is to understand the differences in the nature of these activities between the two levels.

Accordingly, our study addresses these gaps in the literature by examining the following research questions: "*How* (i.e. through which boundary spanning activities) do centralized and decentralized levels in a hybrid TTO structure help academic researchers throughout the pre-spin-off process? *Why* do they differ in the activities they engage in?" In other words, in addition to providing a better understanding of the boundary spanning activities performed by TTOs at different levels, we study the antecedents of their engagement in these activities. As such, following the nature of our research questions, which are *how* and *why* questions, we employ a qualitative research design. Specifically, we analyze the hybrid TTO model of Ghent University. By studying six cases of nascent university spin-offs within Ghent University longitudinally during the pre-spin-off process, we were able to identify both the activities that TTOs engage in to advance the pre-spin-off process and the antecedents of TTOs' involvement.

In addressing these research questions, we aim at contributing to the literature in a number of ways. First, we respond to recent specific calls in the TTO literature to explore the functioning of TTOs (Djokovic & Souitaris, 2008) within different structures (Markman et al., 2005), the type and determinants of activities TTOs engage in (Comacchio et al., 2012;

Markman et al., 2008) and how universities contribute to the process of university spin-off creation (O'Shea et al., 2005). Responding to these calls is important for both research and practice as failure to recognize how TTO structures and processes are operationalized can obscure understanding of how TTOs create value. Second, our research contributes to the wider academic entrepreneurship literature. This literature includes studies at macro-level (studying the role of government and industry), meso-level (focusing on university and the central TTO) and micro-level (studying firms and individual entrepreneurs) (Djokovic & Souitaris, 2008). In particular, recent work at the meso-level has emphasized the importance of the subunit or department level (Bercovitz & Feldman, 2008; Kenney & Goe, 2004), with special attention devoted to workplace peers (Kenney & Goe, 2004; Louis et al., 1989; Stuart & Ding, 2006) and the department chair, that constitute the “localized social environment” (Bercovitz & Feldman, 2008). We show that it may also be relevant to incorporate the decentralized TTO in meso-level studies by illustrating its role in the pre-spin-off process. Third, by exploring a more fine-grained breakdown of the role of TTOs we add to the general organizational ambidexterity literature applied to the university context. Fourth, we add to the proximity literature which generally focuses on inter-organizational dimensions by considering intra-organizational aspects.

This article unfolds as follows. The next section positions our research within boundary spanning theory and proximity literature. We then present the methodological approach used for the longitudinal inductive study of six nascent spin-offs cases. In the fourth section, the empirical findings are presented and four sets of propositions are derived. Finally, we reflect on our results and discuss their implications for practice and further research.

## **2.2. THEORETICAL PERSPECTIVES**

Following Suddaby (2006), we adopt an inductive approach and build our case studies in the context of relevant theory. Heeding the recent call to devote research attention to boundary spanning activities in the research commercialization process (Markman et al., 2008), we rely on boundary spanning theory to address our first research question which

relates to the activities performed by centralized and decentralized TTOs. In order to examine our second research question and shed light on why TTOs engage in different activities, we draw on proximity literature. Indeed, boundary spanners face the challenge of linking agents that are distant from each other along diverse dimensions (Williams, 2002), including geographical, organizational and technological dimensions. In what follows, we elaborate on boundary spanning theory and literature, and focus on proximity as an important framework in explaining the antecedents of engagement in boundary spanning activities.

### **2.2.1. Boundary spanning theory**

Boundary spanning theory originates from organizational ambidexterity theory and argues that organizations assign specific individuals or units a role in managing the boundaries with other organizations that supply critical resource inputs or that are responsible for the distribution of their outputs (Zhang et al., 2011). Boundary spanners are agents who gain knowledge from one domain and move it to be applied in another (Tushman & Scanlan, 1981). As such, these boundary spanners can help organizations to obtain organizational ambidexterity, i.e. to be aligned and efficient in responding to market demands, while simultaneously being adaptive to changes in the environment (Gibson & Birkinshaw, 2004). This traditional role can be identified as *external boundary spanning*. In the academic context, following the new demands on universities, new organizations were established to span boundaries between science and external stakeholders (Hellström & Jacob, 2003). Scholars have explored the mediating role of boundary spanning organizations between science, policy and the corporate sector (Cash, 2001; Guston, 1999; Parker & Crona, 2012) and have indicated that a core task of these organizations lies in facilitating the technology transfer process (Booz & Lewis, 1997; Howells, 2006). Concretely, Siegel et al. (2003a; 2007) identified boundary spanning activities as the actions taken by TTOs to serve as a bridge between “suppliers” of research results (i.e. university scientists) and “customers” (namely firms, entrepreneurs and venture capitalists) who operate in different environments and can potentially help to commercialize academic research. In this conventional view, TTOs are the

formal gateways between university and industry (Rothaermel et al., 2007) and facilitators of industry-science linkages (Wright et al., 2008).

While external boundary spanning has been extensively documented in the literature, less attention has been devoted to *internal boundary spanning*. However, if a specific organizational unit is created with the responsibility for external boundary spanning, new boundaries arise within the organization, which faces the challenges of managing internal knowledge and resource flows between its different units (Tsai, 2002). For instance, Piercy (2009) indicated that, in an operational context, the main challenge faced by executives responsible for sales and marketing processes is being effective in the management of cross-organizational and cross-divisional relationships. Similarly, a product manager needs to engage in both external boundary spanning with outsiders, including customers, consultants and investors, as well as in “internal boundary spanning” between the units of production, finance, advertising and engineering (Lysonski, 1985). In the context of universities, Markman et al. (2008) have suggested that, besides external boundary spanning between academics and corporations, internal boundary spanning between different university departments involved in the commercialization of academic research is an important and complex task, which may be performed by TTOs as well. However, the role of TTOs in internal boundary spanning has so far remained largely neglected. In line with the previous arguments, we found boundary spanning theory to be an important framework in studying the centralized and decentralized TTO’s engagement in pre-spin-off activities.

### **2.2.2. Dimensions of proximity**

Proximity is crucial in inter-organizational collaborations and alliances as it stimulates knowledge transfer and knowledge sharing (Knoben & Oerlemans, 2006; Nooteboom, 1999). Recently, researchers have also pointed to the importance of proximity for the formation and effectiveness of university-industry linkages (Hewitt-Dundas, 2013; Laursen et al., 2011; Messeni Petruzzelli 2011; Woerter, 2012).

Although proximity has frequently been treated as a purely spatial phenomenon, taking a multidimensional perspective is important. Besides the geographical dimension,

organizational, institutional, social and cognitive aspects are equally important for successful knowledge exchange (Boschma, 2005). Knobens & Oerlemans (2006) synthesized these aspects into three main types of proximity. *Geographical* proximity refers to the spatial or physical distance between economic actors (Boschma, 2005). Short distances literally bring people together, favor information contacts and facilitate the exchange of tacit knowledge (Jaffe et al., 1993). Second, *organizational* proximity relates to the extent to which relations are shared in an organizational arrangement (Boschma, 2005). This type of proximity incorporates organizational structure and culture, performance measurement systems, and language. Organizational proximity is in place when interactions between actors are facilitated by rules and routines of behavior, and a same system of representations or set of beliefs (Torre & Ralet, 2005). Finally, *technological* proximity is based on shared technological experiences and knowledge bases (Knobens & Oerlemans, 2006). The mutual understanding makes people more likely to access knowledge from individuals that exhibit greater technological proximity. Similarities in the knowledge bases allow actors to effectively identify, interpret and communicate about relevant knowledge.

Even though prior literature has largely focused on the role of proximity in inter-organizational collaborations, proximity may also facilitate interactions between different units within the same organization. Intra-organizational proximity may foster the way different units share knowledge with each other. For instance, whereas organizational proximity has often been defined as proximity in the cultures of different organizations, organizational units may have distinct subcultures, making it relevant to study intra-organizational aspects of proximity as well (Ashkanasy et al., 2000; Hofstede, 1998). Indeed, we found that, in a hybrid TTO model, specific dimensions of proximity were important in explaining the engagement of centralized and decentralized TTOs in internal and external boundary spanning.

## **2.3. METHODOLOGY**

### **2.3.1. Inductive case study approach**

We employed a longitudinal multiple case study design. Most studies on academic entrepreneurial activity are based upon cross-sectional data linking university characteristics to the creation of university spin-offs. However, to understand how the two TTO levels can advance the pre-spin-off process and why their activities differ, we need to adopt a longitudinal and qualitative approach to capture the changes over time and reduce problems of retrospective biases (Pettigrew, 1990; Rasmussen & Borch, 2010; Yin, 2003).

While our approach is inductive, we framed it in the context of the theories presented above. We followed an iterative process involving a back-and-forth journey between the data collected and existing literature and theories (Van Maanen et al., 2007). We follow the norm to present inductive research in the traditional discrete categories and in the same sequence as quantitative research (Suddaby, 2006). Even though the theoretical framework is presented up front, the selection of theory and its development emerged from the empirical research.

### **2.3.2. Identification of cases and data collection**

The cases all originated from one university, Ghent University (UGent) in Belgium. UGent is a general university, offering all curricula, ranging from engineering and exact sciences to human arts (Wright et al., 2008). Selecting a single site is appropriate for various reasons. First, as extensive data collection is needed at different levels, this research is ideally handled in the context of one university. Second, focusing on one university enhances homogeneity in case design, which is important to draw valid conclusions. Third, single site studies have been successfully applied by other scholars (e.g., Shane & Stuart, 2002; Zhang, 2009). Moreover, UGent is a particularly suitable site because this university has applied a hybrid TTO model which combines centralized and decentralized elements and which corresponds to our research focus.

The UGent TTO was professionalized in 2000, following a grant from the Flemish Government which boosted technology transfer activities at the university. This grant allowed for the implementation of a commercialization policy to turn scientific research into economic returns. Universities receiving the grant got full autonomy to develop their own policy. Consequently, while the UGent TTO had traditionally been organized in a purely centralized

form, the organizational structure was broken up into two different units, thus creating a hybrid structure composed of centralized and decentralized TTO levels. At 31<sup>st</sup> December 2011, the TTO consisted of 30 people at the centralized level, complemented by 21 Technology and Business developers (who constitute the decentralized TTO level), each in charge of a multi-disciplinary valorization cluster, i.e. a cluster of cross-faculty and complementary research groups working on a particular technology or expertise. It is the responsibility of both levels within the hybrid structure to foster and facilitate the translation of the results of UGent's scientific research into commercial products and services that maximize the benefit to society. Together with the financing of the decentralized TTO level, a program for pre-industrial proof-of-concept project funding with a maximum budget of €50,000 (StarTT projects) and pre-venture capital funding for start-up creation with a budget ranging from €250,000 to €500,000 per project (Stepstone projects) was established. As of 31<sup>st</sup> December 2011, UGent had spun off about 45 companies. Additional descriptive characteristics of the selected university are reported in Table 2.1.

**Table 2.1: Key characteristics of Ghent University on the 31<sup>st</sup> of December 2011**

Founding year	1817
Organizational status	Public
Position in Academic Ranking of World Universities	89
Number of faculties	11
Number of students	32,000
Number of staff	7,100
Annual research budget	About €235mio
Medical school	Yes
Science parks	2
Business incubators	3
University seed capital fund (size; maximum investment per company)	Baekeland fund (€11.1mio; €500,000)
Number of staff at centralized TTO	30
Number of staff at decentralized TTO	21

We draw on six longitudinal cases of nascent spin-offs where the phenomenon of interest (i.e. TTO involvement in the pre-spin-off process) is “transparently observable” (Eisenhardt, 1989). Using a finite number of cases (between four and ten, as suggested by Brown &

Eisenhardt, 1997), allowed us to balance the need to generate rich theory with large amounts of data. Triangulation combining several data sources was used to map the situation and evolution of each nascent spin-off during the pre-spin-off process. In line with Pettigrew (1973), an embedded research design was adopted, in which different people in various positions were interviewed. In particular, we interviewed pre-founding team members, decentralized and centralized TTOs and department heads. Following Eisenhardt (1989), for every case, we gradually built up a picture of the nascent spin-off development that was cross-validated by different actors looking at issues from different angles. Interviews were recorded, and transcriptions were made by one of the authors as part of the data analysis process. The face-to-face interviews lasted between one and two hours. Archival data such as business plans, project proposals and curricula vitae were obtained from each informant. In addition, relevant written documentation was obtained from the university website, TTO website, research groups' websites and newspaper articles. By combining the different sources of information over a period of three years, in which interview rounds were conducted every 6 to 9 months, an in-depth description of both the pre-spin-off process and the role of the centralized and decentralized TTOs was obtained.

The interviews were carried out following a narrative approach (Polkinghorne, 1988). During each interview, the pre-founding team members were asked to describe the status of their spin-off project, and the main elements in which they had progressed over the months prior to the interview, as well as the role and contribution of their TTOs. Decentralized and centralized TTOs were requested to describe the evolution of each spin-off project, the activities they had performed and how their involvement helped each pre-founding team to proceed. This type of narrative interviewing, in which there is minimum interruption by the interviewer, was used to obtain a better understanding of the events and to avoid the influence of interviewers' personal views and theoretical perspectives on the data collection. The interview transcripts and documentary evidence were read and reread as data were collected and emerging themes were refined as this process progressed. Patterns of observations were identified and an iterative process allowed us to match empirical data with theoretical explanations. To avoid confirmation biases, two of the authors were kept at a distance from

the data collection process (Doz, 1996). A total of 63 interviews involving 21 different people were conducted over four interview rounds.

### **2.3.3. Description of the cases**

Table 2.2 provides some key characteristics of the six nascent spin-off cases selected for this study. For confidentiality reasons, the nascent spin-offs are labeled as cases A – F .

The six nascent spin-off cases were identified and selected after consulting the centralized TTO management. We deemed it necessary to draw on a heterogeneous set of cases, as our focus was to provide a better understanding of the TTO role in the pre-spin-off process, irrespective of the phase of the process, the technology, or type of spin-off. Consequently, the six nascent spin-offs were in different phases of the pre-spin-off process. Drawing on Vohora et al. (2004), we considered five phases in the development of university spin-offs: research phase, opportunity framing phase, pre-organization phase, re-orientation phase, and sustainable returns phase. Each phase is characterized by a specific group of activities that the (nascent) spin-off must accomplish in order to progress to the next phase. As this research focuses on the pre-spin-off process, we do not consider the phases after firm establishment, i.e. the re-orientation and sustainable returns phases. The six nascent spin-offs were in different research domains, and a mix of technology and service-based spin-offs (Pirnay et al.(2003) was obtained.

## **2.4. RESULTS**

Our six cases provide insights that inform our research questions which focus on understanding 1) the boundary spanning activities of centralized and decentralized TTOs in a hybrid TTO structure, as well as the differences in activities between both levels and 2) the antecedents of the engagement in these activities.

**Table 2.2: Key characteristics of the six nascent spin-offs**

	Spin-off type*	Pre-founding team		Faculty	Field of research	Technology	Pre-spin-off internal funding	Number of patents applied for (granted)	Number of interviews (number of rounds)	Phase 1 <sup>st</sup> interview round	Phase last interview round
		Academics involved	Non-academics involved								
<b>Case A</b>	Technology-oriented	PhD researcher A1° PhD researcher A2° Professor A3	2 Consultants°	Engineering	Textiles	Development and production of custom made products using nanofibres by electrospinning	- May 2009: Stepstone for prototype machine + patent costs - June 2010: Stepstone for market exploration + external business development support + product development and testing	5 (1)	11 (4)	Opportunity framing	Pre-organization
<b>Case B</b>	Technology-oriented	Post-doc B1° Post-doc B2° PhD researcher B3° PhD researcher B4° Professor B5	2 Consultants	Bioscience Engineering	Biochemical and microbial technology	Metabolic modeling and engineering of micro-organisms	- June 2009: Stepstone for technology development + external market consultant(s)	2 (0)	21 (4)	Opportunity framing	Pre-organization
<b>Case C</b>	Technology-oriented	PhD researcher C1° Professor C2 Professor C3 Professor C4 Professor C5 Business developer	/	Engineering	Telecommunication and information processing	Mobile tracking services	- March 2010: Stepstone for technological feasibility + business plan + potential partners/customers	1 (1)	8 (4)	Opportunity framing	Opportunity framing
<b>Case D</b>	Service-oriented	Professor D1 Professor D2 Professor D3 Laboratory team	Engineering team of industry partner	Sciences	Pharmacology	Design and optimization of granulation process	- April 2011: Stepstone for purchase machine from industrial partner + technology development	1 (1)	7 (4)	Opportunity framing	Opportunity framing
<b>Case E</b>	Service-oriented	Post-doc E1° Post-doc E2 PhD researcher E3° PhD researcher E4 Professor E5	/	Sciences	Telecommunication and information processing	Commercial archaeology	/	/	6 (3)	Opportunity framing	Pre-organization
<b>Case F</b>	Technology-oriented	Post-doc F1° Professor F2 Professor F3 Professor F4	/	Sciences	Virology, parasitology and immunology	Development of vaccines, therapeutics and diagnostics	- May 2011: Stepstone for technology development + external business developer and consultant	1 (0)	6 (2)	Opportunity framing	Opportunity framing

\* The core business of technology-oriented spin-offs is rooted in codified knowledge exploited for industrial purposes; conversely, service-oriented spin-offs are devoted to the exploitation of tacit knowledge in a logic of expertise providers (Pirnay et al., 2003). Technology spin-offs are usually based on patents, often long term research, require a lot of financing, often external management and have a longer pre-spin-off process. Service spin-offs arise from services which are often first offered by the university, but then are put into an independent unit. This latter spin-off type usually does not require external management nor external capital.

° Individuals interviewed.

#### **2.4.1. Boundary spanning activities within the hybrid TTO model**

In each interview round, all respondents were asked to reflect on the support activities performed by both TTO levels in the hybrid structure, which had a positive impact on the nascent spin-off progress. Table 2.3 provides a detailed overview of the activities carried out by centralized and decentralized TTOs for each of the six nascent spin-offs since the origin of the spin-off idea.

Our first set of results relates to the type of activities carried out within a hybrid TTO, and indicates clear differences between the centralized and decentralized levels. Extant TTO literature has focused attention solely on TTOs' external boundary spanning role. Our study complements existing research by providing a more fine-grained analysis of the external boundary spanning activities carried out by centralized and decentralized TTOs throughout the pre-spin-off process. Additionally, we find that both TTOs also play an internal boundary spanning role within the university that is crucial to help researchers move through the pre-spin-off process. Moreover, we extend previous literature by highlighting that the type of (internal and external) boundary spanning differs according to the level in the TTO structure. As illustrated in Table 2.3, centralized and decentralized TTOs engage in different external and internal boundary spanning activities during the pre-spin-off process. The differences rely in both the type of activities and the parties with whom the two TTO levels interact while performing their activities. We elaborate on these differences in what follows.

##### ***External boundary spanning***

The centralized TTO level engages to a larger extent in external boundary spanning activities towards experts by looking for (patent) experts (cases A, B and D), market consultants or future CEOs (cases A and B). In case A, the centralized TTO attracted and financed two external consultants for business development support, and temporarily involved an external patent expert. The PhD researcher A1 commented:

**Table 2.3: Support activities of centralized and decentralized TTOs in the six nascent spin-offs in pre-start-up process**

	Centralized TTO level		Decentralized TTO level	
	Representative*	Activities	Representative	Activities
<b>Case A</b>	CTTO 1° CTTO 2°	<ul style="list-style-type: none"> <li>- Involve external patent expert (E)</li> <li>- Assist with the Stepstone project application (I)</li> <li>- Prepare university seed capital fund proposal (I)</li> <li>- Look for external CEO and market consultant (E)</li> <li>- Initiate contact between team and financiers (E)</li> </ul>	DTTO 1°	<ul style="list-style-type: none"> <li>- Foster technology development</li> <li>- Assist with the Stepstone project application (I)</li> <li>- Search for and interact with potential partners and customers (E)</li> </ul>
<b>Case B</b>	CTTO 3° CTTO 4°	<ul style="list-style-type: none"> <li>- Involve patent attorney and external technology expert (E)</li> <li>- Assist with the StarTT and Stepstone project applications (I)</li> <li>- Look for external consultants or managers (E)</li> <li>- Look for a CEO (E)</li> </ul>	DTTO 2°	<ul style="list-style-type: none"> <li>- Initiate and endorse opportunity recognition</li> <li>- Link centralized TTO to pre-founding team (I)</li> <li>- Assist with the Stepstone project application (I)</li> <li>- Bridge different opinions in team (I)</li> <li>- Filter industry contacts (E)</li> </ul>
<b>Case C</b>	CTTO 5° CTTO 2°	<ul style="list-style-type: none"> <li>- Provide help with patent application</li> <li>- Assist with the Stepstone project (I)</li> <li>- Join meetings with industry partner (E)</li> <li>- Build legitimacy for team towards industry (E)</li> </ul>	DTTO 3°	<ul style="list-style-type: none"> <li>- Foster technology development</li> <li>- Look for applications of the technology (E)</li> <li>- Search for first customer contacts (E)</li> <li>- Connect team to potential partners and customers (E)</li> </ul>
<b>Case D</b>	CTTO 3° CTTO 4°	<ul style="list-style-type: none"> <li>- Assist with the Stepstone project application (I)</li> <li>- Provide help with IP and licensing issues (E)</li> <li>- Contracts with industry partner (E)</li> <li>- Help to write the business plan (E)</li> <li>- Look for external experts (E)</li> </ul>	DTTO 4°	<ul style="list-style-type: none"> <li>- Assist with the Stepstone project application (I)</li> <li>- Link centralized TTO level to pre-founding team (I)</li> <li>- Monitor license agreement with industry partner (E)</li> <li>- Look for applications of the technology (E)</li> <li>- Manage contacts with industry (E)</li> </ul>
<b>Case E</b>	CTTO 5°	<ul style="list-style-type: none"> <li>- Provide help with patent application</li> <li>- Translate university objectives to team members (I)</li> <li>- Negotiate distribution/license contract (E)</li> </ul>	DTTO 3°	<ul style="list-style-type: none"> <li>- Endorse opportunity recognition</li> <li>- Search for data for the market analysis (E)</li> <li>- Help to write the business plan (E)</li> <li>- Initiate collaborations between different faculties and research groups (I)</li> </ul>
<b>Case F</b>	CTTO 4°	<ul style="list-style-type: none"> <li>- Assist with the Stepstone project application (I)</li> <li>- Provide help in administration</li> </ul>	DTTO 5°	<ul style="list-style-type: none"> <li>- Initiate and endorse opportunity recognition</li> <li>- Look for applications of the technology (E)</li> <li>- Help to write the business plan (E)</li> <li>- Manage relationships with industrial companies (E)</li> <li>- Check the relevance of research results with industry (E)</li> <li>- Monitor collaboration between different faculties and research groups (I)</li> </ul>

\* Two names in a cell indicate that the initially authorized person at the centralized TTO level was replaced by a different person

CTTO = centralized technology transfer officer; DTTO = decentralized technology transfer officer

(E) = external boundary spanning activity; (I) = internal boundary spanning activity

° Individuals interviewed.

*“Since the TTO has provided support through a number of consultants, things are really moving much faster. Before, we did not even have time to do market analyses. Now, one consultant goes out to talk to potential customers, whereas the other coaches us in doing the market analyses.”*

PhD researcher B4 underlined the value of the centralized TTO fulfilling this external boundary spanning role in order for nascent spin-off B to progress:

*“Even though DTTO2 was willing to provide us assistance with patent applications, DTTO2 lacked the required know-how and practice which slowed down the procedure. Along the way, our pre-founding team learned to approach the centralized TTO for such matters. In order to speed up this application process and to deal with specific issues professionally, CTTO4 got us in touch with patent experts.”*

Moreover, the centralized TTOs engage in looking for additional team members and, in particular, potential CEOs. CTTO1 noted:

*“Before company establishment, nascent spin-off A will need to attract a production expert, who understands shift work and who can take care of cost calculation. The recruitment initiative can either come from us or the team itself. I have also contacted a potential CEO for the company. The research team is aware of this, and I will introduce this person later on. If there is no match with the people already involved in the team, there is no chance this person will become the future CEO.”*

Similarly, in case B, DTTO2 expected the centralized TTO to play an important role in the recruitment of the future CEO. CTTO3 commented:

*“Once the pre-founding team of nascent spin-off B has reached a technological milestone, I will use my network to find external consultants or managers who are capable of founding a technology company.”*

The centralized TTO invoked the help of an external expert to review the technology, which was believed by the researchers to be important in strengthening their business case. DTTO4 involved in nascent spin-off D commented:

*“The activities carried out by the centralized TTO which are valuable to us are contract and IP management issues, provided by the staff themselves or through the involvement of external patent experts.”*

In later phases of the pre-spin-off process, the centralized TTO also carries out external boundary spanning between the pre-founding team and potential financiers. For instance, CTTO2 involved in case A explained:

*“Every story needs cash, either from an investor or from a client. The weakness of nascent spin-off A is the lack of communication with (potential) financiers. It is my job to encourage the team members to act proactively towards the investment community and to facilitate the communication with future investors.”*

In contrast to the centralized TTOs, the decentralized TTOs mainly engage in external boundary spanning towards industrial companies (see cases A, C, D, E and F), which are potential customers, partners and suppliers of nascent spin-offs. Interviewed academic researchers frequently pointed to the significance of their decentralized TTO's industry contacts for the nascent spin-off's evolution. In case A, one of the researchers said that it would have been useless to continue the development of the spin-off idea without this type of support from the decentralized TTO. For case D, DTTO4 described his principal tasks as twofold:

*“On the one hand, I engage in scouting. This means I try to find applications for the technology which are relevant to the industry. On the other hand, it is my responsibility to talk to industry and maintain these contacts.”*

Another illustrative comment from post-doc F1 in case F is:

*“So far, DTTO5 took care of first contacts and relationships with industrial companies. Moreover, when some interesting new research results are developed, DTTO5 will search for feedback from the industry. Obviously, such feedback is valuable, and even crucial, for the future spin-off.”*

Further, she noted that the spin-off idea actually originated from DTTO5's industrial contacts.

Additionally, companies interested in a technology or searching for a collaborator, who want to contact the inventors, typically approach the decentralized TTOs. In case C, DTT03 explained:

*“The technology the team has at its disposal at this moment might be enough for the industry, but the team believes that more added value is necessary before the spin-off can be established. However, one organization already contacted me to use the technology in the context of mobility campaigns.”*

Similarly, in nascent spin-off A, DTT01 explained that he acts as contact person for industrial companies:

*“The relationship with one large pharmaceutical player has evolved relatively quickly. At one point, the company approached me to inform whether it was possible to give them a sample of the product produced with our proprietary technology.”*

These insights lead us to the following propositions concerning the different external boundary spanning roles of centralized and decentralized TTOs:

**Proposition 1a:** Centralized TTOs are more likely than decentralized TTOs to engage in external boundary spanning between pre-founding teams and external experts and financiers.

**Proposition 1b:** Decentralized TTOs are more likely than centralized TTOs to engage in external boundary spanning between pre-founding teams and industrial companies.

### ***Internal boundary spanning***

With regard to the internal boundary spanning role of the centralized TTOs, our data reveal two interesting patterns. First, the communication of the university objectives and spin-off policy to pre-founding team members was frequently mentioned as one of the important support activities (cases A, D, E and F). DTT05 of case E commented as follows:

*“At faculty level, it sometimes seems very hard to follow up on how objectives of the university change. For instance, while the university used to encourage professors to engage in spin-offs formally, nowadays they prefer professors to stay out of spin-offs,*

*and even not engage in the board of directors, since it often gives rise to conflicts of interest. The centralized TTO is aware of the changes in strategy and objectives, and communicates them to us, so that we can live up to the expectations.”*

The centralized TTO also has to clarify the university’s interpretation of the third mission to the members of pre-founding teams. Increased commercialization activity has become an explicit part of the university mission and is promoted as a strategic objective. This observed internal boundary spanning activity was described by DTTO4, responsible for case D:

*“Communicating the university policy to professors is crucial, as they are typically more reluctant towards university-industry collaborations and spin-off creation. As such, effective communication with them is a priority for the centralized TTOs. They explain that the university still pursues scientific excellence as core objective, while at the same time engaging in a commercialization trajectory.”*

Second, centralized TTOs often provide the pre-founding teams with assistance in writing project proposals and early-stage business plans. Our cases revealed that the centralized TTO is a valuable partner for securing internal funds by assisting the pre-founding teams with StarTT and Stepstone project applications (cases A, B, C, D and F). CTTO1 commented as follows:

*“It is often remarkable that neither researchers nor the decentralized TTOs understand how they should write a proposal for StarTT or Stepstone financing. In case A, the team sent me the first version of their project proposal. Even though one of the main decision criteria for Stepstone financing is the commercialization potential, they did not even mention the commercialization possibilities. So I helped them to write that part.”*

Similarly, in case B, CTTO3 said:

*“I assisted DTTO2 and the research team of case B in writing the StarTT and Stepstone projects. As an advisor within a centralized TTO, you read through many project proposals, and you can identify the important prerequisites for such projects to gain approval, for instance the part on the commercialization potential of the technology.”*

As to the decentralized level, several interviewees underlined that one of the main internal boundary spanning activities for the decentralized TTO during the pre-spin-off process is linking the members of the pre-founding team to the centralized TTO level (cases A, B and D). DTT02 explained:

*“The centralized TTO has a very direct way of communicating things to the research team. Sometimes the researchers come to me when they have received a message from the centralized level, and they start arguing why they do not agree with this message. I then simply take some more time to explain the reasoning behind the message, and in the end, they often agree with the centralized TTO.”*

In case B, post-doc B1 similarly argued:

*“The main role of DTT02 is to be the liaison between us and the centralized TTO. As simple post-doctoral researchers, it would be hard for us to open doors at the centralized TTO”.*

In addition, PhD researcher B3 noted:

*“I would not like to be in the shoes of DTT02 as she is somewhere in between the department head, the researchers and the centralized TTO.”*

Consequently, one of the core activities performed by the decentralized TTO concerns linking the centralized TTO and the pre-founding team. DTT04 elaborated on this type of internal boundary spanning activity:

*“You have to know how to approach the researchers. In case D, during the first meeting at the centralized TTO, there were 4 people around the table firing questions at professor D1. After the meeting, the professor wanted to stop the project. He felt there were too many ‘coaches’ and too few ‘do-ers’ around the table. Nowadays, I serve as the link between the research team and the centralized TTO, and I do the communication with the centralized TTO”.*

In many cases, it was the decentralized TTO who identified the opportunity, or proposed the opportunity to the centralized TTO (cases B, C, E and F). For instance, DTT03 commented on the origin of the spin-off idea for case E:

*“When I had just started working as a decentralized TTO, I organized a seminar on spatial information. I knew researchers in archaeology, geography and IT departments were working on this topic, and I thought it would be interesting to join forces across faculties. The idea for the spin-off originated from those first contacts.”*

A similar event occurred in nascent spin-off F, where DTTO5 first initiated and now monitors the collaboration between different research groups within veterinary sciences, bioengineering and biotechnology departments. As such, the decentralized TTO establishes links between different research teams with similar interests.

These insights lead us to propose the following differences in the internal boundary spanning activities between decentralized and centralized TTOs:

**Proposition 2a:** Centralized TTOs are more likely than decentralized TTOs to engage in internal boundary spanning between pre-founding teams and central university management.

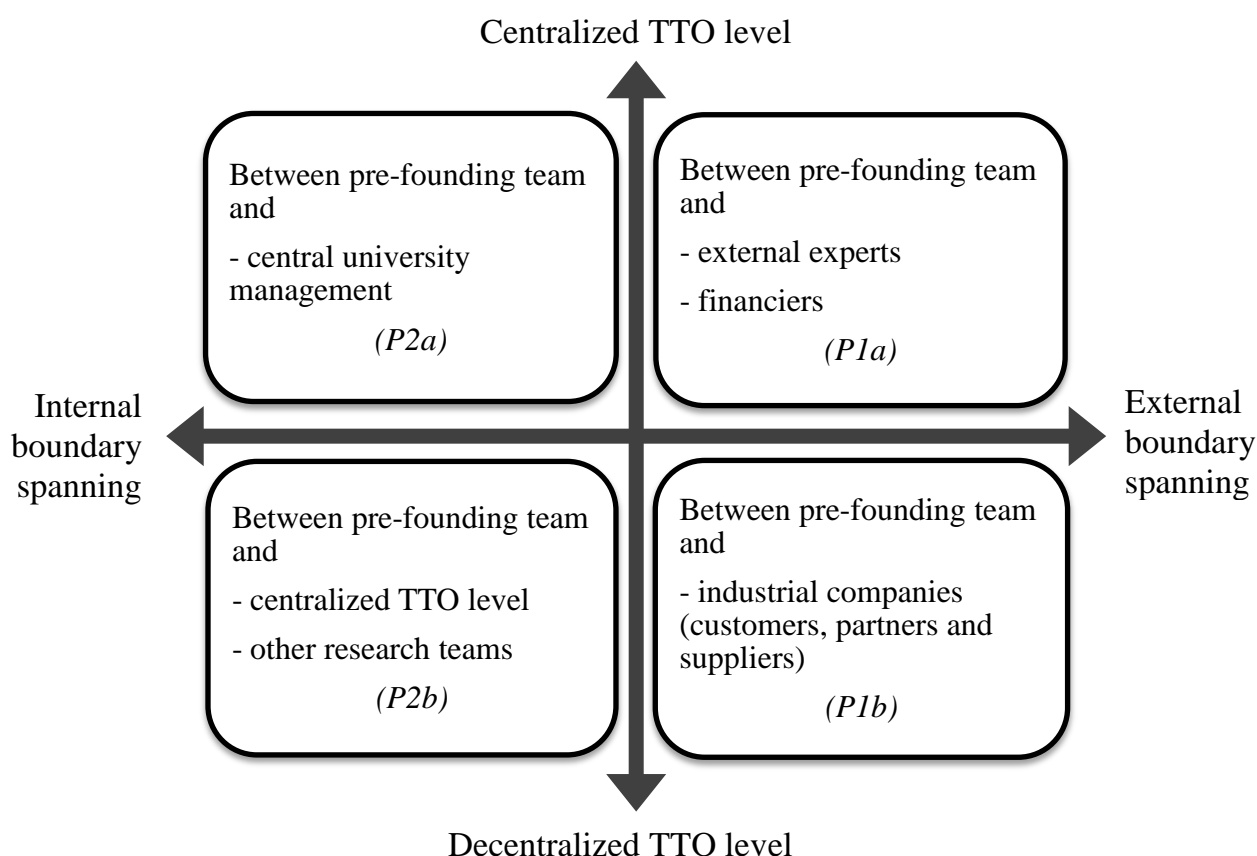
**Proposition 2b:** Decentralized TTOs are more likely than centralized TTOs to engage in internal boundary spanning between pre-founding teams and other research teams, and engage in internal boundary spanning between pre-founding teams and the centralized TTO level.

A summarizing representation of these first two sets of propositions is shown in Figure 2.1.

#### **2.4.2. Antecedents of boundary spanning activities within the hybrid TTO model**

Given the different nature of the activities that centralized and decentralized TTOs perform in the pre-spin-off process and the different parties involved, it is likely that the antecedents of technology transfer activities will be different for the two levels. Our cases provide insights into the role of different dimensions of proximity as antecedents of the external and internal boundary spanning activities carried out by TTOs during the pre-spin-off process.

**Figure 2.1: Boundary spanning activities at different TTO levels**



### ***External boundary spanning***

As to the centralized TTO, the six nascent spin-off cases reveal that this TTO level has a tight relationship with the central university decision making level. This organizational proximity allows centralized TTOs to represent and act on behalf of the university towards external stakeholders during the pre-spin-off process. One of the members of the pre-founding team of case A stated:

*“It is good that CTTO2 understands the overall university objectives and is able to communicate these appropriately to us and, even more importantly, towards external parties such as future investors. His clear understanding of university goals enables him to simultaneously take the interest of the nascent management team and the university into consideration during negotiations.”*

Further, our respondents frequently affirmed that, as a consequence of the organizational proximity towards the central university management, the centralized TTOs are well

connected to the recruitment and investment firms within the university network. In nascent spin-off F, the post-doctoral researcher commented:

*“The centralized TTO level already has connections with relevant parties, such as hiring agencies and venture capitalists, with whom the university has interacted during prior spin-off processes. This allows them to get in touch with suitable parties for attracting additional team members or funding.”*

Accordingly, *organizational proximity* is a key antecedent of the external boundary spanning activities which the centralized TTOs engage in.

As to the decentralized TTO level, our interviews reveal that an important antecedent of the decentralized TTO's engagement in external boundary spanning activities is *technological proximity*. Common scientific or professional backgrounds explain why decentralized TTOs engage in boundary spanning towards industrial companies and the centralized TTO. For instance, the post-doctoral researcher involved in case F said:

*“It is an advantage that DTT05 possesses experience in veterinary medicine, as this allows him to co-judge which proteins are important as well as to identify relevant market parties.”*

In case A, PhD researcher A2 noted:

*“DTT01's background and his judgment of the technological possibilities are invaluable in negotiations with industrial companies.”*

These insights lead us to propose the following differences as to the dimensions of proximity that influence the different external boundary spanning activities of decentralized and centralized TTOs:

**Proposition 3a:** Organizational proximity is a more pronounced antecedent of the external boundary spanning activities of centralized TTOs than it is for decentralized TTOs.

**Proposition 3b:** Technological proximity is a more pronounced antecedent of the external boundary spanning activities of decentralized TTOs than it is for centralized TTOs.

### ***Internal boundary spanning***

With regard to the centralized TTO level, interviewees often stated that centralized TTOs are aware of the university strategy, internal procedures, common practices and (in)formal rules. This *organizational proximity* appears to be an important determinant for why they engage in internal boundary spanning activities between pre-founding teams and the central university management. The post-doctoral researcher in case F said:

*“The centralized TTO is successful in providing guidance for spin-off development. This is reflected in the previous track record of the people working at the centralized TTO. They possess knowledge on how to deal with different issues and follow standardized university procedures.”*

As such, organizational proximity is found to be an important antecedent of the centralized TTO’s engagement in internal boundary spanning.

As to the decentralized level, decentralized TTOs are geographically closely located to the research groups as their offices are located on site. In contrast, the workspace of the centralized TTO level is situated on a spot which is physically more distant from the researchers. DTTO4 describes why geographical proximity affects his internal boundary spanning activities as follows:

*“The most important responsibility in my job is what I call “corridor dynamics”. I have my office in the same building as the academic staff, so I am around, I am on the mailing list of the faculty, so I go and talk to people at receptions, without forcing anything.”*

The result is that geographical proximity facilitates face-to-face contact and the exchange of information between decentralized TTOs and research teams. Another illustrative comment was made by researcher B4:

*“Only once a month, we have a meeting with the centralized technology transfer officer, whereas DTTO2 makes an effort to stay informed and gives feedback on a more regular basis. Further, DTTO2 is nearby, easier to reach and more actively*

*involved as our closest sounding board. We can easily discuss the emails and information she got from the centralized TTO .”*

Consequently, we argue that a first antecedent of decentralized TTOs’ internal boundary spanning is their *geographical proximity* towards the research groups.

Our interviews also demonstrate that technological proximity is a second important antecedent of decentralized TTOs’ internal boundary spanning activities. Since decentralized TTOs are delegated to a specific cluster of research groups, they generally are familiar with the cluster research or technology domain. As such, they are able to understand the members of the pre-founding team and to communicate information about the nascent spin-off to the centralized TTO and other research groups. The overlap of their knowledge bases facilitates successful knowledge exchange. For instance, in case B, DTTO2 has a PhD and experience in biosciences, which enables her to interact easily with the researchers and to explain the technology in basic terms to the centralized TTO who lacks such knowledge. DTTO2 stated:

*“I am the biggest supporter of the team. I push and pull at the same time. I talk to people. I am the memory of the nascent organization.”*

In the majority of our cases, researchers indicated that the decentralized TTO was involved in opportunity recognition and/or technology development thanks to his/her technological proximity. For case A, the PhD researcher A1 described it as follows:

*“DTTO1 has initiated the whole project. He came up with the spin-off idea and remains one of the driving forces behind it. His background allows him to evaluate the feasibility of the technology and to make sure that products are market ready, of course in consultation with the pre-founding team members. “*

As such, a second important antecedent of the decentralized TTO’s engagement in internal boundary spanning is *technological proximity*.

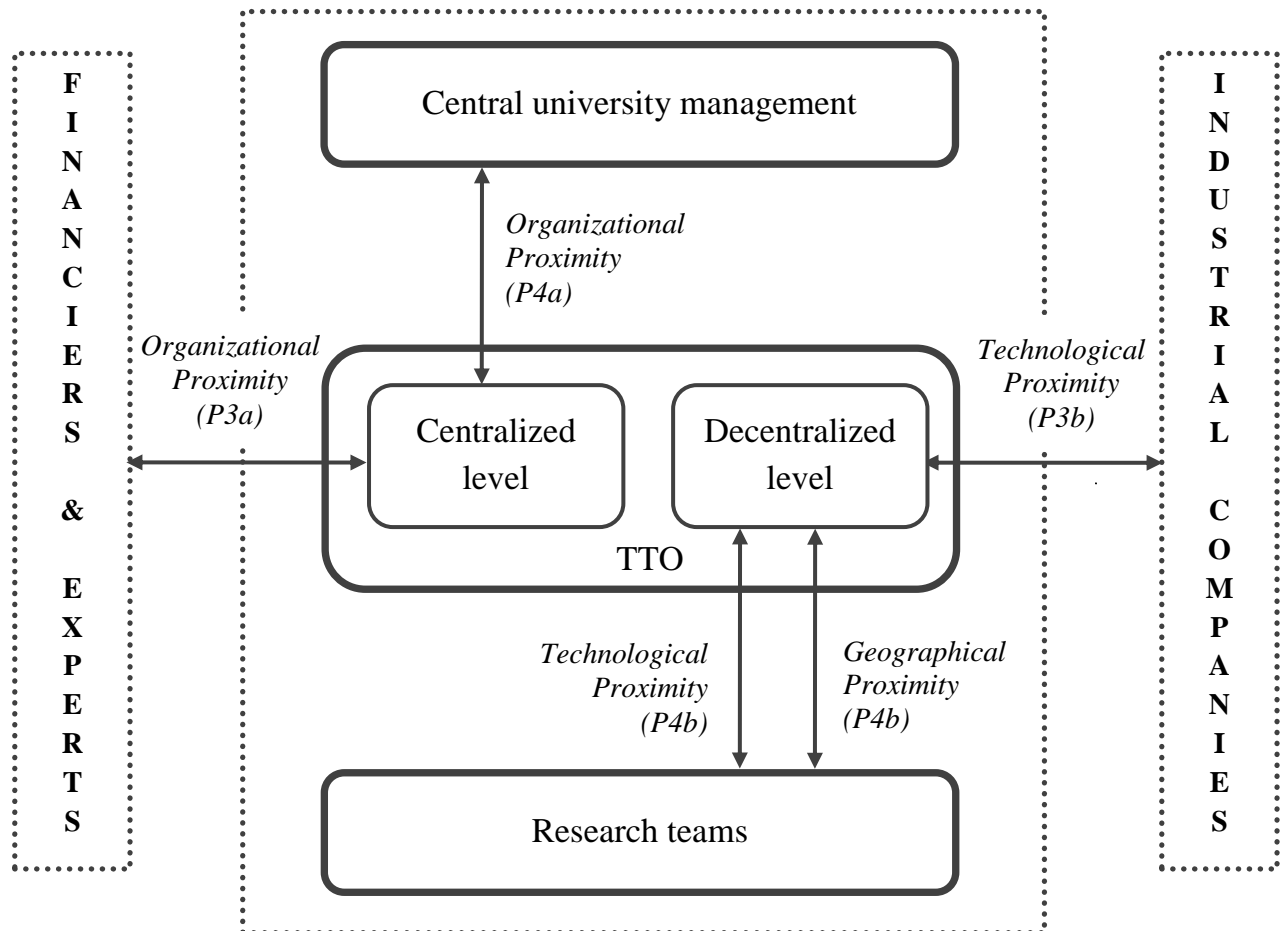
These insights lead us to present the following propositions on the importance of different dimensions of proximity for the internal boundary spanning activities performed by decentralized and centralized TTOs:

**Proposition 4a:** Organizational proximity is a more pronounced antecedent of the internal boundary spanning activities of centralized TTOs than it is for decentralized TTOs.

**Proposition 4b:** Geographical and technological proximity are more pronounced antecedents of the internal boundary spanning activities of decentralized TTOs than for centralized TTOs.

This second set of propositions is summarized in Figure 2.2.

**Figure 2.2: Proximity as an antecedent of boundary spanning activities at different TTO levels**



## 2.5. CONCLUSIONS

Our purpose was to provide new insights into the role of TTOs in the pre-spin-off process to help the pre-founding team to advance. In doing so, we looked beyond the traditional centralized TTO structures and studied a hybrid TTO model which consists of centralized and decentralized levels. Our qualitative analysis has highlighted the existence of a dual boundary spanning role for the two levels within hybrid TTOs. Specifically, the centralized level tries to help pre-founding teams through external boundary spanning activities, by which they bring team members into contact with external experts and financiers. Conversely, external boundary spanning activities at the decentralized level help pre-founding teams get in touch with industrial companies. Moreover, we find that also their *internal* boundary spanning role is not to be neglected. Centralized TTOs are helpful in bridging the gap between the pre-founding teams and the central university level, whereas decentralized TTOs contribute by spanning boundaries between different research teams and between pre-founding team members and the centralized TTO.

Further, we show that the engagement of centralized and decentralized TTOs in different boundary spanning activities is explained by different dimensions of proximity. Whereas the boundary spanning activities of the centralized TTO level are mainly explained by its organizational proximity to the central university management level, geographical and technological proximity cause decentralized TTOs to carry out their boundary spanning activities, implying that they are located physically close to the research teams and share similar knowledge bases.

## 2.6. LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

This research has a number of limitations which suggest areas for further research. First, we concentrate on one structure by which universities can organize their TTO functions, namely the “hybrid TTO model”. While this model has been frequently used in practice, it has been largely understudied, with previous research often considering TTOs to be centralized units. However, further research might usefully compare the boundary spanning role and

drivers of hybrid versus non-hybrid, i.e. entirely (de)centralized, TTO structures. Second, TTOs typically are involved in a wide set of technology transfer mechanisms, ranging from licensing over collaborative research to facilitating spin-off creation. This study specifically focused on the role and drivers of TTOs in the latter activity. Further research could purposefully assess the activities of TTOs in alternative commercialization avenues such as collaborative research, contract research and know-how based consulting, and protection of intellectual property. Moreover, future studies could look at how the choice between licensing and spin-off creation is made by centralized versus decentralized TTO levels. Finally, as this study is qualitative, further research is needed both to formulate the sets of propositions we have developed into testable hypotheses and to test those hypotheses on large samples and in comparative contexts.

In summary, further research could purposefully assess the role of TTOs in other types of technology transfer activities, hereby integrating samples including different TTO models.

## **2.7. CONTRIBUTIONS AND IMPLICATIONS**

In spite of its limitations, our research makes a number of contributions to the academic literature. First, it contributes to the *TTO literature*, which has called for research to explore the activities of TTOs and their determinants (Comacchio et al., 2012; Djokovic & Souitaris, 2008), and various structures by which research institutions house their TTO functions (Markman et al., 2005). As such, our research extends previous TTO research which has mostly focused on centralized TTOs and almost neglected decentralized and hybrid models despite these latter being quite common in practice. Further, our research contributes by showing the importance of TTOs engaging in internal boundary spanning activities. While the organizational behavior literature has emphasized the need for internal and external boundary spanning in other contexts (e.g., in product management, Lysonski, 1985; in multiunit organizations, Tsai, 2002), so far, the technology transfer literature has to a large extent neglected this double function and has mainly concentrated on the external boundary spanning role. Our findings however indicate that, in order for TTOs to help firms to move

through the pre-spin-off process, not only external, but also internal boundary spanning activities are a prerequisite.

Second, this study contributes to the *academic entrepreneurship literature* which has emphasized the importance of the subunit or department level (e.g., Kenney & Goe, 2004; Louis et al. 1989). This literature has shown that individuals tend to conform to localized norms (Bercovitz & Feldman, 2008). Hence, the department chair and workplace peers may play an important role in realizing the university's third mission. Our study indicates that, while examining the localized social environment, in addition to taking into account the workplace peers and the department chair, it is important to consider also decentralized TTOs. By inducing and helping some scientists to engage in the pre-spin-off process, decentralized TTOs may indeed contribute to create a localized social environment that stimulates research commercialization. This paper further enriches the literature on academic entrepreneurship by concentrating on the largely unexplored pre-spin-off process.

Third, we add to the *organizational ambidexterity literature applied to the university context*. Prior studies in this stream have recognized the challenges that universities face when engaging in research, teaching and technology transfer and have highlighted the advantages of structural ambidexterity in successfully pursuing these different activities. Specifically, it has been suggested that autonomous units devoted to technology transfer activities (i.e. TTOs) should be established alongside traditional structures related to teaching and research. Our study shows that, while creating such structures, new intra-organizational boundaries may arise which should not be overlooked.

Fourth, we contribute to the *literature on proximity*. An extensive body of literature has analyzed the different dimensions of proximity (Boschma, 2005; Knobens & Oerlemans, 2006), but has typically considered proximity as an inter-organizational concept. Here, we extend these studies by highlighting the relevance of intra-organizational proximity, i.e. proximity between different units within the same organization.

Our research also has relevant implications for practitioners. Specifically, this study identifies determinants of (hybrid) TTOs' contribution to the pre-spin-off process, which is of relevance to *policy makers* and *university managers* when implementing dual structures at ambidextrous research organizations. Our research can provide guidance for *TTOs* to understand which activities are regarded as helpful to the pre-spin-off process, while presenting directions for university management and policy makers on why different TTO levels are driven to engage in these activities. As such, it offers indications on the implementation of TTO structures and recruitment policies. As to the former, we have shown that decentralized TTOs engage in important internal boundary spanning as a consequence of their geographical proximity to research teams, thus suggesting that these officers should be placed within departments, physically close to the research teams. As to the guidelines for recruitment policies, since the technological proximity between the decentralized TTO level and research teams is another important determinant of internal boundary spanning, TTO managers could maximize the contribution to the pre-spin-off process by hiring decentralized TTOs with education and work experience in areas close to those of the research teams they are supposed to work with. It is important, however, to strike the right balance between having sufficient understanding of the technology with the ability to provide the complementary expertise to develop it commercially. Furthermore, our study can be helpful for *nascent academic entrepreneurs* in understanding the possible role fulfilled by TTOs in a hybrid model.

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### **3. THE INFLUENCE OF ORGANIZATIONAL CULTURE AND CLIMATE ON ENTREPRENEURIAL INTENTIONS AMONG RESEARCH SCIENTISTS**

#### **ABSTRACT**

Over the past decades, universities have increasingly become involved in entrepreneurial activities. Despite efforts to embrace their “third mission”, universities still demonstrate great heterogeneity in terms of their involvement in academic entrepreneurship. This paper adopts an institutional perspective to understand how organizational characteristics affect research scientists’ entrepreneurial intentions. Specifically, we study the impact of university culture and climate on entrepreneurial intentions, including intentions to spin off a company, to engage in patenting or licensing and to interact with industry through contract research or consulting. Using a sample of 437 research scientists from Swedish and German universities, our results reveal that the extent to which universities articulate entrepreneurship as a fundamental element of their mission fosters research scientists’ intentions to engage in spin-off creation and intellectual property rights, but not industry-science interaction. Furthermore, the presence of university role models positively affects research scientists’ propensity to engage in entrepreneurial activities, both directly and indirectly through entrepreneurial self-efficacy. Finally, research scientists working at universities which explicitly reward people for “third mission” related output show higher levels of spin-off and patenting or licensing intentions. This study has implications for both academics and practitioners, including university managers and policy makers.



### 3.1. INTRODUCTION

Universities do not only engage in research and teaching, but are increasingly active in the commercialization of research results, or their so-called “third mission” related to entrepreneurship and economic development (Etzkowitz, 2003; Rasmussen et al., 2006). This entrepreneurial tendency is inspired by decreasing university budgets and pressure from policy makers who view the commercialization of research as a key driver of national competitiveness (Ambos et al., 2008). “Third stream” entrepreneurial activities go beyond the traditional, scientific dissemination mechanisms, such as publications (Van Looy et al., 2011), and include university spin-offs, patenting and licensing activities, contract research and consulting (Abreu & Grinevich, 2013; Wright et al., 2008).

As a result of universities’ growing interest to fulfill their “third mission”, the academic literature has devoted considerable attention to academic entrepreneurship. We refer to Rothaermel et al. (2007), Markman et al. (2008) and Djokovic & Souitaris (2008) for excellent reviews of the literature. In summary, the academic entrepreneurship literature includes studies at macro-level (studying the role of government and industry), meso-level (focusing on the university and the technology transfer office) and micro-level (studying firms and individual entrepreneurs) (Djokovic & Souitaris, 2008). Only recently, scholars have started to explore research scientists’ entrepreneurial intentions (e.g., Mosey et al., 2012; Prodan & Drnovsek, 2010). Entrepreneurial intentions are considered the single best predictor of entrepreneurial behavior (Bird, 1988; Fishbein & Ajzen, 1975) and have been widely studied as outcome variable in diverse contexts (Krueger et al., 2000; Souitaris et al., 2007).

Studying entrepreneurial intentions in an academic context is important given the presence of entrepreneurial potential in scientific knowledge (Obschonka et al., 2012). Academic research has been a crucial ingredient for the development of new products and processes (Mansfield, 1998) and about 70% of inventions require further involvement by the research scientist in order to be successfully commercialized (Jensen & Thursby, 2001). Academic entrepreneurship provides a critical contribution of research scientists to the national economy and society (Ping, 1980) and is often considered crucial for competitive advantage (OECD,

2003). Nevertheless, it is recognized that commercializing research results is difficult. At the heart of the problem is the inherent tension between academic and commercial demands (Hackett, 2001; West, 2008). Universities have tried to overcome this tension in a number of ways, for instance, by establishing technology transfer offices (TTOs) (Siegel et al., 2007). Consequently, it may be valuable for resource-constraint boundary spanners (such as TTOs) to identify those research scientists who are most likely to engage in entrepreneurial activities in order to focus their attention on a specific target group. While analyzing the drivers of entrepreneurial intentions in academia is relevant and has recently received scholarly attention, this paper is motivated by two important gaps in the academic entrepreneurship and entrepreneurial intention literatures.

First, the notion of *academic entrepreneurship* has so far been used in a relatively narrow understanding (Abreu & Grinewich, 2013; Klofsten & Jones-Evans, 2000; Link et al., 2007). Prior research has tended to equate commercialization of academic research to the creation of university spin-offs, defined as new ventures initiated within a university setting and based on technology derived from university research (Rasmussen & Borch, 2010). While spin-offs represent a significant commercialization avenue for universities, other types of academic entrepreneurship must also be taken into consideration (Jain et al., 2009; Link et al., 2007). Specifically, following Abreu & Grinevich (2013), we define academic entrepreneurship as any activity that occurs beyond the traditional roles of teaching and research, which is innovative and comprises an element of risk, and may lead to financial rewards for the individual or the institution. In their seminal work, Louis et al. (1989: 110) adopt a similar broad definition and refer to academic entrepreneurship as “the attempt to increase individual or institutional profit, influence, or prestige through the development and marketing of research ideas or research-based projects”. Along the same lines, Klofsten & Jones-Evans (2000) conceptualize academic entrepreneurship as all commercialization activities outside of the regular university duties of basic research and teaching, and Jain et al. (2009) denote that any form of technology transfer which has some commercial benefit can be defined as academic entrepreneurship. Accordingly, consistent with the classifications by Wright et al. (2008) and Abreu & Grinevich (2013), we address the first identified gap by studying

research scientists' intentions to spin off a company, along with intentions to engage in patenting or licensing and intentions to interact with industry through contract research or consulting. In what follows, we refer to entrepreneurial intentions as intentions to engage in academic entrepreneurship, including this broader spectrum of activities instead of merely university spin-off creation.

Second, within the *entrepreneurial intentions* literature, there is ample evidence of the importance of individual drivers for entrepreneurial intentions (e.g., Dohse & Walter, 2012; Lüthje & Franke, 2003; Souitaris et al., 2007). Surprisingly, only few empirical studies have explored the role of organizational drivers for entrepreneurial intentions. Specifically, Lee et al. (2011) studied entrepreneurial intentions in a corporate setting and Walter et al. (2011) assessed the extent to which characteristics of university departments affect students' self-employment intentions. Similarly, the scarce research that has studied determinants of entrepreneurial intentions in academia has mainly focused on the individual level. Prodan & Drnovsek (2010) for instance found that entrepreneurial self-efficacy was the most important driver of entrepreneurial intentions and found smaller effects related to the type of research and the number of years the research scientist stayed at the institute. Goethner et al. (2012) showed that attitudes and perceived control were key determinants of entrepreneurial intentions in an academic context, whereas Obschonka et al. (2012) identified social identity as a central factor in explaining entrepreneurial intentions. Strikingly, while it is vital to understand the context in which the academic entrepreneur originates, to date, the organizational determinants of research scientists' entrepreneurial intentions remain an unexplored area.

In order to contribute to the identified gaps in both literatures, this paper aims at providing a better insight into the university characteristics that affect research scientists' intentions to engage in different types of academic entrepreneurship. Specifically, we adopt an institutional perspective and focus on university culture and climate as factors shaping research scientists' intentions to create a spin-off (hereafter: "spin-off intentions"), patent or license (i.e. intellectual property rights, hereafter: "IPR intentions") and carry out contract research or

consulting (i.e. industry-science interaction, hereafter: “ISR intentions”). We study our research question in a sample of 437 research scientists from six Swedish and German universities.

This article unfolds as follows. We first present our conceptual framework building on institutional theory and organizational culture/climate literature, followed by a description of our research methodology. We subsequently present our results and discuss implications for academia, practice and future research.

### **3.2. THEORY AND HYPOTHESES**

This study approaches the organization as institution (Zucker, 1987) and draws upon a specific stream in institutional theory, called “new institutionalism” (DiMaggio & Powell, 1983; 1991; Scott, 1987; 2001; Zucker, 1987). Viewing the organization as an institution entails that implemented institutional elements generally arise from within the organization itself or from imitation of similar organizations, not from power or coercive processes located in the state (Zucker, 1987). The neo-institutional perspective rejects the rational-actor models of classical economics and utilizes cognitive and cultural explanations of social and organizational phenomena (DiMaggio & Powell, 1991). Scott (2001: 49) subsequently defines institutions as “multifaceted, durable social structures, made up of symbolic elements, social activities, and material resources”, with the central components of institutions being rules (regulative), norms (normative) and values (cognitive). As institutions’ rules, norms and values stipulate what is appropriate behavior, they render some actions unacceptable or even beyond consideration (DiMaggio & Powell, 1991). Institutions are instrumental in shaping actors’ goals and beliefs (Scott, 1987) and in turn, affect motivational forces and behaviors (De Long & Fahey, 2000; Szulanski, 1996).

Accordingly, we argue that the institutional context in which research scientists are embedded might either trigger or restrain them from engaging in academic entrepreneurship, above and beyond individual-related characteristics. Despite a growing number of initiatives targeted at the “third mission”, universities still demonstrate large heterogeneity in their

degree of entrepreneurial transformation (Martinelli et al., 2008; Tijssen, 2006) and in their support for and involvement in entrepreneurial activities (Hewitt-Dundas, 2011; Kenney & Goe, 2004; Louis et al., 1989; Wright et al., 2008). Universities were traditionally developed to manage activities of research and teaching and, as such, these institutions have to be adapted to incorporate academic entrepreneurship (Colyvas & Powell, 2006). Universities hold distinct ideologies and trajectories towards their entrepreneurial role through which they exercise a strong influence on their members (Stankiewicz, 1986).

Following the above arguments, we propose that university characteristics influence the extent to which research scientists intend to undertake entrepreneurial activities. In what follows, we focus on two particular elements of the institutional context, namely organizational culture and organizational climate, and develop a conceptual framework linking these university characteristics to research scientists' entrepreneurial intentions. Organizational culture and climate are closely related, but distinct constructs (Kuenzi & Schminke, 2009; Schein, 2000). Both constructs conceptualize the way people experience and describe their work environment (Schneider et al., 2013). However, culture denotes assumptions, beliefs, meanings and values within an organization, whereas climate refers to the practices through which culture is manifested (Denison, 1996).

### **3.2.1. The relationship between organizational culture and entrepreneurial intentions**

Adopting an institutional lens is relevant when examining culture (Zilber, 2012), as culture represents one important means by which normative and cognitive structures are transmitted (DiMaggio & Powell, 1991). Organizational culture provides meaning and context (Schein, 1985) and affects how organizational members consciously and subconsciously think and make decisions. Ultimately, organizational culture has an impact on the way people perceive, feel and act (Hansen & Wernerfelt, 1989). Organizational culture shapes the way organizational members set personal and professional objectives, perform tasks and administer resources to achieve them. Within this study, we follow Schein (1985: 9)'s definition of organizational culture as "a pattern of basic assumptions invented, discovered or developed by a given group as it learns to cope with its problems of external adaptation and

internal integration that has worked well enough to be considered valid, and therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems”. Subsequently, organizational culture, acting through institutional belief systems and norms, can be a very effective means of directing the attitude and behavior of organizational members towards entrepreneurial activities.

Consequently, in order to increase research scientists’ interest in entrepreneurial activities, universities could create a culture which is supportive towards such activities, alongside investments in tangible organizational units such as technology transfer offices, incubators and science parks. In this respect, Clark (1998) and Davies (2001) have identified an integrated entrepreneurial culture as a core ingredient for successful institutional transformations into entrepreneurial universities. Along the same lines, O’Shea et al. (2005) argue that universities need to develop a culture supportive of commercialization in order for academic entrepreneurship to flourish.

While there are numerous dimensions of organizational culture (Detert et al., 2000), this study examines two visible components of culture through which universities might influence research scientists’ intentions to engage in entrepreneurial activities. Focusing on visible elements is appropriate, because organizational culture is more likely to be transmitted to organizational members through visible elements (values and behavioral patterns) than through invisible elements (basic assumptions) (Hofstede, 1998; Schein, 1985). In particular, we focus on the presence of a university mission that incorporates academic entrepreneurship and role models that exemplify academic entrepreneurship.

### ***University mission***

An organizational mission is a statement of the organization’s reason for being, long term purpose and distinctiveness, reflecting the institutional beliefs systems and ideologies (Klemm et al., 1991; Swales & Rogers, 1995). The development of an organizational mission is widely acknowledged to be a popular management tool, which requires effective communication to both organizational members and external stakeholders (Cochran & David, 1986; Williams,

2008). A large body of research has indicated that an organizational mission guides the individual behavior of organizational members (Bart, 1996; Smith et al., 2001).

Historically, university missions were primarily directed towards research and teaching, turning their entrepreneurial transformation into a challenging task (Ambos et al., 2008). Institutional change typically requires and implies a modification of the culture or the key institutional elements that shape culture, including the mission (Schein, 1985). As indicated by Jacob et al. (2003), the reconciliation of universities' traditional and entrepreneurial activities does not only require changes in infrastructure but also, amongst others, the adaptation of the university mission. Ideally, an entrepreneurial university should focus on research, teaching and entrepreneurial activities simultaneously (Etkowitz, 2004; Guerrero & Urbano, 2012).

Following institutional theory and given the tendency of organizational members to conform to organizational values regarding entrepreneurship (Lewis et al., 2003; Peters & Fufeld, 1982), in particular in a university context (Friedman & Silberman, 2003; Roberts, 1991), it is likely that the university mission will affect research scientists' entrepreneurial intentions. Accordingly, we argue that the more universities highlight academic entrepreneurship as a fundamental part of their mission, the greater research scientists' intentions to engage in entrepreneurial endeavors. Thus,

**Hypothesis 1:** The extent to which a university mission emphasizes academic entrepreneurship compared to traditional activities is positively related to research scientists' (i) spin-off intentions, (ii) IPR intentions and (iii) ISR intentions.

### ***University role models***

Role models constitute a second key element of organizational culture. The influence of role models on individuals has been highlighted in a number of contexts, including marketing and consumer behavior (Childers & Rao, 1992; Martin & Bush, 2000) and career development (Gibson, 2003; 2004; Kram & Isabella, 1985). Role modeling refers to a cognitive process in which individuals observe attributes of people in social roles similar to

themselves and increase this perceived similarity by imitating these attributes (Erikson, 1985; Gibson, 2004). Individuals are affected by institutional norms, or behavioral patterns of peers within their organization, and tend to act like them (Bercovitz & Feldman, 2008; Haas & Park, 2010; Jain et al., 2009). Since research scientists are exposed to a peer-oriented culture (Samsom & Gurdon, 1993), the internalization or imitation of institutional norms is expected to be strong (Lewis et al., 2003).

Specifically, it is well acknowledged that role models and peers play a crucial role in driving individuals' entrepreneurial activity (Falck et al., 2012; Nanda & Sorenson, 2010; Thornton, 1999). In a university context, the presence of entrepreneurial role models creates an example for research scientists and provides them with a feeling of security. Peer examples signify that academic entrepreneurship is accepted as a legitimate activity within the university, which reduces concerns about the social repercussions of own entrepreneurial actions (Stuart & Ding, 2006). The findings of Shane (2004) and Bercovitz & Feldman (2008) support the view that research scientists' commercialization decisions are socially influenced.

Typically, individuals will imitate the particular behavior of their role models (Bandura, 1986). Indeed, Prodan & Drnovsek (2010) provided evidence on the positive link between perceived role models of spin-off creation and research scientists' intentions to found a company themselves. Along the same lines, we argue that university role models in other types of academic entrepreneurship will also be positively associated with research scientists' intentions to engage in those other types of academic entrepreneurship, including patenting or licensing and contract research or consulting. Hence,

**Hypothesis 2a:** The presence of university role models involved in (i) spin-off creation, (ii) intellectual property rights and (iii) industry-science interaction is positively related to research scientists' (i) spin-off intentions, (ii) IPR intentions and (iii) ISR intentions.

Besides the direct impact of role models on entrepreneurial intentions through internalization or imitation, we expect the presence of role models to also indirectly affect entrepreneurial intentions. Particularly, role models may influence entrepreneurial self-

efficacy, or an individual's confidence in his or her ability to successfully perform entrepreneurial roles and tasks (Chen et al., 1998), through a process of social comparison. Individuals judge their own abilities by comparing themselves to similar others (Festinger, 1954). The presence of entrepreneurial role models will convince research scientists that they have what it takes to engage in entrepreneurial activities themselves, or, in other words, increase their entrepreneurial self-efficacy. In turn, entrepreneurial self-efficacy may affect entrepreneurial intentions. Boyd & Vozikis (1994) developed a theoretical model in which self-efficacy was proposed as an important antecedent of entrepreneurial intentions. Empirical studies have provided strong support for the existence of such relationship (Chen et al., 1998; Krueger, 1993; Zhao et al., 2005). Therefore, we assume that entrepreneurial role models will indirectly, i.e. through entrepreneurial self-efficacy, affect entrepreneurial intentions. Thus,

**Hypothesis 2b:** Entrepreneurial self-efficacy mediates the relation between university role models involved in academic entrepreneurship and research scientists' (i) spin-off intentions, (ii) IPR intentions and (iii) ISR intentions.

### **3.2.2. The relationship between organizational climate and entrepreneurial intentions**

Organizational climate is defined as the shared perceptions of and the meaning attached to policies, practices and procedures that organizational members experience, as well as the kinds of behaviors that are expected, rewarded and supported (Ostroff et al., 2003; Schneider et al., 1998). Climate reflects the tangible, culture-embedding mechanisms of organizations, through which they attempt to direct the energies of organizational members (Quinn & Rohrbaugh, 1983; Schneider et al., 2013). Consequently, organizational climate is not identical, but closely related to organizational culture. Climate represents how culture is manifested through organizational policies and procedures, and how the organizational environment is perceived through the eyes of the individuals operating in that environment (Denison, 1996; Reichers & Schneider, 1990). As part of the institutional context, organizational climate exerts a strong influence on organizational members' motivation and behaviors (Brown & Leigh, 1996; Kuenzi & Schminke, 2009). Therefore, organizational climate can also influence individuals' attitudes and actions towards entrepreneurial activities.

Reward systems have often been seen as a focal dimension of organizational climate (Schneider et al., 1998). Extant literature has shown how organizational reward systems affect individual outcomes including motivation (e.g., Tyagi, 1982), creativity (e.g., Shalley et al., 2004; Tesluk et al., 1997), job performance and satisfaction (e.g., Downey et al., 1975), affective commitment (e.g., Rhoades et al., 2001), knowledge sharing (e.g., Bartol & Srivastava, 2002) and entrepreneurial behavior (e.g., Hornsby et al., 2002).

### ***University reward system***

Organizational rewards, be they monetary or non-monetary, reflect the organization's goals and objectives and encourage individual members to focus their attention on particular activities (Jensen, 1993). Organizational members seek information concerning what activities are rewarded by their institution, and direct their behavior towards such activities while disregarding activities they are not rewarded for (Kerr, 1975). Accordingly, through the implementation of specific reward systems, organizations can enhance the likelihood that desired behaviors occur.

In a university context, reward systems are typically based on research scientists' publication output (Franklin et al., 2001). Nevertheless, scholars have suggested that the establishment of rewards for entrepreneurial activities is needed in order to foster a climate of entrepreneurship within universities (Friedman & Silberman, 2003; Shane, 2004; Siegel et al., 2003). As such, if universities want to encourage their employees to engage in research commercialization, it will be desirable to adapt the incentive systems to the "third mission" (Debackere & Veugelers, 2005; Link et al., 2007; Markman et al., 2004). If reward systems are to stimulate research scientists to direct their efforts towards entrepreneurial activities, they should no longer be exclusively based on research and teaching excellence, but also reward entrepreneurial accomplishments (Henrekson & Rosenberg, 2001; Jensen & Thursby, 2001; Lockett & Wright, 2005).

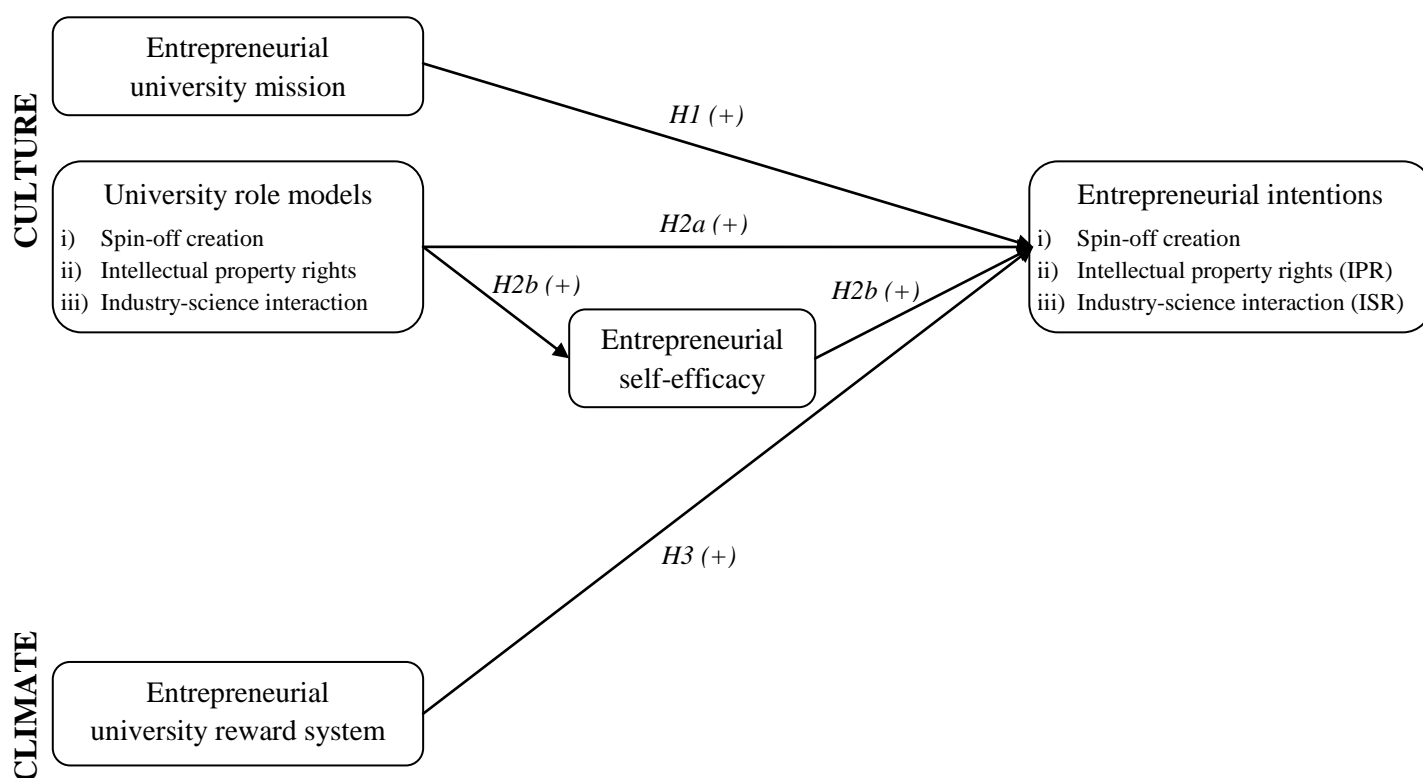
Following institutional theory and the literature on organizational reward systems, we can expect university rewards to affect research scientists' entrepreneurial intentions. Specifically, we argue that the more explicitly the university reward system incorporates entrepreneurial

activities as a criterion compared to the rewards for research and teaching, the greater the research scientist's intentions to engage in entrepreneurial activities. Thus,

**Hypothesis 3:** The extent to which a university reward system incorporates academic entrepreneurship compared to traditional activities is positively related to research scientists' (i) spin-off intentions, (ii) IPR intentions and (iii) ISR intentions..

Figure 3.1 summarizes our hypotheses.

**Figure 3.1: Conceptual model**



### 3.3. METHODOLOGY

#### 3.3.1. Data collection and sample

Our study is based upon unique cross-sectional data collected in 2012 at six universities in two European countries, Sweden and Germany. Both countries have similarly strong and mature infrastructural support for entrepreneurial activities initiated by both governments and individual universities. Sweden and Germany are characterized by high levels of R&D

intensity and a relatively high degree of academic entrepreneurship (Wright et al., 2008). An important difference lies in the academic exemption or professor's privilege in Sweden, which asserts full ownership of intellectual property rights to faculty (Klofsten & Jones-Evans, 2000).

The data collection process included face-to-face interviews with technology transfer officers from each university, followed by an online survey for research scientists involved in different scientific disciplines. First, we contacted the TTOs from the six universities (Chalmers University of Technology, Gothenburg University, Mälardalen University, Halmstad University, KTH Royal Institute of Technology and Technical University Munich). Through face-to-face interviews, we obtained information on university characteristics (e.g., human and financial resources, annual innovation output) and technology transfer practices (e.g., history, organizational structure). Primary data were verified and complemented with secondary data from annual reports, university and TTO websites. Furthermore, we asked permission and assistance to contact research scientists at each university. We specifically targeted research scientists (as opposed to, for instance, tenured professors) as they are more likely to develop their career capital due to uncertainty about which career track will be the most beneficial to them (Krabel & Mueller, 2009). Conversely, professors are typically more focused on establishing their reputation in the scientific community.

The survey population consisted of 8,857 research scientists, of which 5,418 at the Swedish universities and 3,439 at the German universities. Respondents received a request through email to complete an online questionnaire. We obtained 1,103 failure messages indicating that email addresses were invalid or our message could not be sent, resulting in a usable population of 7,754 research scientists. After one week, a reminder email was sent. In total, 850 responses were received (or 11% of the usable population). After elimination of incomplete responses, our final sample consists of 437 research scientists who fully completed the questionnaire, or 5.6% of the usable population. T-tests revealed no significant differences between respondents who filled in all questions and those who provided incomplete responses, or between early and late respondents, in terms of age, gender,

education, position, academic experience, scientific discipline or country ( $p > 0.05$ ). As such, non-response bias was unlikely to be a problem in our dataset (Hair et al., 2006). Some procedural techniques were used to reduce the risk of common method bias. In our email, we guaranteed anonymity to reduce respondents' tendency to give socially desirable answers (Podsakoff et al., 2003). Moreover, careful attention was given to the wording of questions in order to avoid vague concepts and to reduce items' ambiguity (Tourangeau et al., 2000).

### 3.3.2. Measures

#### *Dependent variables*

As academic entrepreneurship can take a variety of forms (Abreu & Grinevich, 2013; Link et al., 2007; Wright et al., 2008), three dependent variables were created. Specifically, we capture research scientists' entrepreneurial intentions in terms of (i) spin-off creation, (ii) intellectual property rights (patenting or licensing), and (iii) industry-science interaction (contract research or consulting). Subsequently, in line with prior research (e.g., Douglas & Fitzsimmons, 2013), principal components analysis (PCA) was used to investigate the underlying structure of our eight measurement items. This confirmed the existence of three factors which accounted for 84.58% of the cumulative variance. Cronbach's alphas were all significantly above the generally accepted criterion of 0.70, indicating high reliability (Hair et al., 2006).

*Spin-off intentions* were measured by the following items: 'How likely is it that, in the foreseeable future, (1) You will engage in the founding of a university spin-off?, (2) You will engage in the establishment of a company based upon an idea and/or technology developed at the university?, and (3) You will participate in the founding of a firm to commercialize your research?', on a scale ranging from 1 (very unlikely) to 7 (very likely). Scale reliability measured by Cronbach's alpha is 0.92.

To measure *IPR intentions*, respondents were asked to respond to the following questions using a 7-point scale with anchors 1 (very unlikely) and 7 (very likely): 'How likely is it that, in the foreseeable future, (1) You will apply for a patent resulting from your research at the

university?, (2) You will license some of your technological developments to the industry?, and (3) You will become the owner of intellectual property rights (patent, copyright, trademark,...)?'. Cronbach's alpha is 0.85.

*ISR intentions* were assessed through the following questions: 'How likely is it that, in the foreseeable future, (1) You will engage in collaborative research with industry?, and (2) You will engage in contract research or consulting activities with industry?'. Scale reliability measured by Cronbach's alpha is 0.91.

### ***Independent variables***

*University mission.* Drawing upon Guerrero & Urbano (2012), we created seven items to measure whether the university mission incorporates academic entrepreneurship. Respondents were asked to indicate their degree of agreement with the following statements on a scale ranging from 1 (strongly disagree) to 7 (strongly agree): 'The mission of my university focuses on (1) Publishing papers with practical implications, (2) Knowledge transfer (patents, licenses, spin-offs), (3) Promoting an entrepreneurial culture, (4) Generating entrepreneurs, (5) Publishing scientific, peer-reviewed papers, (6) Academic excellence (research and teaching), and (7) Consulting and contract research with industry'. Exploratory factor analysis through PCA pointed to the existence of two underlying constructs with eigenvalues above 1 which accounted for 69.73% of the cumulative variance: "focus on entrepreneurial activities" (items 1, 2, 3, 4 and 7; Cronbach's alpha 0.84; mean 4.61) and "focus on traditional activities" (items 5 and 6; Cronbach's alpha 0.78; mean 5.82). Subsequently, we summarized these items in two constructs and divided the values obtained for the first construct by the latter construct. As such, our variable labeled "*Entrepreneurial mission*" expresses the relative importance of "third mission" within the university mission, as perceived by the research scientists.

*University role models.* Participants were asked: 'Has anyone in your university, who you know personally, (1) Created a company based on university research?, (2) Applied for a patent and/or licensed technology?, and (3) Engaged in consulting and/or contract research with industry?'. Responses were coded 1 (41% of the sample for spin-off creation, 46% for patenting or licensing, 68% for consulting or contract research) in case of perceived role

models and 0 otherwise. As such, three dummy variables were generated, labeled “*Spin-off role models*”, “*IPR role models*” and “*ISR role models*”.

*University reward system.* We created six items to reflect whether the university reward system values academic entrepreneurship, beyond the traditional, scientific activities of teaching and research. Using a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), respondents were requested to answer the following statements: ‘My rewards (e.g., salary, additional financial resources, recognition from scientific community, flexi-time...) are determined by (1) Research performance (e.g., number and quality of publications), (2) Involvement in consulting and contract research, (3) Involvement in administrative, service or committee activities, (4) Involvement in patenting and licensing, (5) Teaching performance (e.g., student evaluations), and (6) Involvement in spin-off creation’. Conducting PCA uncovered the existence of two factors, accounting for 72.26% of the cumulative variance, which we named “emphasis on entrepreneurial rewards” (items 2, 4 and 6; Cronbach’s alpha 0.88; mean 2.76) and “emphasis on traditional rewards” (items 1, 3 and 5; Cronbach’s alpha 0.70; mean 4.09). Consequently, we again generated summarized measures for the two constructs and calculated the ratio by dividing the values for the first construct by the latter construct. The measure we obtained was labeled “*Entrepreneurial rewards*” and represents the relative importance of rewards for entrepreneurial activities compared to rewards for traditional activities, from the research scientist’s point of view.

### ***Other variables***

Following prior literature on academic entrepreneurship and entrepreneurial intentions, other characteristics could affect research scientists’ entrepreneurial intentions. In what follows, we elaborate on our mediating and control variables.

*Entrepreneurial self-efficacy* was measured using the scale developed and validated by Zhao et al. (2005), including four items: ‘How confident are you in successfully (1) Identifying new business opportunities?, (2) Creating new products?, (3) Thinking creatively?, and (4) Commercializing an idea or new development?’ (1 = no confidence, 7 = complete confidence). Scale reliability measured by Cronbach’s alpha is 0.81.

*Gender* (0 = male, 1 = female) was controlled for as men are usually more entrepreneurial than women (Crant, 1996; Zhao et al., 2005).

*Position* (0 = doctoral researcher, 1 = post-doctoral researcher) indicates whether the respondent has already obtained a PhD or not.

*Technical degree* (e.g., bio-science, physics, electronics, mechanics, robotics, ...) and *non-technical degree* (e.g., economics, law school, psychology, MBA, ...) assesses the educational degree research scientists obtained (0 = no, 1 = yes). Education is a key element of human capital which has been shown to affect the likelihood of becoming an entrepreneur (Mosey & Wright, 2007; Shane, 2000).

*Academic experience* indicates the number of years respondents have so far spent in academia. Research scientists' embeddedness in academia may lower the likelihood of producing commercial outputs (Ambos et al., 2008; Prodan & Drnovsek, 2010).

*Scientific discipline* was controlled for, as embeddedness in particular disciplines has been shown to influence individuals' propensity to shift towards entrepreneurship (Kenney & Goe, 2004). Specifically, medical inventions have greater marketability than inventions from other disciplines (Powers, 2003), and research scientists at medical faculties are typically more familiar with working at the intersection of basic and applied research (Stuart & Ding, 2006). Further, commercialization activities, especially patenting and licensing, are a common practice in engineering and life sciences (Bercovitz & Feldman, 2008; Owen-Smith & Powell, 2001). Finally, in contrast, social sciences are characterized by research results that are less codified (Pilegaard et al., 2010). Therefore, four dummy variables were included representing the following categories: clinical medicine and pharmacy (*Medicine*), engineering, technology and computer science (*Engineering*), life and agricultural sciences (*Life*), and social and behavioral sciences (*Social*). A fifth category, the discipline of natural sciences and mathematics, was used as reference category.

*Country* was controlled for, given the academic exemption or professor's privilege in Sweden (Klofsten & Jones-Evans, 2000), by including a dummy variable (0 = Germany, 1 = Sweden).

### ***Discriminant validity and common method variance***

Before testing our hypotheses, we ran confirmatory factor analyses to check the distinctiveness of our measures (discriminant validity) and to rule out the impact of common method bias. Discriminant validity was assessed for pairs of constructs by constraining the estimated correlation parameter between constructs to 1 and then performing a chi-square difference test on the values obtained from the constrained and unconstrained models (Anderson & Gerbing, 1988). For all 21 pairs of constructs, the chi-square values were significantly lower for the unconstrained models (i.e.  $\Delta \chi^2_{df=1} > 3.84$ ), which indicates discriminant validity. Furthermore, we wanted to verify whether our results were affected by common method variance, which is a legitimate concern when all variables are gathered through a questionnaire (Podsakoff et al., 2003). Thus, we added a latent variable which was allowed to influence all items of our base model in which all items were allowed to load on their respective latent constructs. This additional latent variable represents the common method extracted from all items (Podsakoff et al., 2003). While CFI and SRMR fit indices indicate that this model is somewhat better than the model without common method variable, PNFI, which takes into account a model's parsimony and hence helps compare models (Hair et al., 2006), was higher for the model without the common method factor (0.75 versus 0.65), pointing to a better model fit. This indicates that common method variance was not a major concern in our study.

### **3.4. RESULTS**

Table 3.1 provides the means, standard deviations and correlations for all variables. Our sample consists of 281 (64%) Swedish and 156 (36%) German research scientists. 41% of our respondents are women and 25% are post-doctoral researchers. In addition, 269 (62%) research scientists in our sample possess a technical degree (science, technology or engineering) and 148 (34%) a non-technical degree (business, social sciences or humanities). On average, respondents indicated having 7.59 years of experience in academia (SD 6.57 years). They are conducting research activities in different scientific disciplines: 92 (21%) are

**Table 3.1: Descriptive statistics and correlations**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) Gender <sup>a</sup>																			
(2) Position <sup>a</sup>	0.05																		
(3) Technical degree <sup>a</sup>	<b>-0.21</b>	<b>-0.14</b>																	
(4) Non-technical degree <sup>a</sup>	<b>0.18</b>	<b>0.14</b>	<b>-0.75</b>																
(5) Academic experience	-0.06	<b>0.36</b>	<b>-0.17</b>	<b>0.16</b>															
(6) Medicine <sup>a</sup>	<b>0.18</b>	<b>0.12</b>	<b>-0.31</b>	<b>0.17</b>	<b>0.19</b>														
(7) Engineering <sup>a</sup>	<b>-0.20</b>	<b>-0.19</b>	<b>0.41</b>	<b>-0.32</b>	<b>-0.18</b>	<b>-0.41</b>													
(8) Life <sup>a</sup>	0.01	-0.05	<b>0.13</b>	<b>-0.14</b>	-0.02	<b>-0.17</b>	<b>-0.26</b>												
(9) Social <sup>a</sup>	<b>0.14</b>	<b>0.10</b>	<b>-0.43</b>	<b>0.53</b>	0.08	<b>-0.24</b>	<b>-0.36</b>	<b>-0.15</b>											
(10) Entrepreneurial self-efficacy	<b>-0.23</b>	<b>-0.08</b>	<b>0.16</b>	<b>-0.14</b>	0.04	<b>-0.12</b>	<b>0.17</b>	-0.01	-0.06										
(11) Country <sup>a</sup>	<b>0.09</b>	<b>0.12</b>	<b>-0.22</b>	<b>0.24</b>	<b>0.23</b>	<b>0.31</b>	<b>-0.19</b>	<b>-0.11</b>	<b>0.15</b>	<b>-0.14</b>									
(12) Entrepreneurial mission	<b>-0.15</b>	<b>-0.09</b>	<b>0.12</b>	<b>-0.12</b>	-0.03	<b>-0.17</b>	<b>0.13</b>	-0.03	0.02	<b>0.18</b>	-0.11								
(13) Spin-off role models	-0.08	<b>0.11</b>	<b>0.10</b>	<b>-0.11</b>	<b>0.11</b>	0.01	<b>0.15</b>	0.03	<b>-0.15</b>	<b>0.19</b>	0.01	0.05							
(14) IPR role models	<b>-0.12</b>	<b>0.10</b>	<b>0.21</b>	<b>-0.24</b>	<b>0.08</b>	0.08	<b>0.11</b>	0.02	<b>-0.28</b>	<b>0.16</b>	<b>-0.11</b>	0.04	<b>0.46</b>						
(15) ISR role models	<b>-0.11</b>	-0.02	0.15	<b>-0.12</b>	0.01	<b>-0.11</b>	<b>0.11</b>	-0.02	-0.07	<b>0.24</b>	0.01	<b>0.12</b>	<b>0.39</b>	<b>0.30</b>					
(16) Entrepreneurial rewards	-0.08	-0.08	<b>0.11</b>	<b>-0.17</b>	<b>-0.09</b>	-0.02	<b>0.15</b>	-0.07	<b>-0.16</b>	<b>0.21</b>	-0.07	<b>0.18</b>	<b>0.13</b>	<b>0.08</b>	<b>0.11</b>				
(17) Spin-off intentions	<b>-0.17</b>	-0.06	<b>0.23</b>	<b>-0.16</b>	-0.04	<b>-0.08</b>	<b>0.15</b>	0.03	<b>-0.14</b>	<b>0.55</b>	-0.02	<b>0.23</b>	<b>0.22</b>	<b>0.20</b>	<b>0.20</b>	<b>0.27</b>			
(18) IPR intentions	<b>-0.24</b>	-0.01	<b>0.32</b>	<b>-0.29</b>	-0.00	<b>-0.11</b>	<b>0.18</b>	0.04	<b>-0.22</b>	<b>0.48</b>	<b>-0.12</b>	<b>0.24</b>	<b>0.28</b>	<b>0.36</b>	<b>0.20</b>	<b>0.30</b>	<b>0.58</b>		
(19) ISR intentions	<b>-0.19</b>	-0.06	<b>0.38</b>	<b>-0.28</b>	<b>-0.08</b>	<b>-0.22</b>	<b>0.30</b>	-0.02	<b>-0.21</b>	<b>0.37</b>	-0.05	<b>0.16</b>	<b>0.15</b>	<b>0.21</b>	<b>0.33</b>	<b>0.20</b>	<b>0.48</b>	<b>0.37</b>	
Mean	0.41	0.25	0.62	0.34	7.59	0.21	0.38	0.10	0.17	3.80	0.64	0.83	0.41	0.46	0.68	0.74	2.89	2.63	4.54
Standard deviation	0.49	0.43	0.49	0.47	6.57	0.41	0.49	0.30	0.38	1.27	0.48	0.33	0.49	0.50	0.47	0.51	1.61	1.58	1.84

Pearson correlation coefficient (1-tailed), indicating significant correlations ( $p < 0.05$ ) in **bold**;  $n = 437$

<sup>a</sup> Correlations of binary variables should be interpreted with care.

involved in clinical medicine or pharmaceutical research, 166 (38%) in engineering, technology or computer science, 44 (10%) in life or agricultural sciences, 74 (17%) in social and behavioral sciences, and 61 (14%) in natural sciences or mathematics. On average, research scientists in our sample have greater intentions to liaise with industry through contract research or consulting (4.54) than to create a spin-off company (2.89) or to engage in patenting or licensing activities (2.63).

Hierarchical OLS regressions were performed for the three types of entrepreneurial intentions – spin-off intentions, IPR intentions and ISR intentions – to evaluate the direct relationships (Hypothesis 1, 2a and 3). In the first model, we entered only the control variables, while the independent variables were added in the second model. We checked for multicollinearity problems by calculating variance inflation factors (VIFs) for all models. The highest VIF was 2.7, which is substantially below the critical value of 5 (Hair et al., 2006) and indicates that multicollinearity is unlikely to be a concern in our study. Our results are presented in Table 3.2.

Models 1, 3 and 5 are baseline models consisting of control variables only. Results indicate that research scientists holding a technical degree (science, technology, or engineering) have greater intentions to engage in spin-off creation ( $p < 0.01$ ), intellectual property rights ( $p < 0.01$ ) and industry-science interaction ( $p < 0.001$ ). Further, in line with prior research (Prodan & Drnovsek, 2010; Zhao et al., 2005), entrepreneurial self-efficacy positively affects research scientists' entrepreneurial intentions ( $p < 0.001$  for all three dependent variables). Consistent with Ambos et al. (2008), the baseline models indicate that the more time research scientists have spent in academia, the lower their intentions to found a spin-off and to undertake interactions with the industry ( $p < 0.05$ ). Finally, significant country and discipline effects ( $p < 0.05$ ) exist for ISR intentions, with Swedish research scientists showing greater intentions to carry out contract research or consulting activities compared to their German colleagues, and with respondents active in clinical medicine or pharmacy, and in social and behavioral sciences exhibiting lower ISR intentions.

**Table 3.2: OLS regression unstandardized coefficients (standard errors in parentheses)**

<b>Outcome</b>	<b>(i) Spin-off intentions</b>		<b>(ii) IPR intentions</b>		<b>(iii) ISR intentions</b>	
	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>	<b>Model 5</b>	<b>Model 6</b>
Constant	-0.004 (0.313)	-0.879* (0.362)	0.463 (0.322)	-0.428 (0.352)	2.431*** (0.379)	1.622*** (0.435)
<b>Control</b>						
Gender	-0.098 (0.129)	-0.040 (0.134)	-0.214 (0.133)	-0.217 (0.130)	-0.147 (0.157)	-0.062 (0.160)
Position	0.076 (0.151)	0.050 (0.156)	0.295 (0.155)	0.196 (0.150)	0.071 (0.182)	0.147 (0.184)
Technical degree	0.537** (0.193)	0.596** (0.203)	0.624** (0.198)	0.527** (0.196)	0.972*** (0.234)	0.984*** (0.242)
Non-technical degree	0.249 (0.197)	0.383 (0.213)	-0.124 (0.203)	-0.011 (0.204)	0.188 (0.240)	0.275 (0.252)
Academic experience	-0.022* (0.010)	-0.018 (0.011)	0.003 (0.010)	-0.004 (0.010)	-0.025* (0.012)	-0.014 (0.013)
Medicine	0.048 (0.231)	-0.069 (0.239)	-0.187 (0.236)	-0.129 (0.232)	-0.643* (0.278)	-0.614* (0.285)
Engineering	0.001 (0.189)	-0.140 (0.199)	-0.191 (0.193)	-0.113 (0.190)	0.060 (0.228)	0.109 (0.235)
Life	0.154 (0.251)	0.135 (0.262)	-0.128 (0.256)	0.081 (0.250)	-0.519 (0.303)	-0.337 (0.310)
Social	-0.234 (0.255)	-0.372 (0.267)	-0.504 (0.261)	-0.208 (0.259)	-0.700* (0.308)	-0.656* (0.319)
Entrepreneurial self-efficacy	0.658*** (0.049)	0.618*** (0.052)	0.527*** (0.051)	0.439*** (0.050)	0.423*** (0.060)	0.367*** (0.063)
Country	0.246 (0.138)	0.385** (0.142)	0.034 (0.142)	0.101 (0.137)	0.402* (0.167)	0.373* (0.170)
<b>Predictor</b>						
Entrepreneurial mission		0.611** (0.196)		0.548** (0.190)		0.235 (0.236)
Spin-off role models		0.331** (0.132)				
IPR role models				0.739*** (0.129)		
ISR role models						0.762*** (0.165)
Entrepreneurial rewards		0.404** (0.128)		0.508*** (0.124)		0.274 (0.153)
F-statistic	20.879***	19.155***	18.823***	20.358***	15.379***	14.569***
R <sup>2</sup>	0.32	0.39	0.30	0.40	0.26	0.32
Adjusted R <sup>2</sup>	0.31	0.37	0.28	0.38	0.24	0.30
R <sup>2</sup> change		0.07***		0.10***		0.06***

\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001; n = 437

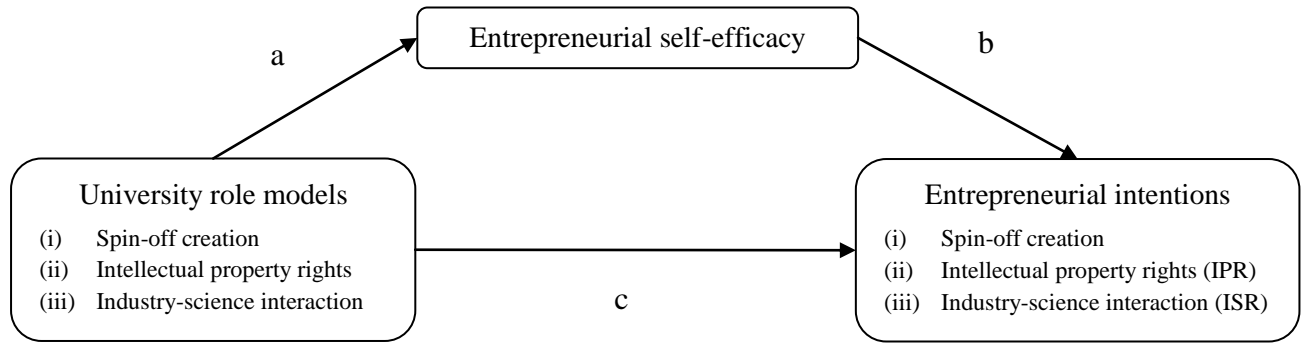
Models 2, 4 and 6 present the results for the direct effects of culture and climate on entrepreneurial intentions, whilst controlling for individual characteristics, discipline and country effects. In each of our full models, adding independent variables to the baseline

model leads to significant improvements of  $R^2$  ( $p < 0.001$ ). We find *partial support for Hypothesis 1*, which proposed that the degree to which a university mission highlights academic entrepreneurship relative to its traditional tasks is positively associated with research scientists' entrepreneurial intentions. Entrepreneurial mission only shows a significant positive relationship with spin-off intentions ( $p < 0.01$ ) and IPR intentions ( $p < 0.01$ ), but not with ISR intentions. *Hypothesis 2a*, which looked at the direct relationship between university role models and research scientists' entrepreneurial intentions, is *supported* for all three dependent variables. The presence of spin-off role models is positively related to spin-off intentions ( $p < 0.01$ ), IPR role models to IPR intentions ( $p < 0.001$ ) and ISR role models to ISR intentions ( $p < 0.001$ ). Our findings also *partially support Hypothesis 3*, which states that the explicitness of academic entrepreneurship as criterion in the university reward system, compared to research and teaching, is positively related to research scientists' entrepreneurial intentions. Entrepreneurial rewards has a significant positive influence on spin-off intentions ( $p < 0.001$ ) just as IPR intentions ( $p < 0.001$ ), but not on ISR intentions.

In order to test for the indirect relationship between university role models and intentions through entrepreneurial self-efficacy (*Hypothesis 2b*), we used a macro developed by Preacher & Hayes (2008). This allows us to disentangle the impact of direct and indirect (mediation) effects and relies on bootstrapping to test the mediation effect. We ran three analyses for each type of entrepreneurial intentions (role models related to specific entrepreneurial activities) with other independent variables as covariates. The output generated is shown in Figure 3.2.

Figure 3.2 displays the significance of the indirect effects, in particular the extent to which entrepreneurial self-efficacy mediates the relationship between university role models and entrepreneurial intentions. The indirect effect of spin-off role models on spin-off intentions via entrepreneurial self-efficacy is positive and significant (95% CI = 0.083 – 0.403). Further, the relationship between IPR role models (95% CI = 0.028 – 0.254) and ISR role models (95% CI = 0.091 – 0.325) on respectively IPR and ISR intentions is significantly mediated by entrepreneurial self-efficacy. This provides *support for Hypothesis 2b*.

**Figure 3.2: Diagram of the mediation effect**



$$\begin{aligned}\text{Total effect} &= \text{Indirect effect} + \text{Direct effect} \\ &= (a \times b) + c\end{aligned}$$

	a	b	Bootstrap-indirect effect	95% CI
(i)	0.3693** (0.1206)	0.6184*** (0.0524)	0.2284 (0.0814)	0.0829 – 0.4031
(ii)	0.2876* (0.1231)	0.4391*** (0.0504)	0.1263 (0.0568)	0.0276 – 0.2535
(iii)	0.5100*** (0.1237)	0.3669*** (0.0633)	0.1871 (0.0588)	0.0910 – 0.3248

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ ;  $n = 437$

F-statistics are significant at 0.1% level. Confidence intervals (CI) are bias-corrected based on 10,000 bootstrap samples.

Covariates included: gender, position, technical degree, non-technical degree, academic experience, scientific discipline, country, entrepreneurial mission and entrepreneurial rewards.

Standard errors in parentheses.

### 3.4.1. Robustness checks

We conducted post hoc analyses to assess the robustness of our results and to provide more fine-grained insights into the impact of organizational culture and climate on research scientists' entrepreneurial intentions. First, while we deliberately assessed organizational culture and climate through the perceptions of research scientists, it is relevant to verify the degree to which people within an organization agree in their perceptions (Schneider et al., 2013). We subsequently calculated the (two-way random) intra-class correlation coefficients (ICCs) for the responses received on the items for mission and reward system for each university. ICC(2) is an index of the reliability of the group means and is commonly interpreted in line with other measures of reliability, with 0.70 or higher deemed adequate (Bliese, 2000; LeBreton & Senter, 2008). All ICCs were significantly above this generally accepted minimum value, with the lowest ICC equaling 0.89. This points to considerable convergence in the opinions of research scientists on the university mission and reward

system. Second, given that both organizational culture and climate were shown to be an effective means to shape research scientists' entrepreneurial intentions, we reran analyses including interaction effects. We found significant positive interaction effects between cultural elements and climate, but only for IPR intentions. Particularly, entrepreneurial rewards reinforce the positive relation between entrepreneurial mission and IPR intentions, as well as the positive impact of IPR role models on research scientists' intentions to engage in patenting or licensing themselves.

### **3.5. DISCUSSION AND CONCLUSION**

This paper has sought to contribute to our understanding of how organizational culture and climate affect entrepreneurial intentions in academia, thereby adopting an institutional perspective. Our study provides evidence that universities can shape research scientists' intentions to engage in spin-off creation, intellectual property rights and industry-science interaction, by offering an institutional environment that promotes academic entrepreneurship. First, our analyses reveal interesting insights into the influence of *organizational culture* on entrepreneurial intentions. Particularly, the more universities emphasize academic entrepreneurship in their mission compared to research and teaching, the greater research scientists' intentions to engage in spin-off creation and intellectual property rights. Surprisingly, our results do not show a similar impact for entrepreneurial mission on ISR intentions. Furthermore, a second element of university culture, the presence of role models that exemplify a specific type of academic entrepreneurship, leads to stronger intentions among research scientists to imitate the same commercialization mechanism. At the same time, entrepreneurial role models also exert an indirect influence on entrepreneurial intentions through an increase of research scientists' entrepreneurial self-efficacy. Specifically, research scientists who detect entrepreneurial role models in their university feel more confident that they could successfully engage in entrepreneurial activities themselves, and are therefore more likely to hold entrepreneurial intentions. Second, as for *organizational climate*, research scientists working at universities which explicitly allocate rewards for entrepreneurial

endeavors were found to possess higher levels of spin-off and patenting or licensing intentions. Our distinct findings for ISR intentions may be explained by the fact that universities have tended to exert little control over industry-science interaction, compared to alternative commercialization mechanisms (Klofsten & Jones-Evans, 2000). Additionally, contract research and consulting activities performed by research scientists are strongly determined by personal relationships between industrial companies and particular professors or departments (Wright et al., 2008). Therefore, this type of academic entrepreneurship may have been institutionalized prior to the emergence of universities' "third mission", or at the sub-organizational level. This provides a potential explanation why industry-science interaction is less subject to institutional norms articulated by the university mission or incorporated in the university reward system, as compared to spin-off creation or IPR activities.

This study contributes to the academic literature in a number of ways. First, this study contributes to the *academic entrepreneurship literature*, in which entrepreneurial intentions have only recently started to receive attention. Specifically, we extend entrepreneurial intentions in academia beyond the restrictive focus on spin-off creation, by including a broader canvas of commercialization mechanisms (Wright et al., 2008). Our study also enriches prior research by showing that formal (patenting, licensing, spin-offs) versus informal or "soft" (consulting, contract research) commercialization activities have different determinants (Abreu & Grinewich, 2013; Klofsten & Jones-Evans, 2000; Link et al., 2007). Furthermore, we use an institutional lens to study the impact of organizational context on entrepreneurial intentions, while controlling for individual factors. Importantly, whereas university culture has been identified as a key driver for academic entrepreneurship (Clark, 1998; Jacob et al., 2003; Martinelli et al., 2008; Siegel et al., 2004), to this point no research has provided a theoretical framework nor empirical evidence on the association between university culture and the development of entrepreneurial intentions. As such, this research responds to recent calls by Djokovic & Souitaris (2008) to untangle the impact of an entrepreneurial culture within the university and by O'Shea et al. (2005) to explain academic entrepreneurship in terms of university culture and rewards. Particularly, we show that

elements of organizational culture, namely university mission and the presence of role models, just as organizational climate, including the extent to which the university reward system values entrepreneurial activities, have an important effect on research scientists' entrepreneurial intentions. Second, this paper enriches the *entrepreneurial intentions literature* which has predominantly focused on individual-level explanations of entrepreneurial intentions, but has to a large extent neglected organizational determinants. Given that individuals are embedded in institutional contexts, they cannot be studied in an isolated manner. Accordingly, we respond to calls by Dohse & Walter (2012), Fayolle & Liñan (2014), and Lee et al. (2011) to contextualize entrepreneurial intentions.

Our research also has relevant implications for practitioners, including policy makers and university management. First, for *policy makers*, who base university funding upon evaluation criteria including a mix of research, teaching and entrepreneurial activities (Etzkowitz et al., 2000), it may be useful to understand how the universities they finance could enhance their commercialization output. Consequently, for instance, they could help to increase this output by stimulating universities to include entrepreneurial activities as part of the reward system. Second, for *university management*, this research shows that it is beneficial to incorporate academic entrepreneurship in the university mission and to make sure that research scientists are aware of existing role models. While examining the mechanisms through which university management could communicate that entrepreneurship is a fundamental part of the university mission was beyond the scope of our study, it is likely that any sort of communication (e.g., newsletters, speeches by university management) that increases the awareness among research scientists of the importance of entrepreneurial activities within their university will generate higher levels of entrepreneurial intentions. Furthermore, university management could ensure that role models make public appearances more frequently and as such, focus research scientists' attention on academic entrepreneurship as an ongoing and accepted organizational practice. Finally, university management could establish a reward system that does not only value scientific output, but also distributes rewards for research scientists' engagement in entrepreneurial activities.

Our study has a number of limitations which suggest fruitful areas for further research. First, data were collected at six universities in Germany and Sweden. While we find limited country differences based upon our analyses, there is little reason to assume that our results could not be generalized to other regions in Europe. Yet, further research could broaden the geographical scope and develop similar studies in other countries or study universities in a broader range of contexts. Also, future studies could assess to which extent our results hold in samples of public research institutions or university colleges. Second, while our results indicate that raising awareness of an entrepreneurial mission or role models is conducive to entrepreneurial intentions, our study does not provide insights into how such awareness could be generated by universities and what communication mechanisms yield the better result. Consequently, future research could explore how to make research scientists optimally aware of the organizational culture in order to direct their behavior towards entrepreneurial activities. Third, our data collection is cross-sectional in nature. As such, we are unable to assess the impact of changes in the university mission or reward system on entrepreneurial intentions, nor to evaluate under which organizational conditions entrepreneurial intentions actually translate into entrepreneurial behavior. We encourage future studies to employ longitudinal research designs to shed light on these issues. Finally, this paper deliberately focused on institutional characteristics at the level of the university. While we controlled for individual-level factors that have been found to affect entrepreneurial intentions, future research could purposefully assess which individual-level and organizational-level determinants reinforce each other, applying multilevel analysis techniques. Along the same lines, given that the entrepreneurial transformation takes place at multiple levels (Colyvas & Powell, 2006), we call for research that further disentangles the impact of institutional context on entrepreneurial intentions, by including characteristics at different levels in the university. Specifically, given that organizational culture may exist for a whole organization but also simultaneously in the form of subcultures (De Long & Fahey, 2000; Schneider et al., 2013), a strong entrepreneurial spirit at the institutional level without support from local levels might have a less effective impact on research scientists' entrepreneurial intentions. Subsequently,

future research could study culture and climate within the research group, department, faculty and/or university.

In spite of these limitations, to our knowledge, this paper is the first to address the impact of organizational characteristics on entrepreneurial intentions in an academic context. Controlling for individual characteristics and considering academic entrepreneurship in a broad sense, we found that university culture and climate largely affect research scientists' entrepreneurial intentions.

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## **4. SPIN-OFF VERSUS START-UP INTENTIONS: A TALE OF TWO PASSIONS**

### **ABSTRACT**

The purpose of this paper is to disentangle how individuals' "passion orchestra" is related to entrepreneurial intentions. We study our research question in academia, where research scientists are increasingly required to simultaneously engage in both commercialization activities and traditional research and teaching duties. Drawing on passion literature and role identity theory, we propose a path model that links two types of passion relevant in this context, namely entrepreneurial and scientific passion, to spin-off versus start-up intentions. While spin-off intentions refer to intentions to found a firm based upon research results, start-up intentions denote intentions to establish any type of company, for instance a new venture independent from scientific output produced within a university. Using a sample of 2,308 research scientists from 24 universities in 5 European countries, our findings reveal that higher levels of entrepreneurial passion are associated with both stronger spin-off and start-up intentions. Further, scientific passion is positively associated with research scientists' intentions to create a spin-off, but negatively with their propensity to establish a start-up. Entrepreneurial self-efficacy and affective commitment towards the university mediate these effects. Finally and importantly, the two types of passion show characteristic interaction effects. Scientific passion moderates the entrepreneurial passion-intentions relationship such that it strengthens spin-off intentions, but weakens start-up intentions. Our results have relevant implications for both academics and practitioners, including government agencies, technology transfer offices and university management.



## 4.1. INTRODUCTION

An emerging body of entrepreneurship literature indicates that passion plays a key role in the venture creation process (Baum et al., 2001; Cardon et al., 2005; Smilor, 1997). Entrepreneurial passion is defined as intense positive emotions towards entrepreneurial tasks and activities, which are related to roles that are prominent to the entrepreneur's self-identity (Cardon et al., 2009). Recent research has valuably extended our knowledge of entrepreneurial passion by shedding light on its multi-faceted rather than singular nature and its impact on cognitive processes and entrepreneurial actions. In particular, Cardon et al. (2009) differentiate between the entrepreneur's role as inventor, founder and developer, and passion associated with these roles. However, while prior studies have focused on different types of entrepreneurial passion, the "passion orchestra", i.e. the intra-individual coexistence and interrelation of entrepreneurial passion and passions for other non-entrepreneurial roles, remains an unexplored area. Given that individuals may retain passion for multiple roles at the same time, one of the key questions left unanswered is how entrepreneurial passion shapes the entrepreneurial process when no longer studied in an isolated matter but in chorus with other types of passion.

Our study is unique in that it acknowledges that different types of passion might affect the entrepreneurial process differently and, most importantly, via a characteristic interaction of the passion types within the individual. This approach follows the logic of the person-oriented psychology perspective (Magnusson, 1998; Magnusson & Törestad, 1993; von Eye, 2010), which has been receiving considerable attention and support in contemporary psychological science. The central premise is that the individual functions as a totality, which implies that "the whole is more than the sum of its parts". Hence, it might not suffice to study individual characteristics in an isolated way. One should also look at intra-individual interactions and patterns of these characteristics to fully understand the individual and intra-individual dynamics. Translated to our case, we are particularly interested in unraveling the "passion orchestra", i.e. how different types of passion function and interact within the individual. This paper scrutinizes whether the motivational effect of entrepreneurial passion in the earliest

stages of the entrepreneurial process may depend to some degree on other relevant forms of passion, which may strengthen or weaken the effect of entrepreneurial passion.

Specifically, we investigate the relationship between the “passion orchestra” and entrepreneurial intentions in an academic context. Recently, entrepreneurial intentions in academia have been introduced as an outcome variable of interest (Goethner et al., 2012; Mosey et al., 2012; Obschonka et al., 2012; Prodan & Drnovsek, 2010). The academic context is highly relevant as, over the past decades, universities have increasingly become involved in their “third mission” related to entrepreneurship and economic development. Following this evolution, research scientists must assume different roles as they are expected to engage in both entrepreneurial activities and traditional research and teaching activities (Etzkowitz, 2003; Jain et al., 2009) and thus, can develop different types of passion. Accordingly, our paper disentangles the effect of entrepreneurial and scientific passion on entrepreneurial intentions among research scientists, and thereby aims at contributing to two distinct literatures.

First, we enrich extant *literature on (entrepreneurial) passion* by studying how the “passion orchestra”, as opposed to passion for entrepreneurial roles exclusively, is related to entrepreneurial intentions. As such, we respond to a call by Cardon et al. (2013) to examine the effects of entrepreneurial passion, both uniquely and along with other affective dimensions.

Second, this study aims at contributing to the *academic entrepreneurship literature* in a number of ways. Specifically, while prior research has pointed to the importance of research scientists’ personal networks, perceived role models, academic experience and applied research engagement (Prodan & Drnovsek, 2010), as well as attitudes, perceived control, social norms and group identification (Goethner et al., 2012; Obschonka et al., 2012) for entrepreneurial intentions, we complement existing research by introducing the concept of passion and showing its relevance in the context of academic entrepreneurship. Furthermore, we posit that academics may hold different types of entrepreneurial intentions. While one research scientist may aspire to spin off a firm initiated within a university setting and based

upon research results (Rasmussen & Borch, 2010; Steffensen et al., 2000), another scientist may have intentions to found any type of company, for instance a new venture detached from his or her academic research. This distinction is important, particularly for universities and technology transfer managers, who view research commercialization as an avenue for increasing their budgets and responding to policy makers' pressure to increase national competitiveness through commercialization of academic research (Ambos et al., 2008). As such, understanding which factors are related to intentions to found a firm based upon university research (i.e. spin-off intentions) versus intentions to found any type of company (i.e. start-up intentions) is particularly relevant from a practical perspective. From a theoretical point of view, prior research has extensively studied university spin-offs (Djokovic & Souitaris, 2008; Wright et al., 2008) and has suggested different typologies (e.g., Druilhe & Garnsey, 2004; Nicolaou & Birley, 2003), but has neglected to acknowledge that some research scientists may have intentions to engage in entrepreneurial activities which are unrelated to their research. Therefore, in studying the "passion orchestra" and entrepreneurial intentions, we differentiate between respectively research scientists' spin-off and start-up intentions.

Specifically, building upon passion literature and role identity theory, we analyze the following research question: "How do different types of passion and their interactions relate to spin-off and start-up intentions?". Survey data from 2,308 research scientists working at 24 universities in five European countries allow us to identify how and when the "passion orchestra" relates to entrepreneurial intentions.

## **4.2. LITERATURE REVIEW**

### **4.2.1. The concept of passion**

Passion represents a strong inclination towards an activity that people like, find important, and in which they invest significant time and energy (Vallerand et al., 2003). Passion is a domain-specific notion, i.e. the target is a specific activity that depicts certain values (Chen et al., 2009). Additionally and importantly, to be passionate, this target activity must be

internalized into one's self-concept or identity (Cardon et al., 2009; Vallerand et al., 2003; 2007). The dualistic model by Vallerand et al. (2003) further posits that obsessive or harmonious passion can emerge dependent on the type of internalization process taking place. *Harmonious* passion is the result of an activity that has been internalized autonomously into the individual's identity, i.e. the person sees the activity as being important in itself without any contingencies attached to it. By contrast, *obsessive* passion is formed when the activity is internalized in such a way that it controls the individual's identity.

Passion has been the focus of a large body of research in the realm of social psychology. The concept has been studied in diverse contexts including passion for one's work or job (e.g., Boyatzis et al., 2002; Ho et al., 2011; Klapmeier, 2007), or other activities such as gambling, music and sports (e.g., Donahue et al., 2009; Mageau et al., 2005; Vallerand, 2008). Extant literature has associated passion with both positive and negative psychological, affective and behavioral outcomes.

#### **4.2.2. Passion and entrepreneurship**

Passion is also at the heart of entrepreneurship (Cardon et al., 2005). Smilor (1997: 342) notes that passion is "perhaps the most observed phenomenon of the entrepreneurial process" and Bird (1989: 7) indicates that entrepreneurial behavior is "passionate, full of emotional energy, drive, and spirit". The experience of passion is linked to successful entrepreneurs; it is the "fire of desire" that fuels their daily efforts (Cardon et al., 2009) and motivates them to persistently engage in entrepreneurial activities even in the face of challenge and adversity (Cardon et al., 2005; 2013; Chandler & Jansen, 1992; Chen et al., 2009). Moreover, passion is a key predictor of venture growth (Baum et al., 1998; 2001; Baum & Locke, 2004). Finally, passion has been associated with entrepreneurs' ability to raise capital from investors (Cardon et al., 2009; Mitteness et al., 2012; Sudek, 2006), and to hire and motivate key employees (Cardon, 2008).

Yet, it is only recently that entrepreneurship scholars have introduced and conceptualized the notion of entrepreneurial passion (Cardon et al., 2005). Entrepreneurial passion is defined as "consciously accessible, intense positive feelings experienced by engagement in

entrepreneurial activities, associated with roles that are meaningful and salient to the self-identity of the entrepreneur” (Cardon et al., 2009: 517). Further, Cardon et al. (2009) put forward three distinct role identities based on different aspects of the entrepreneurial process: (1) an inventor identity where the passion is for activities involved in identifying, inventing and exploring new opportunities, (2) a founder identity, where the passion is for activities involved in establishing a venture for commercializing and exploiting opportunities, and (3) a developer identity, where the passion is for activities related to nurturing, growing, and expanding the venture after its founding. These different identity-related passions affect goal-related cognitions and propel specific entrepreneurial outcomes (Cardon et al., 2009). Thus, entrepreneurial passion, acting through its components of intense positive emotions tied to salient identities, is a key driver of entrepreneurial behavior (Cardon et al., 2009; Murnieks et al., 2012).

In what follows, we build a theoretical framework linking entrepreneurial and scientific passion to entrepreneurial intentions in academia. As entrepreneurial intentions are formed early on in the entrepreneurial process (Bird, 1988; Krueger et al., 2000; Lee et al., 2011), we focus on the inventor identity for studying entrepreneurial passion, thereby following Cardon et al. (2013)’s recommendation to consider the domains of entrepreneurial passion separately as they fit a particular research question.

#### **4.3. THEORY AND HYPOTHESES**

Identities are vital components of passion, as they represent a powerful motivational impulse for activities (Cardon et al., 2009; 2013; Vallerand et al., 2003). Therefore, we build upon (role) identity theory, integrated with extant (entrepreneurial) passion literature, to formulate hypotheses concerning how research scientists’ “passion orchestra” relates to their intentions to engage in spin-off versus start-up creation.

#### **4.3.1. (Role) Identity theory**

Roles are positions in society (e.g., doctor, teacher, or entrepreneur) that reflect a set of expectations for goals, behavior and action (Jain et al., 2009; Stets & Burke, 2000). Once these roles are internalized into one's self-concept, they become identities and help a person define himself and his behavior accordingly (Burke, 1991; Cast, 2004; Stets & Burke, 2000). Identity theory acknowledges that individuals possess distinct salient identities (Callero, 1985; Stryker 1968; Stryker & Serpe, 1994). These multiple identities are organized hierarchically such that an identity situated higher in the hierarchy is more salient than those placed lower (Stryker & Burke, 2000). Highly salient identities are likely to generate intense positive emotions, such as passion, because of the relative importance of these identities to the individual involved (Burke, 1991; Murnieks & Mosakowski, 2006; Stryker, 2004). Moreover, individuals are more strongly motivated to enact highly salient identities (Stryker & Serpe, 1994).

In the context of our study, an academic setting, research scientists are increasingly expected to assume multiple role identities which might be enacted and evoke different passions (Murnieks et al., 2012). Individuals are not simply required to switch from one activity to another, but to build the simultaneous capacity for two activities (i.e. academic productivity and commercialization), which is especially challenging due to conflicting nature of academic and commercial demands (Ambos et al., 2008; Owen-Smith & Powell, 2004). Accordingly, in what follows, we disentangle how research scientists' passion for entrepreneurial activities (i.e. entrepreneurial passion), passion for scientific research activities (i.e. scientific passion), and the interplay between both passions (i.e. "passion orchestra"), are related to entrepreneurial intentions. Moreover, to understand the pathways through which the different types of passion affect entrepreneurial intentions in academia, we also study indirect effects of entrepreneurial and scientific passion on intentions. In particular, scholars have suggested to view passion as a trait-like characteristic that exerts an influence on the entrepreneurial process via more proximal, motivational factors like self-efficacy (Baum & Locke, 2004; Shane et al., 2003). Besides self-efficacy beliefs, we also study

indirect effects via the individual's affective commitment towards the research institution where he or she is employed to take into account the social context of the research scientist (Nanda & Sørensen, 2010). Prior research demonstrated that psychological dynamics with regard to the parent organization affect the motivation process underlying research scientists' entrepreneurial intentions – intentions to leave the ivory tower of academia (e.g., Nanda & Sørensen, 2010; Obschonka et al., 2012).

#### **4.3.2. Entrepreneurial passion**

As an individual's multiple identities are organized in a hierarchical organization scheme (Stryker & Serpe, 1994), the entrepreneurial role identity will not be equally pertinent or salient to all individuals' self concept. In an academic context, the arrival of the entrepreneurial university calls for individuals to pursue different roles and to balance research and commercialization activities simultaneously (also referred to as contextual ambidexterity) (Ambos et al., 2008; Etzkowitz, 2003; Gibson & Birkenshaw, 2004). Subsequently, research scientists are more and more expected to broaden their repertoire of role identities (Jain et al., 2009; Lam, 2010; Owen-Smith & Powell, 2004). Specifically, in addition to their traditional scientific identity, they should incorporate a new entrepreneurial role identity. However, differences exist in the hierarchies that research scientists apply to their dual role identities. Given the importance of identity for entrepreneurial passion and entrepreneurial passion being a significant driver of entrepreneurial action (Cardon et al., 2009; 2013; Murnieks et al., 2012; Vallerand et al., 2003; 2007), we expect that the more salient the research scientist's entrepreneurial role identity, the stronger his or her entrepreneurial passion and the greater his or her intentions to engage in entrepreneurial activities. Following the above arguments, we contend that research scientists with more entrepreneurial passion will experience stronger entrepreneurial intentions, both in terms of spin-off and start-up creation. Thus, we propose:

**Hypothesis 1a:** Entrepreneurial passion is positively related to spin-off intentions.

**Hypothesis 1b:** Entrepreneurial passion is positively related to start-up intentions.

Next to the direct impact of entrepreneurial passion on both spin-off and start-up intentions, we expect the presence of passion for entrepreneurial activities to also indirectly affect entrepreneurial intentions through a more proximal key antecedent, namely entrepreneurial self-efficacy. Entrepreneurial self-efficacy refers to an individual's self-confidence in his or her ability to perform entrepreneurial roles and tasks successfully (Chen et al., 1998; Zhao et al., 2005). Whereas entrepreneurial passion and entrepreneurial self-efficacy both underline the importance of engaging in activities that are meaningful for one's self-identity (Bandura, 1997; Vignoles et al., 2006), these are two distinct constructs (Cardon et al., 2009; 2013) and we assume that the former positively affects the latter. In particular, individuals who are passionate about an activity are more likely to develop their skills at it, which does not only increase their ability to perform the activity but also augments their self-efficacy beliefs (Baum & Locke, 2004). Additionally, positive arousal and feelings associated with a particular activity, which are an inherent part of passion (Cardon et al., 2009), can elevate an individual's perceived self-efficacy or confidence to succeed in that activity (Murnieks et al., 2012). Following these arguments, we expect a positive relation between entrepreneurial passion and entrepreneurial self-efficacy. In turn, entrepreneurial self-efficacy has been shown to enhance entrepreneurial intentions (Boyd & Vozikis, 1994; Chen et al., 1998; Krueger, 1993; Zhao et al., 2005). Research scientists who feel confident that they have the requisite entrepreneurial capabilities are more likely to aspire to the founding of either a spin-off or start-up. Subsequently, we propose an indirect relationship between entrepreneurial passion and intentions through entrepreneurial self-efficacy. Hence, we assume:

**Hypothesis 2a:** The positive relationship between entrepreneurial passion and spin-off intentions is mediated by entrepreneurial self-efficacy.

**Hypothesis 2b:** The positive relationship between entrepreneurial passion and start-up intentions is mediated by entrepreneurial self-efficacy.

#### 4.3.3. Scientific passion

Given individuals' passions related to multiple salient identities (Callero, 1985; Stryker 1968; Stryker & Serpe, 1994) and passion being at the heart of entrepreneurship (Cardon et al., 2005), it is likely that different passions simultaneously play a role in the entrepreneurial process. In academia, notwithstanding the institutional transformation and the emergence of an entrepreneurial identity, university scientists still assume their traditional scientific identity and invest significant time and energy in research activities. Then again, given the hierarchical organization of individuals' multiple identities (Stryker & Serpe, 1994), not all research scientists will accord equal salience or importance to their scientific role identity, evoking different levels of scientific passion. Following the above arguments, we expect research scientists' scientific passion to be associated with entrepreneurial intentions, but differently for respectively spin-off and start-up intentions. In particular, since university spin-offs are companies based upon scientific research results (Rasmussen & Borch, 2010; Steffensen et al., 2000), researchers looking to maintain and nurture their scientific role identity and passion are likely to possess higher levels of spin-off intentions. University spin-offs usually exploit technologies that are radically new, disruptive and early stage (Christensen, 2003; Danneels, 2004). As spin-offs are typically formed around specific scientific knowledge that is embodied in researchers (Clarysse et al., 2007), we argue that research scientists who are highly passionate about generating scientific knowledge will show a greater tendency to further expand their passion through spin-off creation. On the contrary, the establishment of a start-up is not necessarily related to or may even be detached from scientific research activities and therefore, research scientists searching to fuel their scientific role identity and passion are less likely to have start-up intentions. Accordingly, we postulate that research scientists with high levels of scientific passion hold greater intentions to found a university spin-off, but lower intentions to establish a start-up. Thus:

**Hypothesis 3a:** Scientific passion is positively related to spin-off intentions.

**Hypothesis 3b:** Scientific passion is negatively related to start-up intentions.

Next to this direct relationship, we posit that scientific passion also indirectly influences entrepreneurial intentions through affective organizational commitment or the attachment-based orientation towards one's organization (Meyer & Allen, 1991). Such commitment denotes "the relative strength of an individual's identification with and involvement in a particular organization" (Mowday et al., 1979: 226). Passionate individuals demonstrate positive emotions and a strong liking for a particular activity, which is positively related to their affective commitment towards the organization in which they carry out this activity (Forest et al., 2011). Therefore, we expect research scientists with high levels of scientific passion to be more attached to their university as the university accommodates them to carry out activities related to such passion. Consecutively, employees' affective commitment towards the organization has traditionally shown to be a negative predictor of turnover (intentions) (Meyer & Allen, 1997; Somers, 1995), and entrepreneurial intentions in particular (Kickul & Zaper, 2000). Accordingly, in line with these studies in other contexts, we expect a negative relationship between affective organizational commitment and start-up intentions. This is because the binding of a research scientist to the university will increase his or her desire to remain a member of this university and to carry on university related activities, rather than to leave in order to found a new venture. In contrast, in the case of spin-off intentions, we hypothesize a positive association as spin-offs originate within the university context based upon scientific results (Rasmussen & Borch, 2010; Steffensen et al., 2000) and parent universities remain often highly involved in their spin-off firms after foundation (Siegel et al., 2003; Smilor et al., 1990; Vohora et al., 2004). So, we assume affective organizational commitment to be a mediator between scientific passion and entrepreneurial intentions. Specifically, we expect a positive relationship between scientific passion and affective commitment, just as a positive association between affective commitment and spin-off intentions, but a negative link between affective commitment and start-up intentions. Hence:

**Hypothesis 4a:** The positive relationship between scientific passion and spin-off intentions is mediated by affective commitment.

**Hypothesis 4b:** The negative relationship between scientific passion and start-up intentions is mediated by affective commitment.

#### **4.3.4. “Passion orchestra”**

Finally, we contend that the individual’s “passion orchestra”, i.e. the interplay between multiple passions within the person, will shape his or her entrepreneurial intentions in a characteristic way that would not be detectable if one only looks at the isolated effects of the single passion types. Specifically, we predict that the association between entrepreneurial passion and intentions, as stated in hypotheses 1a and 1b, will also be contingent on research scientists’ level of scientific passion, and that spin-off and start-up intentions are affected differently. University spin-offs are mainly the result of two key determinants: a strong scientific knowledge base and an entrepreneurial mindset (Roberts, 1991). As spin-off creation requires research scientists to fuse their dual role identities and to pursue their entrepreneurial and scientific passion simultaneously, we put forward scientific passion as amplifier in the positive association between entrepreneurial passion and spin-off intentions. Research scientists who possess entrepreneurial passion and, in combination, are highly passionate about scientific research, will exhibit greater intentions to create university spin-offs. At the same time, we propose scientific passion to weaken the positive association between entrepreneurial passion and start-up intentions. Whereas a highly salient entrepreneurial role identity and entrepreneurial passion are vital for start-up intentions to develop (as stated in Hypothesis 1b), it is likely that having another central role identity and related passion may interfere with this process, particularly if the other role identity is not required for or conflicting with the activity pursued (Stryker & Burke, 2000). In contrast to spin-off intentions, which call for the integration of multiple identities and passions, research scientists’ scientific role identity is not instrumental for the formation of start-up intentions. Specifically, following insights on identity conflict (Shepherd & Haynie, 2009; Stryker & Burke, 2000), enacting a salient scientific role identity entails activities which are inherently different from the founding of any type of business, and may constrain individuals’ ability to behave in accordance with their entrepreneurial role identity. Consequently, high levels of

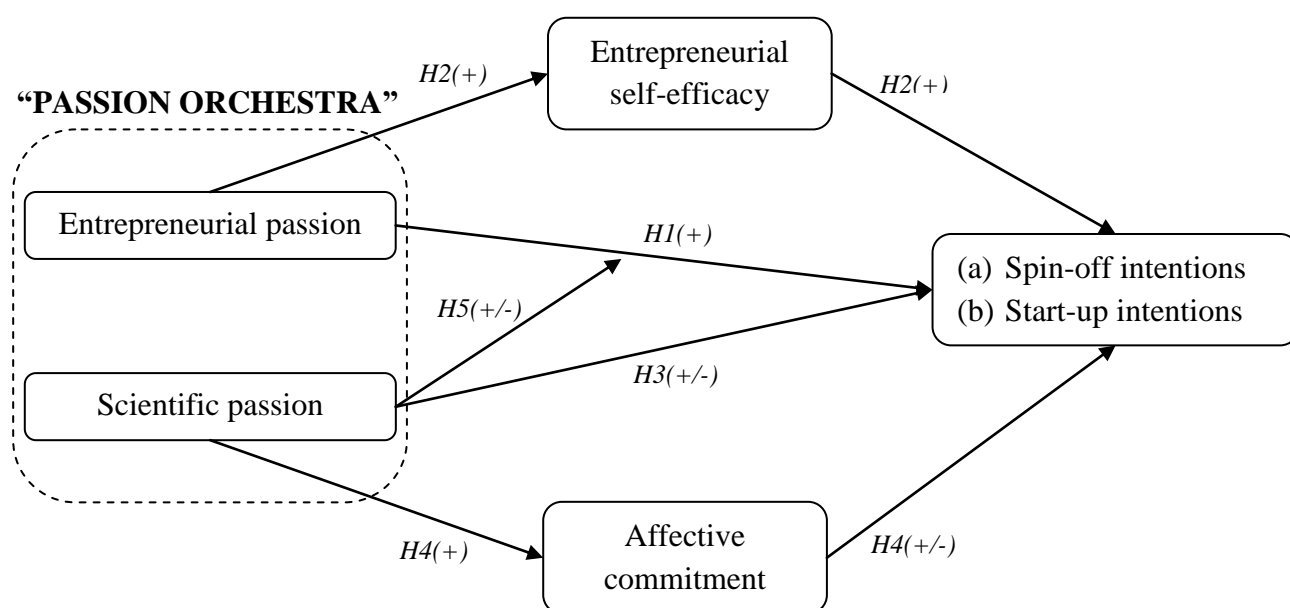
scientific passion could hinder research scientists from following their entrepreneurial passion. Taken together, we expect among research scientists with a strong entrepreneurial passion, those who also report a strong passion for scientific research to possess stronger intentions to create a spin-off but weaker start-up intentions. Hence:

**Hypothesis 5a:** Scientific passion strengthens the relationship between entrepreneurial passion and spin-off intentions.

**Hypothesis 5b:** Scientific passion weakens the relationship between entrepreneurial passion and start-up intentions.

Figure 4.1 summarizes our conceptual model.

**Figure 4.1: Conceptual model**



## 4.4. METHODOLOGY

### 4.4.1. Data collection and sample

Our study is based upon cross-sectional data collected in 2012-2013 at 24 universities in five European countries. The clusters proposed by the Global Leadership and Organizational Behavior Effectiveness research program (GLOBE) were used as the starting point for our country selection (Gupta et al., 2002). GLOBE builds upon nine cultural dimensions to

capture similarities in norms, values and beliefs for the construction of societal clusters (Javidan et al., 2006). Based on this classification, we selected the following countries: Sweden (Nordic Europe), Spain (Latin Europe), Slovenia (Eastern Europe), Germany and Belgium (Germanic Europe). Furthermore, an important difference at country level lies in the academic exemption or professor's privilege in Sweden, which asserts full ownership of intellectual property rights to faculty (Klofsten & Jones-Evans, 2000). For each country, we compiled a list of all universities by means of secondary sources (including reports by ministries of education, university rankings, technology transfer networks and general internet searches). Next, we selected one or two geographical regions within each country and contacted all universities through emailing their technology transfer offices (TTOs), asking for their participation in this research. In case of non-response over email, TTOs were contacted by telephone. Eventually, we received positive answers from 40 out of 58 TTOs.

Subsequently, we started arranging face-to-face interviews with TTOs, in which stage another 9 TTOs were not available or eventually not willing to participate, resulting in 31 TTOs offering full collaboration. Through these interviews, we obtained information on university characteristics (e.g., human and financial resources, annual innovation output) and technology transfer practices (e.g., history and organizational structure). Primary data were verified and complemented with secondary data from annual reports, university and TTO websites. Furthermore, we asked permission and assistance to contact individual research scientists from different disciplines at each university, which was not feasible in 7 universities due to privacy rules or non-existence of staff directories. Our survey specifically targeted research scientists (as opposed to, for instance, tenured professors) as these are more likely to develop their career capital due to uncertainty about which career track will be the most beneficial to them (Krabel & Mueller, 2009). In contrast, professors are typically more focused on establishing their reputation in the scientific community through the production of scientific output. Additionally, as the newer generation of research scientists is more familiar with universities' rising "third mission" since the beginning of their career, they can be expected to develop different levels of scientific and entrepreneurial passion along a continuum.

The survey population consisted of 32,358 research scientists. Respondents received a request through email to complete an online questionnaire, followed by a kind reminder after one week. We obtained 6,442 failure messages indicating that email addresses were invalid or our message could not be sent, resulting in a usable population of 25,916 research scientists. In total, 4,515 responses were received (or 17% of the usable population, which is comparable to previous research in this domain (Obschonka et al., 2012)). After elimination of incomplete responses, our final sample consists of 2,308 research scientists who fully completed the questionnaire, or 9% of the usable population. T-tests revealed no significant differences between respondents who filled in all questions and those who provided incomplete responses, or between early and late respondents, in terms of age, gender, education, experience, discipline or country ( $p > 0.05$ ). Some procedural techniques were used to reduce the risk of common method bias. In our email, we guaranteed anonymity to reduce respondents' tendency to give socially desirable answers (Podsakoff et al., 2003). Moreover, careful attention was given to the wording of questions in order to avoid vague concepts and to reduce items' ambiguity (Tourangeau et al., 2000).

#### **4.4.2. Measures**

##### ***Dependent variables***

*Spin-off intentions* were measured through the following items, based upon Krueger et al. (2000)'s scale for entrepreneurial intentions and the definition of university spin-offs (Rasmussen & Borch, 2010; Steffensen et al., 2000): 'How likely is it that, in the foreseeable future, (1) You will engage in the founding of a university spin-off?, (2) You will engage in the establishment of a company based upon an idea and/or technology developed at the university?, and (3) You will participate in the founding of a firm to commercialize your research?', on a scale ranging from 1 (very unlikely) to 7 (very likely). Cronbach's alpha is 0.92, indicating high scale reliability (Hair et al., 2006).

*Start-up intentions* were captured by asking respondents to respond to the following two questions, based on Kolvereid (1997): 'How likely is it that, in the foreseeable future, (1) You

will pursue a career as entrepreneur?, and (2) You will start your own business?’ (1 = very unlikely, 7 = very likely). Scale reliability measured by Cronbach’s alpha is 0.85.

In line with prior research (e.g., Douglas & Fitzsimmons, 2013), we used principal components analysis (PCA) with varimax rotation to investigate the underlying structure of the five items. This confirmed the existence of two factors with eigenvalues above 1.00 which accounted for 86.83% of the cumulative variance. Additionally, we conducted confirmatory factor analysis (CFA) to verify the distinctiveness of our two dependent variables. We compared a two-factor model where the two latent variables were allowed to correlate, with a one-factor model where all five items loaded on one latent variable. The results showed that the two-factor model (comparative fit index [CFI] = 0.95; root mean square of approximation [RMSEA] = 0.08 (confidence interval [CI]: 0.082 – 0.086); standardized root mean residual [SRMR] = 0.05) fits the data better than the one-factor model (CFI = 0.93; RMSEA = 0.10 (CI: 0.094 – 0.097); SRMR = 0.07). This indicates that spin-off and start-up intentions can be discriminated by respondents.

### ***Independent variables***

*Entrepreneurial passion* was assessed by Cardon et al. (2013)’s passion for inventing scale, which incorporates the two dimensions of intense positive feelings and identity centrality<sup>3</sup>. Respondents were asked to indicate their degree of agreement with the following statements on a scale ranging from 1 (strongly disagree) to 7 (strongly agree): ‘(1) It is exciting to figure out new ways to solve unmet market needs that can be commercialized, (2) Searching for new ideas for products/services to offer is enjoyable to me, (3) I am motivated to figure out how to make existing products/services better, (4) Scanning the environment for new opportunities really excites me, (5) Inventing new solutions to business problems is an important part of who I am, (6) I frequently think about inventing new solutions to business problems, (7) Identifying and developing new business opportunities is central to how I define myself, and (8) I would feel a loss if I were forced to give up searching for new solutions to

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<sup>3</sup> However, as our conceptual framework is built upon identity theory, we included three additional items for the centrality of the inventor role in respondents’ identity (i.e. items 6, 7 and 8; developed by Cardon et al. (2013) in the construction of their measurement instrument).

business problems.’ We conducted PCA which validates the existence of one factor (Cronbach’s  $\alpha = 0.94$ ).

*Scientific passion* was measured through Vallerand et al. (2003)’s obsessive passion scale, which we applied to scientific research activities. We chose to operationalize obsessive passion rather than harmonious passion for two reasons. First, obsessive passion takes greater space in the person’s identity than harmonious passion (Vallerand et al., 2003). As we draw upon role identity theory to build the conceptual model, it is more relevant to consider obsessive passion. Second, while harmonious passion is in balance with other aspects and activities of an individual’s life, obsessive passion may interfere with other aspects and activities (Vallerand et al., 2003). Given our interest in the “passion orchestra”, or the interplay between different types of passion, obsessive passion is the better option. The developed items are as follows: ‘(1) I cannot live without engaging in scientific research, (2) The urge is so strong, I can’t help myself from doing scientific research, (3) I have difficulty imagining my life without scientific research, (4) I am emotionally dependent on my engagement in scientific research, (5) I have a tough time controlling my need to engage in scientific research, (6) I have almost an obsessive feeling for scientific research, and (7) My mood depends on me being able to do scientific research.’ The Cronbach’s  $\alpha$  coefficient for the scale is 0.93.

### ***Mediating variables***

*Entrepreneurial self-efficacy* was assessed using the scale developed and validated by Zhao et al. (2005), including four items: ‘How confident are you in successfully (1) Identifying new business opportunities?, (2) Creating new products?, (3) Thinking creatively?, and (4) Commercializing an idea or new development?’ (1 = no confidence, 7 = complete confidence). Scale reliability measured by Cronbach’s  $\alpha$  is 0.82.

*Affective commitment* towards the organization was measured with a 5-item scale (Cheng et al., 2003; O’Reilly & Chatman, 1986) that captures research scientists’ internalization to and identification with their university. We presented respondents the following statements on a Likert scale with anchor points 1 (strongly disagree) to 7 (strongly agree): ‘(1) I feel a sense

of ownership for this university rather than being just an employee, (2) I talk up this university to my friends as a great organization to work for, (3) I would accept almost any type of job assignment in order to keep working for this university, (4) Since joining this university, my personal values and those of the university have become more similar, and (5) I find that my values and the university's values are very similar.' Scale reliability measured by Cronbach's alpha is 0.85.

### ***Control variables***

*Gender* (0 = male, 1 = female) was controlled for as men are usually more entrepreneurial than women (Crant, 1996; Zhao et al., 2005).

*Technical degree* (e.g., bio-science, physics, electronics, mechanics, robotics, ...) and *non-technical degree* (e.g., economics, law school, psychology, MBA, ...) assesses the degree research scientists obtained (0 = no, 1 = yes). Education is a key element of human capital which has been shown to affect the likelihood of becoming an entrepreneur (Mosey & Wright, 2007).

*Scientific experience* denotes the number of years respondents have so far spent in academia. Research scientists' embeddedness in academia may lower the likelihood of producing commercial outputs (Ambos et al., 2008).

*Entrepreneurial experience* indicates whether or not research scientists have ever started or attempted to start their own business, including any self-employment (0 = no, 1 = yes). Prior entrepreneurial exposure has been positively related to entrepreneurial passion (Gielnik et al., 2014) and entrepreneurial intentions (Krueger, 1993; Zhao et al., 2005).

*Scientific discipline* was controlled for, as embeddedness in particular disciplines and their cultures has been shown to influence individuals' propensity to shift towards entrepreneurship (Kenney & Goe, 2004). Specifically, four dummy variables were included representing the following categories: social and behavioral sciences (Social), clinical medicine and pharmacy (Medicine), engineering, technology and computer science (Engineering), and life and agricultural sciences (Life) (reference category = Natural sciences and mathematics).

Country dummies were included for Sweden, Germany, Slovenia, and Spain (reference category = Belgium).

### ***Discriminant validity***

Before testing our hypotheses, we ran confirmatory factor analyses to check the distinctiveness of the measures. Discriminant validity was assessed for pairs of constructs by constraining the estimated correlation parameter between constructs to 1 and then performing a chi-square difference test on the values obtained from the constrained and unconstrained models (Anderson & Gerbing, 1988). For all 21 pairs of constructs, the chi-square values were significantly lower for the unconstrained models (i.e.  $\Delta \chi^2_{df=1} > 3.84$ ), which indicates discriminant validity.

**Table 4.1: Descriptive statistics and correlations**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Gender <sup>a</sup>											
(2) Technical degree <sup>a</sup>	<b>-0.23</b>										
(3) Non-technical degree <sup>a</sup>	<b>0.20</b>	<b>-0.67</b>									
(4) Entrepreneurial experience <sup>a</sup>	<b>-0.12</b>	-0.03	<b>0.08</b>								
(5) Scientific experience	<b>-0.11</b>	-0.02	-0.01	<b>0.10</b>							
(6) Entrepreneurial passion	<b>-0.15</b>	<b>0.21</b>	<b>-0.14</b>	<b>0.19</b>	-0.01						
(7) Scientific passion	<b>-0.05</b>	0.03	-0.03	-0.01	0.03	<b>0.09</b>					
(8) Entrepreneurial self-efficacy	<b>-0.20</b>	<b>0.18</b>	<b>-0.11</b>	<b>0.24</b>	<b>0.04</b>	<b>0.67</b>	<b>0.16</b>				
(9) Affective commitment	<b>-0.05</b>	0.02	0.02	0.00	0.03	<b>0.23</b>	<b>0.30</b>	<b>0.18</b>			
(10) Spin-off intentions	<b>-0.18</b>	<b>0.25</b>	<b>-0.19</b>	<b>0.17</b>	0.03	<b>0.54</b>	<b>0.10</b>	<b>0.50</b>	<b>0.18</b>		
(11) Start-up intentions	<b>-0.15</b>	<b>0.12</b>	<b>-0.05</b>	<b>0.36</b>	<b>-0.09</b>	<b>0.49</b>	<b>-0.05</b>	<b>0.48</b>	0.02	<b>0.44</b>	
Mean	0.49	0.58	0.47	0.17	7.94	3.42	5.00	3.73	3.67	2.74	2.67
Standard deviation	0.50	0.49	0.50	0.37	6.11	1.47	1.28	1.24	1.27	1.54	1.57

Pearson correlation coefficients (1-tailed), indicating significant correlations ( $p < 0.05$ ) in **bold**;  $n = 2,308$

<sup>a</sup> Correlations of binary variables should be interpreted with care.

## **4.5. RESULTS**

Table 4.1 presents descriptive statistics and the correlations among all variables, except for country and discipline dummies. Our sample consists of 27% Swedish, 24% German, 5% Slovene, 15% Spanish and 29% Belgian research scientists. Half of our sample (49%) are

women. As to their education, 1,339 (58%) respondents have obtained a technical degree (science, technology or engineering) and 1,085 (47%) a non-technical degree (business, social sciences or humanities). On average, research scientists indicated having 7.94 years of experience in academia (SD 6.11 years) and 17% of our sample has entrepreneurial experience. Our respondents are carrying out research activities in different scientific disciplines: 669 (29%) in social and behavioral sciences, 346 (15%) in clinical medicine or pharmaceutical research, 600 (26%) in engineering, technology or computer science, 323 (14%) in life or agricultural sciences, and 369 (16%) in natural sciences or mathematics.

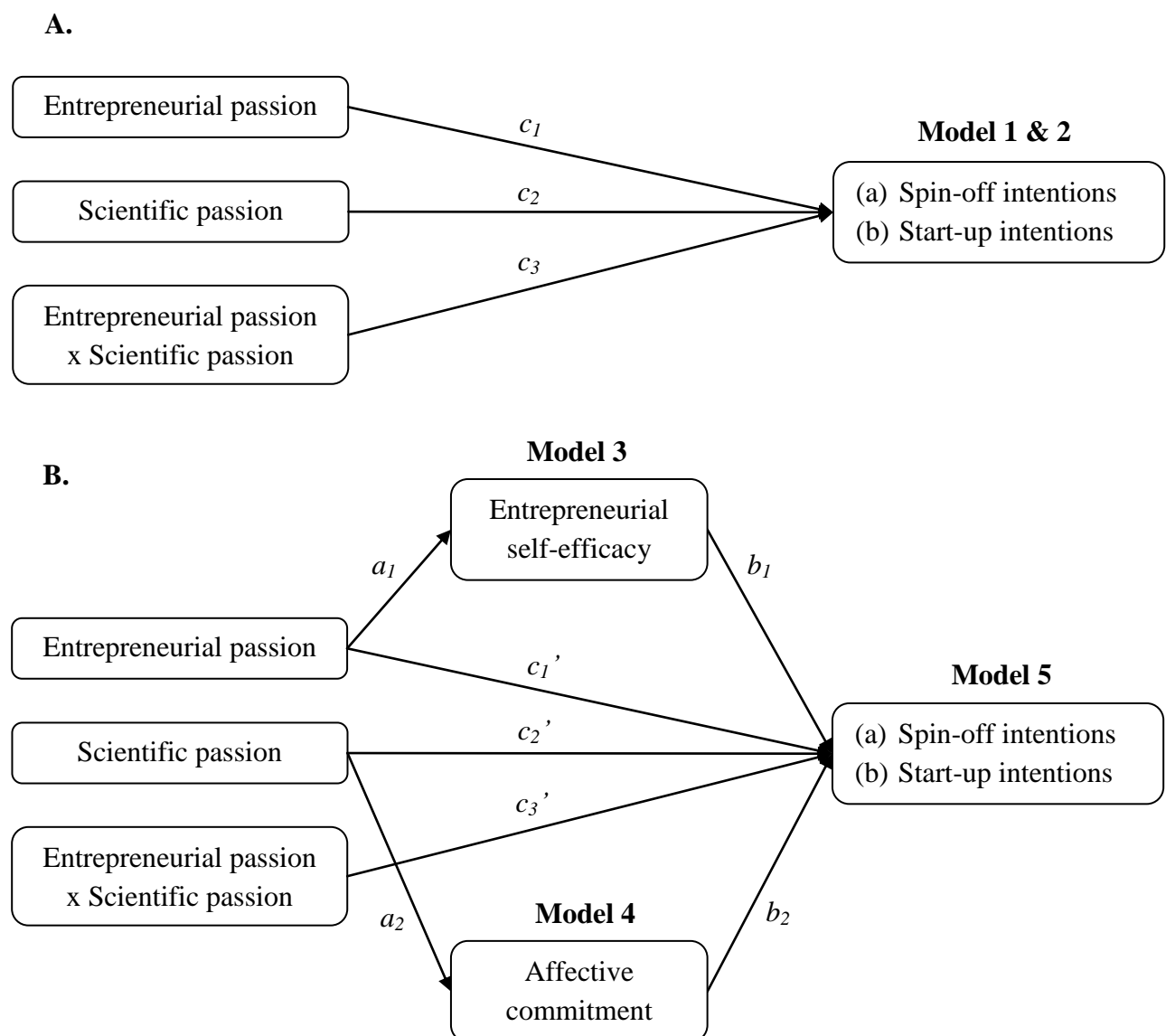
OLS regression analyses were carried out to test our hypotheses for both spin-off and start-up intentions. Variance inflation factors were calculated and ranged between 1.04 and 2.87, indicating that multicollinearity is unlikely to be an issue in our study (Hair et al., 2006). Additionally, we used a regression-based path analysis with the aid of existing computational tools for estimating mediation and moderation effects (Hayes, 2013). In particular, we utilized the PROCESS macro developed by Preacher & Hayes (2008), which relies on bootstrapping, in order to decompose the impact of direct and indirect effects. Figure 4.2 depicts a graphical representation of the estimated models, while Tables 4.2a and 4.2b provide the results of the analyses for spin-off and start-up intentions respectively.

As for the control variables included in our regression analyses, in line with prior research and for both dependent variables, we find that men report greater entrepreneurial intentions than women (Crant, 1996; Zhao et al., 2005) and that there is a positive relationship between prior entrepreneurial experience and entrepreneurial intentions (Krueger, 1993; Zhao et al., 2005). In addition, research scientists holding a technical degree (science, technology, or engineering) have stronger intentions to engage in spin-off creation. Further, the more experience they have in academia, the lower research scientists' propensity to set up a start-up company (Ambos et al., 2008). Finally, we also observe some country and discipline effects. For instance, Swedish research scientists consistently show greater spin-off and start-up intentions compared to their counterparts in other European countries. Likewise, our analyses

reveal that research scientists in engineering, technology or computer science have higher levels of both types of entrepreneurial intentions.

Figure 4.2 illustrates our conceptual model (as presented in Figure 4.1) in path diagram, which consists of distinct sub models. Specifically, models 1 and 2 (in panel A of Figure 4.2) represent the total effect models using OLS regression analysis, whereas models 3 to 5 (in panel B of Figure 4.2) decompose these models and obtained effects, allowing to estimate the extent to which (moderated) mediation or indirect effects occur.

**Figure 4.2: Conceptual model (Figure 4.1) represented in the form of a path model, referring to OLS regression coefficients (Tables 4.2a and 4.2b)**



Model 1 reveals a significantly positive coefficient for entrepreneurial passion both in the case of spin-off intentions ( $c_1 = 0.495$ ;  $p < 0.001$ ), reported in Table 4.2a, and start-up intentions ( $c_1 = 0.466$ ;  $p < 0.001$ ), shown in Table 4.2b. Thus, we *find support for Hypothesis 1a and 1b*. Models 3 and 5 disentangle model 1 in order to evaluate whether indirect effects of entrepreneurial passion through entrepreneurial self-efficacy exist. Focal coefficients in these models are  $c_1'$ , referring to the direct path from entrepreneurial passion to entrepreneurial intentions, just as  $a_1$  and  $b_1$ , which jointly allow to assess the indirect path through entrepreneurial self-efficacy. The difference between the total effect ( $c_1$ ) and the direct effect after controlling for a proposed mediator ( $c_1'$ ) is the indirect effect of entrepreneurial passion on entrepreneurial intentions through entrepreneurial self-efficacy ( $a_1*b_1$ ). A formal test of this difference indicates whether entrepreneurial self-efficacy acts as a mediator, as predicted by Hypothesis 2a and 2b. A 95% confidence interval for this indirect effect, based on 10,000 bootstrap samples, was found to be between 0.115 and 0.183 for spin-off intentions ( $a_1*b_1 = 0.148$ ) and between 0.137 and 0.202 for start-up intentions ( $a_1*b_1 = 0.169$ ). As zero is not included in the interval for both dependent variables, entrepreneurial self-efficacy can be construed as a mediator between entrepreneurial passion and the two types of entrepreneurial intentions, so we *accept Hypothesis 2a and Hypothesis 2b*.

As for the link between scientific passion and entrepreneurial intentions, model 1 demonstrates a significantly positive coefficient for spin-off intentions ( $c_2 = 0.128$ ;  $p < 0.001$ ; Table 4.2a), and a significantly negative effect on start-up intentions ( $c_2 = -0.118$ ;  $p < 0.001$ ; Table 4.2b). This provides *support for Hypothesis 3a and 3b*. Following the same logic as above for the mediation effect, models 4 and 5 decompose model 1 such that the indirect effect of scientific passion through affective organizational commitment can be assessed for both types of entrepreneurial intentions (Hypothesis 4a and 4b; coefficients  $a_2$  and  $b_2$ ). Our analyses indicate that 95% of the bootstrap estimates of the indirect effect are between 0.008 and 0.040 for spin-off intentions ( $a_2*b_2 = 0.023$ ), and between -0.042 and -0.010 for start-up intentions ( $a_2*b_2 = -0.025$ ). Since zero is not included in both confidence intervals, we *accept Hypothesis 4a and Hypothesis 4b*.

**Table 4.2a: OLS regression unstandardized coefficients (standard errors in parentheses)**  
**– spin-off intentions**

		Model 1	Model 2			Model 3	Model 4	Model 5
Outcome		Spin-off intentions	Spin-off intentions			Entrepreneurial self-efficacy	Affective commitment	Spin-off intentions
Intercept		0.125 (0.165)	1.098*** (0.275)			1.707*** (0.101)	1.645*** (0.157)	0.662* (0.277)
<b>Predictor</b>								
Entrepreneurial passion	$c_1 \rightarrow$	0.495*** (0.019)	0.194** (0.071)	$a_1 \rightarrow$		0.535*** (0.014)		$c_1' \rightarrow$ 0.026 (0.073)
Scientific passion	$c_2 \rightarrow$	0.128*** (0.023)	-0.066 (0.049)		$a_2 \rightarrow$		0.334*** (0.022)	$c_2' \rightarrow$ -0.126* (0.050)
Entrepreneurial self-efficacy							0.129*** (0.022)	$b_1 \rightarrow$ 0.277*** (0.029)
Affective commitment						0.035* (0.016)		$b_2 \rightarrow$ 0.069** (0.223)
Entrepreneurial x scientific passion	$c_3 \rightarrow$		0.059*** (0.013)					$c_3' \rightarrow$ 0.060*** (0.013)
<b>Control</b>								
Gender		-0.176** (0.057)	-0.181*** (0.056)			-0.167*** (0.040)	-0.035 (0.053)	-0.126* (0.056)
Technical degree		0.180* (0.076)	0.191* (0.075)			0.081 (0.054)	0.036 (0.071)	0.201** (0.075)
Non-technical degree		-0.088 (0.079)	-0.089 (0.079)			0.001 (0.057)	0.087 (0.074)	-0.077 (0.080)
Entrepreneurial experience		0.244*** (0.074)	0.248*** (0.073)			0.354*** (0.053)	-0.099 (0.070)	0.168* (0.073)
Scientific experience		-0.004 (0.004)	-0.004 (0.004)			0.005 (0.003)	0.002 (0.004)	-0.006 (0.004)
Social		-0.114 (0.097)	-0.103 (0.097)			-0.029 (0.069)	0.148 (0.091)	-0.119 (0.096)
Medicine		0.102 (0.101)	0.103 (0.101)			-0.167* (0.072)	0.005 (0.094)	0.153 (0.104)
Engineering		0.219* (0.087)	0.201 <sup>†</sup> (0.086)			-0.055 (0.061)	0.216** (0.080)	0.195* (0.085)
Life		0.219* (0.098)	0.224* (0.098)			-0.139 (0.070)	-0.116 (0.091)	0.259** (0.097)
Sweden		0.289*** (0.072)	0.292*** (0.071)			0.058 (0.051)	-0.388*** (0.067)	0.297*** (0.071)
Germany		0.158* (0.075)	0.171* (0.075)			0.213*** (0.054)	-0.596*** (0.070)	0.160* (0.075)
Slovenia		0.103 (0.127)	0.114 (0.126)			-0.042 (0.091)	-0.340** (0.118)	0.138 (0.125)
Spain		0.792*** (0.094)	0.816*** (0.093)			0.067 (0.063)	0.126 (0.088)	0.756*** (0.093)
R <sup>2</sup>		0.346	0.352			0.488	0.162	0.377
F-statistic		80.844***	77.615***			142.755***	28.908***	75.501***

<sup>†</sup> p < 0.10; \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001; n = 2,308

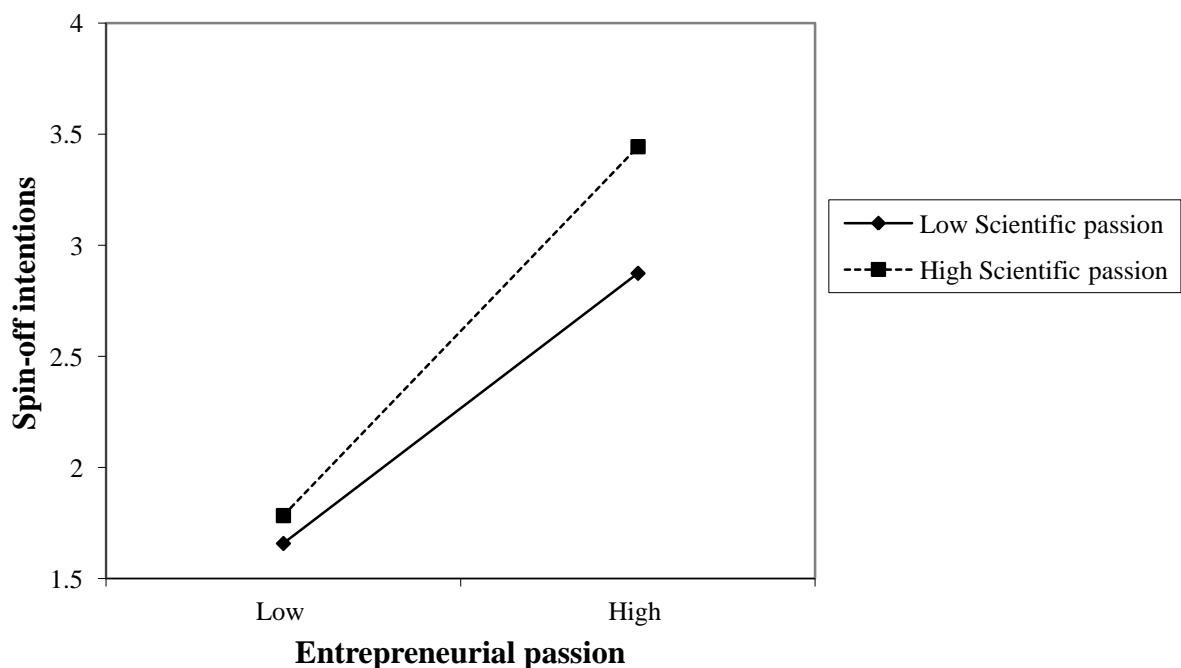
**Table 4.2b: OLS regression unstandardized coefficients (standard errors in parentheses)**  
**– start-up intentions**

		<b>Model 1</b>	<b>Model 2</b>			<b>Model 3</b>	<b>Model 4</b>	<b>Model 5</b>
<b>Outcome</b>		Start-up intentions	Start-up intentions			Entrepreneurial self-efficacy	Affective commitment	Start-up intentions
Intercept		1.608*** (0.167)	1.175*** (0.279)			1.707*** (0.101)	1.645*** (0.157)	0.963*** (0.280)
<b>Predictor</b>								
Entrepreneurial passion	$c_1 \rightarrow$	0.466*** (0.020)	0.600*** (0.072)	$a_1 \rightarrow$		0.535*** (0.014)		$c_1' \rightarrow$ 0.435*** (0.073)
Scientific passion	$c_2 \rightarrow$	-0.118*** (0.023)	-0.032 (0.050)		$a_2 \rightarrow$		0.334*** (0.022)	$c_2' \rightarrow$ -0.052 (0.050)
Entrepreneurial self-efficacy							0.129*** (0.022)	$b_1 \rightarrow$ 0.317*** (0.030)
Affective commitment						0.035* (0.016)		$b_2 \rightarrow$ -0.075** (0.023)
Entrepreneurial x scientific passion	$c_3 \rightarrow$		-0.026 <sup>†</sup> (0.013)					$c_3' \rightarrow$ -0.024 <sup>†</sup> (0.013)
<b>Control</b>								
Gender		-0.205*** (0.057)	-0.203*** (0.057)			-0.167*** (0.040)	-0.035 (0.053)	-0.158** (0.057)
Technical degree		0.094 (0.077)	0.051 (0.080)			0.081 (0.054)	0.036 (0.071)	0.049 (0.076)
Non-technical degree		0.051 (0.080)	0.051 (0.080)			0.001 (0.057)	0.087 (0.074)	0.052 (0.079)
Entrepreneurial experience		1.127*** (0.075)	1.125*** (0.075)			0.354*** (0.053)	-0.099 (0.070)	1.005*** (0.075)
Scientific experience		-0.029*** (0.005)	-0.029*** (0.005)			0.005 (0.003)	0.002 (0.004)	-0.030*** (0.004)
Social		0.103 (0.098)	0.098 (0.098)			-0.029 (0.069)	0.148 (0.091)	0.101 (0.097)
Medicine		0.031 (0.102)	0.030 (0.102)			-0.167* (0.072)	0.005 (0.094)	0.079 (0.101)
Engineering		0.145 <sup>†</sup> (0.088)	0.152 <sup>†</sup> (0.088)			-0.055 (0.061)	0.216** (0.080)	0.176* (0.086)
Life		-0.008 (0.099)	-0.010 (0.099)			-0.139 (0.070)	-0.116 (0.091)	0.035 (0.098)
Sweden		0.172* (0.073)	0.171* (0.073)			0.058 (0.051)	-0.388*** (0.067)	0.146* (0.072)
Germany		0.082 (0.076)	0.077 (0.076)			0.213*** (0.054)	-0.596*** (0.070)	-0.031 (0.076)
Slovenia		-0.071 (0.128)	-0.075 (0.128)			-0.042 (0.091)	-0.340** (0.118)	-0.113 (0.127)
Spain		-0.030 (0.095)	-0.040 (0.095)			0.067 (0.063)	0.126 (0.088)	-0.101 (0.094)
R <sup>2</sup>		0.346	0.347			0.488	0.162	0.379
F-statistic		80.760***	76.039***			142.755***	28.908***	76.051***

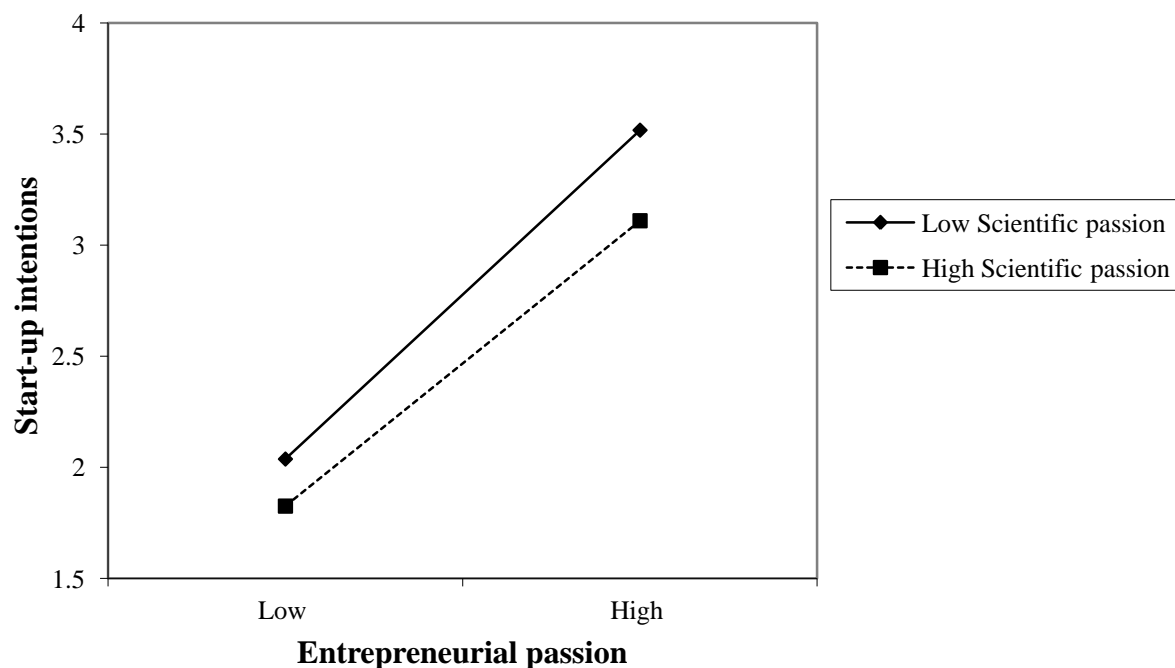
<sup>†</sup> p < 0.10; \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001; n = 2,308

Finally, an estimate and test of significance of path  $c_3$  in model 2 can be used to determine whether and how scientific passion moderates the relationship between entrepreneurial passion and entrepreneurial intentions (Hypothesis 5a and 5b). As shown in Table 4.2a, our analyses confirm a significantly positive moderation effect for spin-off intentions ( $c_3 = 0.059$ ,  $p < 0.001$ ), thus *supporting Hypothesis 5a*. The graphical representation of this interaction pattern is presented in Figure 4.3a, indicating that research scientists with high levels of entrepreneurial passion have greater spin-off intentions, especially when they are also highly passionate about scientific research. On the contrary, in the case of start-up intentions or Table 4.2b, the coefficient  $c_3$  is significantly negative ( $c_3 = -0.026$ ,  $p < 0.10$ ). Consequently, we also *accept Hypothesis 5b*. Figure 4.3b depicts this moderation effect for start-up intentions. As entrepreneurial passion increases, start-up intentions increase. However, this seems to be less the case when research scientists have higher levels of scientific passion. In other words, scientific passion reduces the positive impact of entrepreneurial passion on start-up intentions.

**Figure 4.3a: Moderation effect of scientific passion on the relationship between entrepreneurial passion and spin-off intentions (*Hypothesis 5a*)**



**Figure 4.3b: Moderation effect of scientific passion on the relationship between entrepreneurial passion and start-up intentions (*Hypothesis 5b*)**



#### 4.6. DISCUSSION AND CONCLUSION

The aim of this paper was to disentangle the “passion orchestra”, i.e. the simultaneous occurrence of different passion types within the individual, during the earliest stages of the entrepreneurial process. Specifically, we studied our research question in a particularly relevant context, namely academia, in which individuals are assumed to execute a set of different activities and to assume multiple identities. We used survey data from 2,308 research scientists working at 24 universities in five European countries. First, our findings confirm that spin-off and start-up intentions are distinct constructs. Second, we offer empirical evidence that research scientists’ entrepreneurial and scientific passion are associated differently with spin-off and start-up intentions. Concretely, while our analyses show that entrepreneurial passion is positively related to both spin-off and start-up intentions, research scientists with high levels of scientific passion show greater intentions to found a spin-off company, but lower start-up intentions. Furthermore, we identify entrepreneurial self-efficacy and affective organizational commitment to be important mediators in these relations. Finally, central to our exploration of the “passion orchestra”, we find that scientific passion acts as a

moderator in the entrepreneurial passion–intentions relationship. In particular, while scientific and entrepreneurial passion reinforce each other in the case of spin-off intentions, we find scientific passion to weaken the positive association between entrepreneurial passion and start-up intentions. As such, identities and related passion are at times boosting each other, while at other times impeding each other. Our results indicate that the extent to which this occurs depends on the type of activity the individual intends to pursue. This illustrates the importance of considering different types of passion and their interplay instead of studying one isolated individual characteristic, which is in line with the person-oriented psychology perspective.

Our research has implications for both academics and practitioners. For academia, first, it contributes to the *literature on entrepreneurial passion* by linking the concept to entrepreneurial intentions and by elucidating the interrelation between entrepreneurial passion and other non-entrepreneurial passion within the person. Our work demonstrates that individuals can hold a variety of passions, and that an individual's "passion orchestra", rather than entrepreneurial passion as sole element, affects the entrepreneurial process. Building on role identity theory, we suggest that the concept of the "passion orchestra" provides a starting point to explore research questions in other contexts requiring dual role identities, such as social entrepreneurship where individuals face the challenge of pursuing social impact and financial goals simultaneously (Mair et al., 2006; Peredo & McLean, 2006; Stevens et al., 2014). Second, our paper enriches the *academic entrepreneurship literature*, which has so far overlooked the impact of affect and only recently started to explore entrepreneurial intentions in academia, by studying the "passion orchestra" underlying such intentions. In doing so, we propose a conceptualization of research scientists' "passion orchestra" as a combination of scientific and entrepreneurial passion, which differs based on the salience of researchers' scientific and entrepreneurial role identity. As such, we operationalize how research scientists occupy different positions on a continuum defined by two polar types where one passion predominates ("traditional scientist" versus "entrepreneur"), as put forward by Jain et al. (2009) and Lam (2010). At the same time, the identification of the joint influence of entrepreneurial and scientific passion sheds light on ambidexterity issues at the individual

level in a university context (Ambos et al., 2008), that is whether research scientists should focus on one or the other role and related scientific versus entrepreneurial activities. Additionally, by distinguishing between spin-off and start-up intentions, our study adds to the debate whether academic entrepreneurship constitutes a brain drain to universities (e.g., Toole & Czarnitzki, 2010), and under which conditions this will be more or less the case. Indeed, while spin-off firms are likely to engage in collaboration with parent universities (Wright et al., 2006), this will to a much lesser extent be the case with start-ups, thus representing a higher social cost. For practitioners, such as *government agencies and TTOs*, our study draws attention to the importance of research scientists' passionate displays in academic entrepreneurship. Our results indicate that entrepreneurial and scientific passion can reinforce each other when related to spin-off intentions. Given the time and budgetary constraints of actors such as TTOs (Jones-Evans & Klofsten, 1999; Siegel et al., 2003), it may be desirable to focus specifically on research scientists having high levels of both types of passion, i.e. those individuals that exhibit a strong dedication for scientific research as well as deeply enjoy the search for new solutions to business problems. From the viewpoint of *university managers*, this research also informs the question whether they should create an environment where research scientists are expected to wear 'two hats' or to focus on one or the other role (i.e. exploration or scientific activities versus exploitation or entrepreneurial activities). Detection of the combined effect of scientific and entrepreneurial passion on spin-off intentions advocates the former option, as the two roles may complement and reinforce each other.

This study also has a number of limitations that may lead to future research avenues. First, the cross-sectional nature of our data calls for prudence in the interpretation of the findings as causality cannot be evaluated. Following this cross-sectional nature, we are also unable to investigate the impact of changes in identity salience and the "passion orchestra" on entrepreneurial intentions, nor to observe whether and when intentions translate into the creation of spin-offs and/or start-ups. Future studies using a longitudinal research lens could scrutinize these questions. A second limitation is that institutional logics, which were beyond the scope of this study, may trigger or restrain research scientists from having entrepreneurial

passion. Therefore, future work could purposefully assess how institutional differences cause divergence in individuals' "passion orchestra" or play a moderating role in the passion-intentions relationship. Third, this paper deliberately focused on spin-off versus start-up intentions. As research commercialization includes a broad spectrum of mechanisms (e.g., university spin-offs, patents, licensing, contract research and consulting) (Wright et al., 2008), future studies could unravel the impact of research scientists' "passion orchestra" on their intentions to engage in these different entrepreneurial activities. Finally, the extent to which our findings hold outside the academic entrepreneurship context warrants further research. For instance, future scholars could investigate the interplay between entrepreneurial passion and social passion underlying social entrepreneurs and their performance, or more generally, how entrepreneurs may be driven by the convergence of entrepreneurial passion and passion for non-entrepreneurial roles related to their core business activity (such as music, fashion or IT).

In conclusion, our study finds that research scientists' "passion orchestra" impact their entrepreneurial intentions, both directly and indirectly through entrepreneurial self-efficacy and affective organizational commitment, and that these results vary for spin-off versus start-up intentions. In addition, where scientific passion is an amplifier in the link between entrepreneurial passion and spin-off intentions, it operates as an impediment in the relationship between entrepreneurial passion and start-up intentions.

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## **5. ACADEMIC ENTREPRENEURSHIP: A MULTILEVEL EXAMINATION OF INDIVIDUAL, SUBUNIT AND ORGANIZATION EFFECTS**

### **ABSTRACT**

This study utilizes a multilevel approach to both estimate the relative importance of individual, subunit, and organization effects on entrepreneurial intentions in academia, as well as to investigate specific factors within the subunit effect and their interactions with other levels. Using a dataset of 2,652 research scientists from 386 departments in 24 European universities, our findings reveal that intra-university differences, caused by the influence of the department level, should not be ignored when studying academic entrepreneurship. Whereas research scientists' entrepreneurial intentions are mostly influenced by individual differences, department membership explains more variation than the university as a whole. Furthermore, drawing upon organizational culture literature, we identify a department's adhocracy culture, characterized by flexibility and external orientation, to be positively related to entrepreneurial intentions. Finally, consistent with trait activation theory, we find that strong adhocracy cultures reinforce the positive association between proactive personality and entrepreneurial intentions. This effect is further intensified when the university also has a technology transfer office with a substantial size. Our results have relevant implications for both academics and practitioners, including university managers, department heads and policy makers.



## 5.1. INTRODUCTION

Entrepreneurship research is dominated by single-level studies, mainly focusing on the individual or the firm as unit of analysis (Davidsson & Wiklund, 2001). Recently, however, a growing recognition has emerged that a multilevel approach, incorporating individual, organizational and environmental elements, yields a more complete understanding of entrepreneurial phenomena (Hitt et al., 2007; Welter, 2011). Whereas numerous opportunities still exist for multilevel research to make a significant contribution to the field of entrepreneurship (Shepherd, 2011; Zahra & Wright, 2011), so far, studies building bridges across different levels remain scarce.

The need to go beyond a single level of analysis is particularly relevant in the academic entrepreneurship literature. Following the growing role of universities as a hub of innovation, commercialization and new firm creation, alongside traditional tasks of research and teaching (Ambos et al., 2008), scholars have devoted substantial attention to explaining academic entrepreneurship.<sup>4</sup> However, while distinct levels of analysis have been considered in the academic entrepreneurship literature, these have generally been studied in relative isolation (Lockett et al., 2005; Rothaermel et al., 2007). In particular, an extensive body of literature at the *micro-level* has scrutinized the characteristics of individual academic entrepreneurs, founding teams and spin-off firms. Second, *meso-level* studies have focused on the university and the technology transfer office (TTO), in order to identify the support structures, policies, mechanisms and incentives that foster academic entrepreneurship. Finally, some research at the *macro-level* has explored the influence of regulations or initiatives of national and regional governments, and industry or market conditions (Djokovic & Souitaris, 2008).

Consequently, to date, insights are lacking on how the heterogeneous nature of context (i.e. meso and/or macro-level) affects the emergence and performance of (potential) academic entrepreneurs (i.e. micro-level). Given that organizational contexts can shape the development of individual cognitions, attitudes and behaviors (Mowday & Sutton, 1993), referred to as

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<sup>4</sup> We refer to Rothaermel et al. (2007), Markman et al. (2008), and Djokovic & Souitaris (2008) for excellent reviews of the literature.

“top-down” processes in multilevel theory (Kozlowski & Klein, 2000), our study aims at bridging the gap between the micro- and meso-level. Specifically, we acknowledge that research scientists’ intentions to engage in academic entrepreneurship may emerge due to variation at the meso-level, next to, and through interaction with, individual-related antecedents.

In addition, current meso-level studies have predominantly examined the role of the university. While university characteristics, such as policies and infrastructure (e.g., Fini et al., 2011; Phan et al., 2005), research intensity (e.g., Hewitt-Dundas, 2012), and the nature of the TTO (e.g., Bercovitz et al., 2001; Markman et al., 2005), are important drivers of academic entrepreneurship, departments within the same university may demonstrate great heterogeneity in terms of entrepreneurial activity (Grimaldi et al., 2011). So far, however, empirical studies have largely ignored the department level, which is quite surprising. Indeed, some research has indicated the importance of the “localized social environment”, with special attention allocated to workplace peers (Kenney & Goe, 2004; Louis et al., 1989; Stuart & Ding, 2006) and the department chair (Bercovitz & Feldman, 2008). Furthermore, Rasmussen et al. (2014) revealed significant differences in early spin-off performance due to variation in initial departmental support. Nevertheless, while of considerable theoretical and practical interest, empirical evidence on the department level is scant. Since research scientists are typically embedded in departments, which are in turn embedded in universities, one of the fundamental questions left unanswered is the importance of the relatively neglected department level to variance in academic entrepreneurship, compared with the well-studied individual and university level.

Accordingly, the *first* research objective of this paper is to advance our understanding *whether the department actually matters*, through evaluating the extent to which department membership explains differences in academic entrepreneurship. Specifically, we study academic entrepreneurial intentions, which have recently received increased attention in the literature (Goethner et al., 2012; Huyghe & Knockaert, 2014; Obschonka et al., 2012; Prodan & Drnovsek, 2010). Using data on 2,652 research scientists nested in 386 departments at 24

European universities, we utilize hierarchical linear modeling (HLM) to simultaneously assess the variance accounted for by the individual, subunit and organization level. Subsequently, as *second* research objective, our paper disentangles the direct effect of *specific factors at the department level* on entrepreneurial intentions, as well as cross-level interactions between the micro-level (research scientist) and the meso-level (university and department). Specifically, building on organizational culture literature and trait activation theory (Tett & Burnett, 2003), we develop and test hypotheses about the role of department culture.

This work contributes to the (academic) entrepreneurship literature in several ways. First, responding to general calls for multilevel research in entrepreneurship (Davidsson & Wiklund, 2001; Shepherd, 2011; Zahra & Wright, 2011), our study provides more fine-grained insights into relationships that traverse different levels of analysis. In particular, we address the need to contextualize entrepreneurship in academia, put forward as pertinent future research avenue by Djokovic & Souitaris (2008), Lockett et al. (2005), Markman et al. (2008), and Rothaermel et al. (2007). The present study further adds to the extant academic entrepreneurship literature that generally has concentrated on either the micro- or meso-level of analysis, but has lacked sufficiently complex models or richness in data for blending the two. Second, by examining the extent to which the department is influential, we contribute to the emerging debate in the academic entrepreneurship literature on whether a shift in focus is needed from the university level to the relatively neglected department level (Rasmussen et al., 2014). Additionally, we enrich the entrepreneurship literature by introducing and highlighting the importance of organizational subcultures to the (academic) entrepreneurial process, thereby integrating insights from person-situation interaction theory. Finally, we extend the recent stream of studies on entrepreneurial intentions in academia by investigating the interplay between individual and contextual determinants in the configuration of such intentions.

## **5.2. THEORY AND HYPOTHESES**

### **5.2.1. Research objective 1: Department level effects on entrepreneurial intentions**

Organizations are generally characterized by differentiation (horizontal) and integration (vertical), resulting in multiple levels of conceptual interest (Kozlowski & Klein, 2000). Lower-level entities are nested hierarchically in upper-level entities, such as individuals in subunits, and subunits in organizations (Hitt et al., 2007). Organizational behavior researchers have demonstrated the pivotal role of the subunit level for a broad range of individual outcomes including innovation (Miron et al., 2004), organizational citizenship behavior (Kidwell et al., 1997), creativity (Hirst et al., 2009), performance (Bommer et al., 2007), job satisfaction (Seibert et al., 2004), and turnover (Liu et al., 2012).

Similarly, in a university context, research scientists are typically embedded in research groups or departments, which are in turn clustered in faculties and universities (Markman et al., 2009). Consequently, we can expect the subunit level to affect entrepreneurial activities or research scientists' propensity to engage in such endeavors. In fact, though prior research has largely documented the impact of university characteristics on academic entrepreneurship, the literature has also alluded to the importance of the subunit or department level (Bercovitz & Feldman, 2008; Kenney & Goe, 2004; Louis et al., 1989; Rasmussen et al., 2014; Stuart & Ding, 2006), but has provided limited evidence on the existence of a department-level effect. Therefore, following assertions in the academic entrepreneurship literature, just as indications provided in the organizational behavior literature, we argue that department level effects are at play in academic entrepreneurship and can be detected by employing a multilevel model. Specifically, in studying entrepreneurial intentions in academia, we propose:

**Hypothesis 1:** The department level explains significant variance in entrepreneurial intentions (in addition to individual and university effects).

### **5.2.2. Research objective 2: Cross-level direct and moderation effects of department culture**

Assuming that the department level plays a vital role in academic entrepreneurship, we subsequently aim at understanding which departmental characteristics may affect research scientists' entrepreneurial intentions. In doing so, we focus on the cross-level direct and moderation effects of department culture.

### ***Direct effect of department culture on entrepreneurial intentions***

Organizational culture can be defined as a set of values and beliefs shared by members of the same organization, which influence their thoughts, feelings and behaviors (Cameron & Quinn, 1999; O'Reilly et al., 1991; Schein, 1985). Organizational culture provides a framework through which individuals internalize expectations about their roles and behaviors in the organization (Deshpandé & Webster, 1989). Researchers have explored the overall effects of organizational culture on diverse individual outcomes, including entrepreneurial behavior (e.g., Hornsby et al., 2002; Ireland et al., 2009). At the same time, scholars have widely observed the existence of distinct subcultures within an organization (Hofstede, 1998; Schneider et al., 2013; Trice & Beyer, 1993). Subcultures may develop within different departments, functional areas and/or work groups (Hofstede, 1998; Van Maanen & Barley, 1984). As such, in addition to the influence of the overall organizational culture on individual outcomes, organizational members are also affected by the value systems of the organizational subunits in which they are embedded (Adkins & Caldwell, 2004; Boisnier & Chatman, 2003). Subsequently, in a university context, certain departments may have cultural values that trigger academic entrepreneurship, while others may have a culture that inhibits research scientists' entrepreneurial intentions.

A widely accepted and theoretically driven conceptualization, that covers the key dimensions of organizational culture as identified in Detert et al.'s (2000) literature review, is Quinn & Rohrbaugh's (1983) competing values framework. The framework calls attention to how opposing values exist in organizations or subunits, and how "different mixtures of values are reflected in both their desired ends as well as in their means to attain them, such as their structural designs and mechanisms of coordination and control" (Zammuto & O'Connor, 1992: 711). Four culture types – clan, hierarchy, market, and adhocracy - are differentiated according to whether organizations or subunits value flexibility and discretion versus stability and control, and whether they adopt an internal versus external orientation (Cameron & Quinn, 1999). As pointed out by Quinn (1988), these four culture types are not mutually exclusive, and empirical evidence supports that they can exist concurrently in a single

organization (e.g., Zammuto & Krakower, 1991). Furthermore, Buenger et al. (1996) have shown that competing value sets differ from one subunit to another.

Of particular relevance in the context of our study is the adhocracy culture type (flexibility and external orientation), given its emphasis on innovation, creativity and risk-taking (Cameron & Freeman, 1991; Cameron & Quinn, 1999; Hult et al., 2002). A strong adhocracy culture occurs in dynamic organizations or subunits that can adapt rapidly when new circumstances arise (Cameron & Quinn, 1999). Accordingly, we expect university departments with adhocracy cultures to provide a setting where entrepreneurial intentions are more likely to arise among research scientists. This is because the entrepreneurial process is fraught with difficulties, unforeseeable hazards and high levels of uncertainty (Nelson & Winter, 1982). Groen & Walsh (2013) for instance indicate that in order to successfully commercialize emerging and disruptive technologies, entrepreneurs need to engage in activities which are difficult to manage, such as alliance management and open innovation, and have to creatively develop new business models. Subsequently, given the innovative and risk-oriented spirit which is likely to prevail in adhocracy-type departments, we expect entrepreneurial intentions to reside within such departments. Hence, we assume:

**Hypothesis 2:** A department's adhocracy culture is positively related to entrepreneurial intentions.

### ***Moderation effects of department culture on entrepreneurial intentions***

As we have contended so far, using a multilevel perspective, we expect department culture to affect academic entrepreneurship, over and above factors at other levels. Beyond the direct relation of department culture to entrepreneurial intentions, we draw upon trait activation theory to conceptualize the moderation effects of department culture, as such building bridges between the individual and subunit level. Trait activation theory focuses on a person-situation interaction model to explain individual behavior as a response to relevant cues found in situations (Tett & Guterman, 2000). The underlying principle is that individuals are more likely to behave in a way consistent with their personality trait when the contextual influence at play is relevant to the trait (Hirst et al., 2009; Tett & Burnett, 2003). Applying trait

activation theory to our research objective, aimed at understanding the meaning of department culture for academic entrepreneurship, we can expect individuals possessing personality traits leaning towards entrepreneurship to especially behave consistently with these traits when their context fosters entrepreneurial behavior.

Following this logic, an important trait in our study is proactive personality, which refers to the enduring behavioral tendency of people to take action to influence their environment (Bateman & Crant, 1993). Individuals high in proactive personality “identify opportunities and act on them, show initiative, take action, and persevere until meaningful changes occur” (Crant, 2000: 439). Proactive personality has been associated with positive outcomes across many domains, such as job performance (Thompson, 2005), career success (Seibert et al., 1999), and entrepreneurship (Becherer & Maurer, 1999; Crant, 1996; Fuller & Marler, 2009). Furthermore, prior studies have shown how organizations can provide cues that activate an individual’s proactive personality, and related behavior (e.g., Erdogan & Bauer, 2005; Li et al., 2010).

As argued above, we identify adhocracy cultures as cultures which are, thanks to their flexibility and external orientation, supporting entrepreneurial activities. In such contexts, individuals possessing traits oriented towards entrepreneurship are more likely to engage or intend to engage in entrepreneurial activities. Accordingly, we assume that the positive relationship between proactive personality and entrepreneurial intentions, as found by Crant (1996), also holds in a university context. However, consistent with the moderation implied by trait activation theory, we argue that a departmental adhocracy culture may provide cues that bring out proactive personality and entrepreneurial intentions. Indeed, given that adhocracy cultures exemplify proactive strategies (Zammuto & Krakower, 1991; Zammuto & O’Connor, 1992), according to trait activation theory, the interaction between person and situation will stimulate proactive personality and behavior. Therefore, we contend that entrepreneurial intentions resulting from research scientists’ proactive personalities are more likely to occur in university departments with a strong adhocracy culture. Thus, we hypothesize:

**Hypothesis 3:** A department's adhocracy culture moderates the positive relationship between proactive personality and entrepreneurial intentions, such that the effect is reinforced when a strong adhocracy culture is in place.

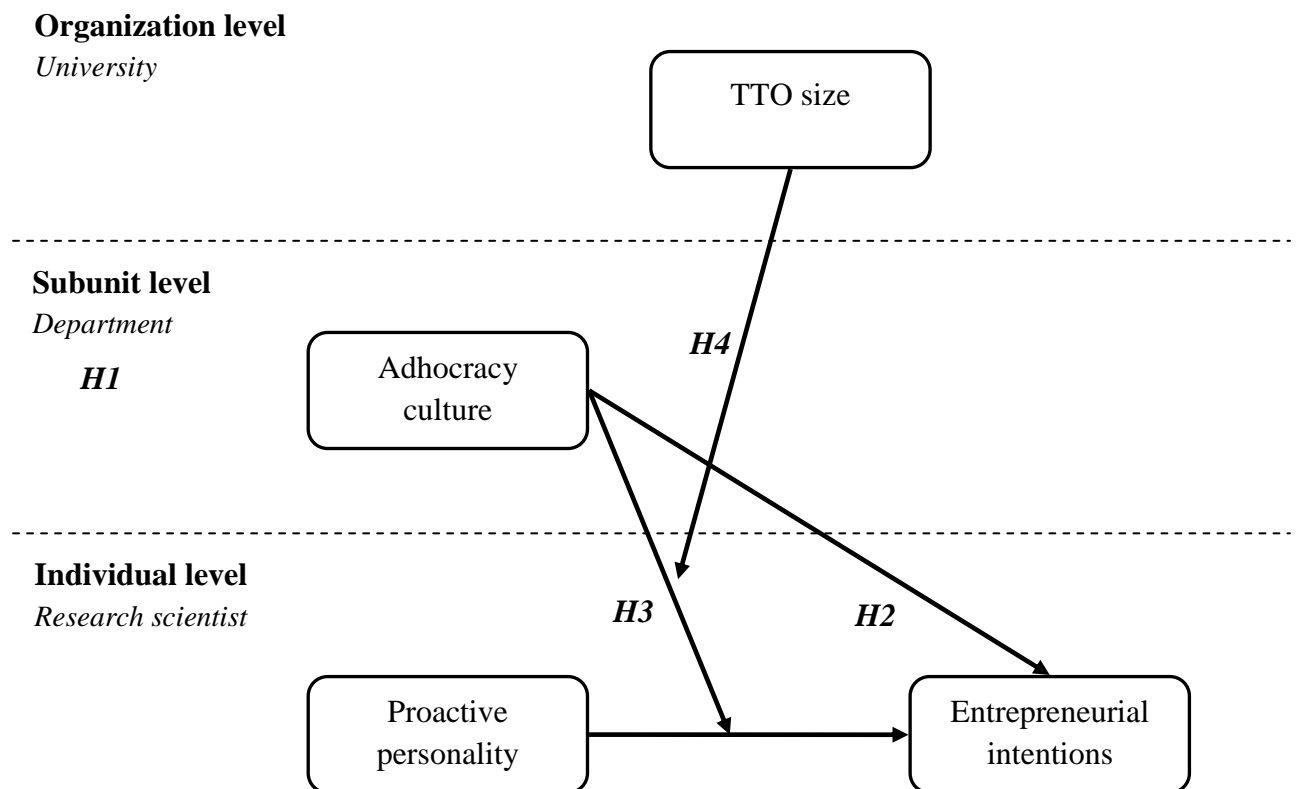
Alongside their embeddedness in subunits, individuals are part of the overall organization. Hence, contextual cues that trigger research scientists' entrepreneurial traits can originate from the department level, as hypothesized above, but also from the university as a whole. We expect that, in addition to the activation of proactive personality through a department's adhocracy culture, resulting in higher levels of entrepreneurial intentions, university support structures or policies could further enhance this effect. Therefore, in what follows, we bring together the individual, subunit and organization level.

Concretely, in line with trait activation theory, we argue that the positive relation between proactive personality and entrepreneurial intentions will be reinforced if both the subunit and organizational context display an external orientation and thus stimulate entrepreneurship. This is because proactive individuals characteristically scan their environment for opportunities (Bateman & Crant, 1993), and this outward focus translates into greater entrepreneurial intentions (Crant, 1996). At the department level, adhocracy cultures are inherently characterized by an external orientation, in which prospecting for opportunities is valued (Cameron & Quinn, 1999). As for the university level, in response to the increasing emphasis on their entrepreneurial activities, most universities have established dedicated TTOs (Markman et al., 2008). TTOs fulfill a boundary spanning role between academia and industry, or the university and its external environment (Ambos et al., 2008). In their boundary spanning activities, TTOs serve as a bridge between internal "suppliers" of research results (i.e. research scientists or groups) and external "customers" (i.e. firms, entrepreneurs and venture capitalists) who operate in different environments (Huyghe et al., 2014; Siegel et al., 2003). As such, the extent to which the university has an external orientation is manifested in the size of its TTO. Taken together, we argue that proactive research scientists will possess even higher levels of entrepreneurial intentions when they are working in departments with a strong adhocracy culture which are part of universities with a large TTO. So:

**Hypothesis 4:** A university's TTO size and a department's adhocracy culture moderate the positive relationship between proactive personality and entrepreneurial intentions, such that the effect is reinforced when both a large TTO and strong department adhocracy culture are in place.

Figure 5.1 depicts the conceptual model for this study.

**Figure 5.1: Conceptual model**



We also included control variables at the individual (gender, entrepreneurial experience), subunit (entrepreneurial role models) and organization (university size, professor's privilege) levels.

## 5.3. METHODOLOGY

### 5.3.1. Data collection and sample

Our study is based upon cross-sectional data collected in 2012-2013 at 24 universities in five European countries. As starting point for our data collection, we used the clusters put forward by the Global Leadership and Organizational Behavior Effectiveness research

program (GLOBE) (Gupta et al., 2002). GLOBE builds upon nine cultural dimensions to capture similarities in norms, values and beliefs for the construction of societal clusters (Javidan et al., 2006). Based on this classification, we selected the following countries: Sweden (Nordic Europe), Spain (Latin Europe), Slovenia (Eastern Europe), Germany and Belgium (Germanic Europe). For each country, we compiled a list of all universities by means of secondary sources (including reports by ministries of education, university rankings, technology transfer networks and general internet searches). Next, we selected one or two geographical regions within each country and contacted all universities through emailing their technology transfer offices (TTOs), asking for their participation in our research. In case of non-response over email, TTOs were contacted by telephone. Eventually, we received positive answers from 40 out of 58 TTOs contacted.

Subsequently, we started arranging face-to-face interviews with TTOs, in which stage another 9 TTOs were not available or eventually not willing to participate, resulting in 31 TTOs offering full collaboration. Through these interviews, we obtained information on university and TTO characteristics (e.g., human and financial resources, annual innovation output). Primary data were verified and complemented with secondary data from annual reports, university and TTO websites. Furthermore, we asked permission and assistance to contact individual research scientists from different disciplines at each university, which was not feasible in 7 universities due to privacy rules or non-existence of staff directories. Our survey specifically targeted research scientists (as opposed to, for instance, tenured professors) as these are more likely to develop their career capital due to uncertainty about which career track will be the most beneficial to them (Krabel & Mueller, 2009). In contrast, professors are typically more focused on establishing their reputation in the scientific community through the production of scientific output.

The survey population consisted of 32,358 research scientists. Respondents received a request through email to complete an online questionnaire, followed by a kind reminder after one week. We obtained 6,442 failure messages indicating that email addresses were invalid or our message could not be sent, resulting in a usable population of 25,916 research scientists.

In total, 4,515 responses were received (or 17% of the usable population, which is comparable to previous research in this domain (Obschonka et al., 2012). After elimination of incomplete responses and departments with less than two respondents or insufficient within-department agreement (i.e.  $r_{wg(j)} < 0.70$ ; Bliese, 2000), our final sample consists of 2,652 research scientists nested in 386 departments who fully completed the questionnaire, or 10% of the usable population. T-tests revealed no significant differences between respondents who filled in all questions and those who provided incomplete responses, or between early and late respondents, in terms of gender, age, human capital, discipline or country ( $p > 0.05$ ).

### **5.3.2. Measures**

#### ***Dependent variable***

*Entrepreneurial intentions* were assessed using the scale developed by Linan & Chen (2009). The six items measured on a 7-point Likert scale (1 = strongly disagree; 7 = strongly agree) were: (1) I am ready to do anything to be an entrepreneur, (2) My professional goal is to become an entrepreneur, (3) I will make every effort to start and run my own firm, (4) I am determined to create a firm in the future, (5) I have very seriously thought of starting a firm, and (6) I have the strong intention to start a firm some day. Cronbach's alpha is 0.96, indicating high scale reliability (Hair et al., 2006).

#### ***Independent and moderation variables***

*Proactive personality* was measured using a shortened version of the Bateman & Crant (1993) scale, as validated by Seibert et al. (1999). Respondents were asked to indicate their degree of agreement with the following statements on a scale ranging from 1 (strongly disagree) to 7 (strongly agree): '(1) I am constantly on the lookout for new ways to improve my life, (2) Wherever I have been, I have been a powerful force for constructive change, (3) Nothing is more exciting than seeing my ideas turn into reality, (4) If I see something I don't like, I fix it, (5) No matter what the odds, if I believe in something I will make it happen, (6) I love being a champion for my ideas, even against others' opposition, (7) I excel at identifying opportunities, (8) I am always looking for better ways to do things, (9) If I believe in an idea,

no obstacle will prevent me from making it happen, and (10) I can spot a good opportunity long before others can.’ Scale reliability measured by Cronbach’s alpha is 0.88.

*Adhocracy culture* was captured with Cameron & Quinn’s (1999) scale. Based on the competing values framework, the instrument asks respondents to indicate the extent to which their department possesses characteristics associated with each of the four culture types along four dimensions (character, leadership, cohesion and emphasis). For adhocracy, respondents were presented the following four statements on a Likert scale with anchor points 1 (strongly disagree) to 7 (strongly agree): ‘(1) My department is a very dynamic and entrepreneurial place. People are willing to stick their necks out and take risks, (2) The head of my department is generally considered to exemplify entrepreneurship, innovation, or risk-taking, (3) The glue that holds my department together is commitment to innovation and development, and (4) My department emphasizes acquiring new resources and creating new challenges; trying new things and prospecting for opportunities are valued.’ To justify aggregation to the subunit level, first it was necessary to ascertain that there is little variance *within* departments in respondents’ perceptions of adhocracy culture. A second prerequisite for aggregation was that there is variance *across* departments in perceptions of adhocracy culture. Both the mean value of inter-rater agreement ( $r_{wg(j)} = 0.78$ ) and intra-class correlations ( $ICC(1) = 0.13$ ;  $ICC(2) = 0.77$ ) supported aggregating individual research scientists’ responses to the department level through the calculation of the mean score (Bliese, 2000).

*TTO size* is measured by the total number of FTE staff working at the university’s TTO (including IP and licensing staff, excluding staff employed in science parks or incubator facilities), based upon interview data.

### ***Control variables***

As our study aims at developing a multilevel model that incorporates the individual, department and university level, we also deemed it necessary to include control variables at these different levels.

At the level of the individual research scientist, *gender* (0 = male, 1 = female) was controlled for as men are usually more entrepreneurial than women (Crant, 1996; Zhao et al., 2005). *Entrepreneurial experience* indicates whether or not research scientists have ever started or attempted to start their own business, including any self-employment (0 = no, 1 = yes). Prior entrepreneurial exposure has been found to relate positively to entrepreneurial intentions (Obschonka et al., 2012; Zhao et al., 2005).

At the department level, *entrepreneurial role models* indicate whether the department has members who founded their own business (0 = no, 1 = yes). Research scientists' entrepreneurial decisions are shown to be socially influenced (Bercovitz & Feldman, 2008), and the presence of entrepreneurial role models diminishes concerns about the social ramifications of own entrepreneurial actions (Stuart & Ding, 2006)

At the university level, the natural logarithm of the number of academic staff is used as an indicator of *university size*. Finally, the presence of *professor's privilege* or the academic exemption in Swedish universities, which gives full ownership of intellectual property rights to researchers (Klofsten & Jones-Evans, 2000), was controlled for through the inclusion of a dummy variable (0 = no, 1 = yes).

**Table 5.1: Descriptive statistics and correlations**

	Mean	SD	(1)	(2)	(3)	(4)
<i>Level 1 – Individual (n = 2,652)</i>						
(1) Gender <sup>a</sup>	0.49	0.50				
(2) Entrepreneurial experience <sup>a</sup>	0.17	0.38	<b>-0.12</b>			
(3) Proactive personality	4.83	0.90	<b>-0.09</b>	<b>0.16</b>		
(4) Entrepreneurial intentions	2.47	1.51	<b>-0.19</b>	<b>0.37</b>	<b>0.37</b>	
<i>Level 2 – Subunit (n = 386)</i>						
(1) Entrepreneurial role models <sup>a</sup>	0.79	0.41				
(2) Adhocracy culture	3.88	0.69	<b>0.14</b>			
<i>Level 3 – Organization (n = 24)</i>						
(1) University size	3.30	0.37				
(2) Professor's privilege <sup>a</sup>	0.33	0.48	-0.33			
(3) TTO size	15.00	18.11	<b>0.36</b>	0.11		

Pearson correlation coefficients (1-tailed), indicating significant correlations ( $p < 0.05$ ) in bold

<sup>a</sup> Correlations of binary variables should be interpreted with care.

## 5.4. RESULTS

### 5.4.1. Analytical strategy

Table 5.1 presents the means, standard deviations, and correlations among the variables under study. The dependent variable of this study, entrepreneurial intentions, was operationalized at the individual level of analysis, while the independent variables were measured at the individual (research scientist), subunit (department), and organization (university) level. We used three-level HLM (Raudenbush & Bryk, 2002) to test our hypotheses. In contrast to OLS regression analysis, HLM explicitly accounts for the nested data structure and allows to simultaneously estimate the impacts of factors at different levels on individual-level outcomes, while maintaining appropriate levels of analysis for these predictors (Hofmann et al., 2000).

**Table 5.2: Hierarchical linear modeling (HLM) estimations of variance (*Hypothesis 1*)**

Entrepreneurial intentions	Variance component	Percentage of total variance	d.f.	$\chi^2$
<i>Unconditional model</i>				
Level 1 variance (between individuals)	2.12126	92.63%		
Level 2 variance (between subunits)	0.11552	5.04%	362	503.78***
Level 3 variance (between organizations)	0.05327	2.33%	23	60.98***

\*\*\*  $p < 0.001$

n = 2,652 individuals (level 1), 386 subunits (level 2), and 24 organizations (level 3)

### 5.4.2. Research objective 1: Department level effects on entrepreneurial intentions

A fully unconditional model, a null model with no predictors, is used to examine the proportion of variance in entrepreneurial intentions attributable to each level of analysis, with particular interest in the subunit or department level. As illustrated in Table 5.2, the unconditional modeling partitions the total variance into three components: between individuals, between subunits, and between organizations. The analyses reveal that only 2.33 per cent of the variance in entrepreneurial intentions resides between universities, 5.04 per cent lies between departments within universities, and the largest percentage of variance, 92.63 per cent occurs at the individual level. At the same time, however, the chi-squared test

confirms that significant variance occurs across both departments and universities ( $p < 0.001$ ).

Since our data demonstrate sufficient between-department variance in entrepreneurial intentions, this provides *support for Hypothesis 1*.

**Table 5.3: HLM unstandardized coefficients (robust standard errors in parentheses) (Hypotheses 2 – 4)**

Entrepreneurial intentions	Model 1		Model 2		Model 3	
<i>Level 1</i>						
Intercept	2.525****	(0.126)	2.525****	(0.126)	2.525****	(0.122)
Gender	-0.331****	(0.051)	-0.333****	(0.051)	-0.328****	(0.051)
Entrepreneurial experience	1.266****	(0.065)	1.267****	(0.064)	1.267****	(0.064)
Proactive personality	0.493****	(0.030)	0.484****	(0.027)	0.477****	(0.030)
<i>Level 2</i>						
Entrepreneurial role models	-0.037	(0.115)	-0.037	(0.115)	-0.045	(0.111)
Adhocracy culture	0.164**	(0.068)	0.164**	(0.068)	0.124**	(0.059)
<i>Level 3</i>						
University size	-0.232	(0.183)	-0.232	(0.182)	-0.224	(0.190)
Professor's privilege	-0.227**	(0.096)	-0.227**	(0.096)	-0.220**	(0.097)
TTO size	-0.001	(0.002)	-0.001	(0.002)	-0.001	(0.002)
<i>Level 1 x 2</i>						
Proactive personality x Adhocracy culture			0.108*	(0.062)	0.074	(0.070)
<i>Level 1 x 3</i>						
Proactive personality x TTO size					0.001	(0.001)
<i>Level 2 x 3</i>						
Adhocracy culture x TTO size					0.006***	(0.002)
<i>Level 1 x 2 x 3</i>						
Proactive personality x Adhocracy culture x TTO size					0.003*	(0.002)
<hr/>						
R <sup>2</sup> <sub>between-individuals</sub>	0.24		0.24		0.24	
R <sup>2</sup> <sub>between-subunits</sub>	0.18		0.17		0.25	
R <sup>2</sup> <sub>between-organizations</sub>	0.47		0.47		0.43	
R <sup>2</sup> <sub>total</sub>	0.24		0.24		0.24	

\*  $p < 0.10$ ; \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ , \*\*\*\*  $p < 0.001$

n = 2,652 individuals (level 1), 386 subunits (level 2), and 24 organizations (level 3)

°  $R^2_{\text{total}} = R^2_{\text{between-individuals}} \times 92.63\% + R^2_{\text{between-subunits}} \times 5.04\% + R^2_{\text{between-organizations}} \times 2.33\%$

### 5.4.3. Research objective 2: Cross-level direct and moderation effects of department culture

Now that we have empirical support that the department level plays a part in the academic entrepreneurial process, a necessary condition is fulfilled for our second research objective or assessing the role of specific departmental factors, such as culture, in research scientists'

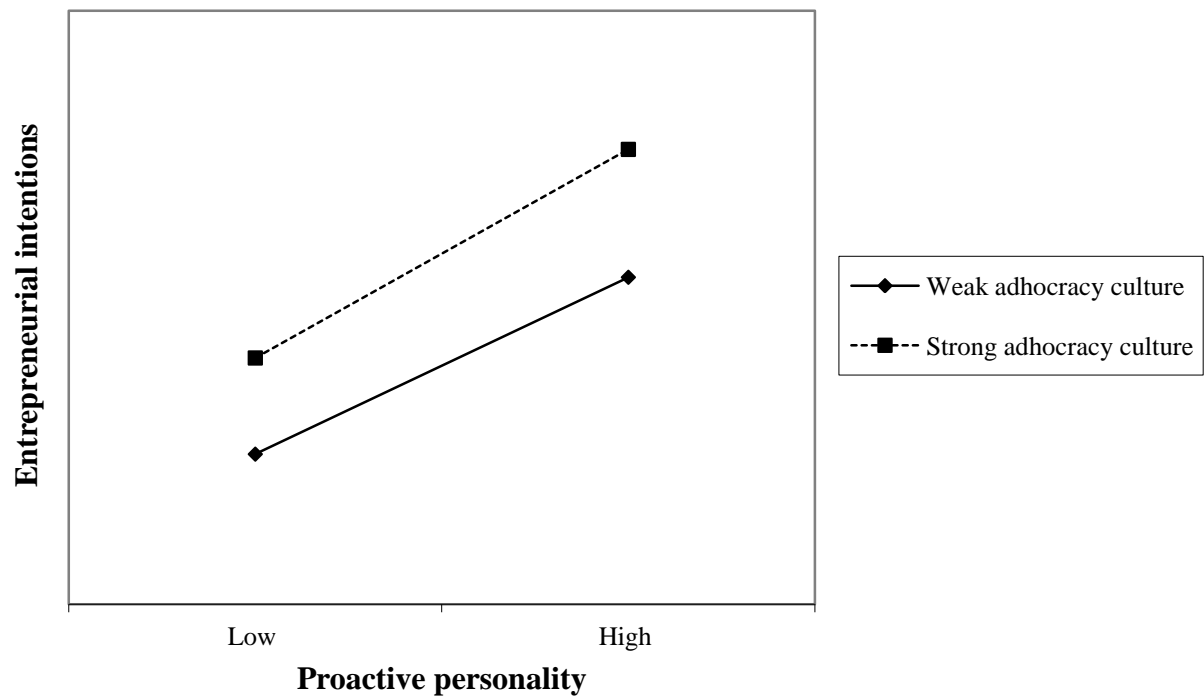
entrepreneurial intentions. Consequently, we tested the cross-level direct effect (Model 1) and moderation effects (Models 2 and 3) of a department's adhocracy culture, presented in Table 5.3.

As for the control variables included in our study, our findings are mostly consistent with prior research. In particular, at the individual level, we find that women possess lower entrepreneurial intentions than men ( $p < 0.001$ ) (Crant, 1996; Zhao et al., 2005), and that entrepreneurial experience (Obschonka et al., 2012) and proactive personality (Crant, 1996) relate positively to entrepreneurial intentions ( $p < 0.001$ ). Our data do not demonstrate a significant influence of entrepreneurial role models present within departments. At the university level, we find universities with the professor's privilege to be less conducive to research scientists' entrepreneurial intentions ( $p < 0.05$ ). Finally, we do not observe a direct effect of university nor TTO size.

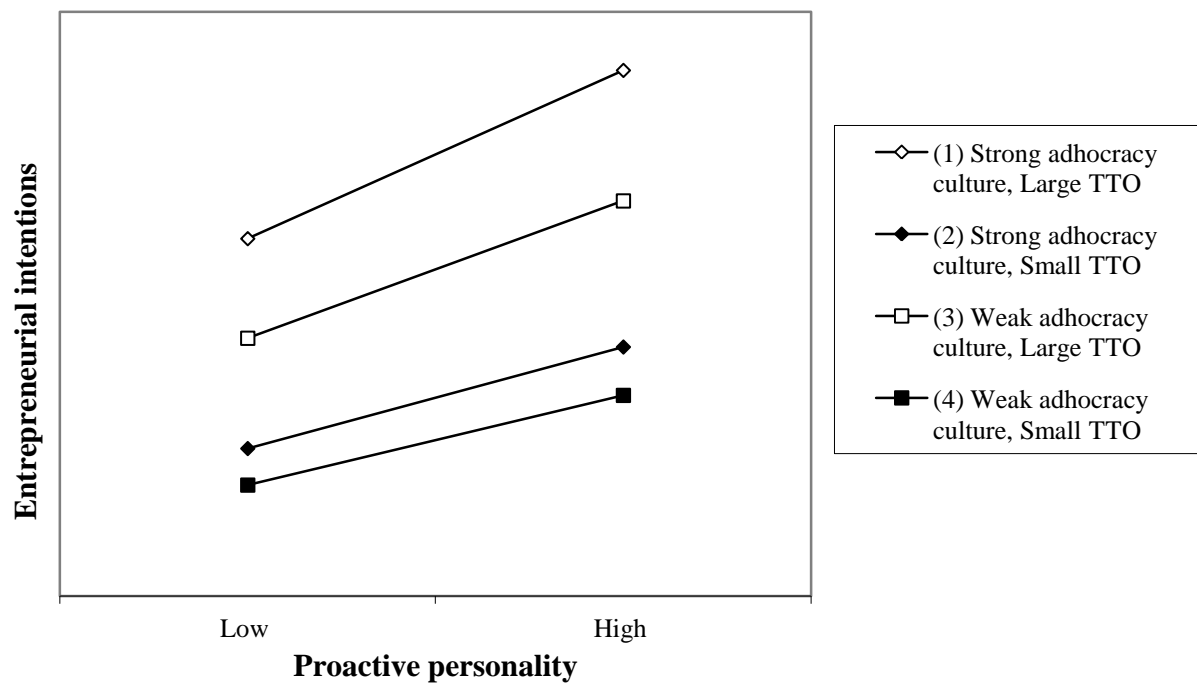
Turning to our hypotheses, Model 1 shows a positive direct relationship of departmental adhocracy culture on research scientists' intentions to engage in entrepreneurial activities (0.164;  $p < 0.05$ ), *as predicted by Hypothesis 2*. A precondition for testing cross-level interactions is that the slope coefficient of the relationship between proactive personality and entrepreneurial intentions varies across individuals. Results confirmed significant variance in the level 1 slope (variance = 0.04;  $\chi(377) = 424.32$ ,  $p < 0.05$ ). Subsequently, we include adhocracy culture as a moderator in Model 2. The positive and significant coefficient (0.108;  $p < 0.10$ ) *corroborates Hypothesis 3* that individuals' proactive personality leads to even greater entrepreneurial intentions when their department has a strong adhocracy culture. The graphical representation of the interaction pattern for the moderator at one standard deviation below and above the mean is presented in Figure 5.2.

Finally, we introduce the three-way-interaction in Model 3 and find *support for Hypothesis 4*, which proposed that adhocracy culture and TTO size are simultaneously reinforcing the positive link between proactive personality and entrepreneurial intentions (0.003;  $p < 0.10$ ). Figure 5.3 visualizes this moderation effect.

**Figure 5.2: Cross-level moderation effects of adhocracy culture on the relationship between proactive personality and entrepreneurial intentions (*Hypothesis 3*)**



**Figure 5.3: Cross-level moderation effects of TTO size and adhocracy culture on the relationship between proactive personality and entrepreneurial intentions (*Hypothesis 4*)**



## 5.5. DISCUSSION AND CONCLUSION

The purpose of this paper was to provide more fine-grained insights into *whether* and *how* department membership affects academic entrepreneurship through the use of multilevel analysis. First, drawing on a sample of 2,652 research scientists from 386 departments in 24 European universities, our findings indicate that, in addition to the influence of the individual and the overall organization, the subunit or department level does matter for academic entrepreneurship. What is more, the variation in entrepreneurial intentions between research scientists was primarily dependent upon individual differences, while the department effect outweighs the university effect. This observation is in line with Kozlowski & Klein's (2000: 20) notion of bond strength, or "the extent to which characteristics, behaviors, dynamics, and processes of one level or unit influence the characteristics, behaviors, dynamics, and processes of another level or unit", which increases with proximity. In view of that positive association, individuals are more likely to be influenced by their personal attributes, followed by subunit level characteristics, and then by organizational factors. Hence, we conclude that the department is at least as important as level of analysis as the university. Second, we identify a department's adhocracy culture as an explanatory factor for entrepreneurial intentions in academia. Research scientists working in departments with a value system that emphasizes flexibility and that has an external orientation, show a greater propensity to become an entrepreneur. Next to this cross-level direct effect, building on insights from trait activation theory, we find a department's adhocracy culture to act as a moderator as well. In particular, research scientists' proactive personality traits are more likely to be translated into entrepreneurial intentions in strong adhocracy cultures. Finally, our analyses also extend understanding of the interplay between individual, subunit and organizational antecedents of entrepreneurial intentions. A combination of a strong adhocracy culture at the department level and a large TTO at the university level reinforces the positive effect of a proactive personality on entrepreneurial intentions.

Our results have several implications for theory and practice. For academia, this paper makes a number of contributions to *the (academic) entrepreneurship literature*. First, our

study presents a conceptual framework and related empirical validation that reflects the multilevel nature of entrepreneurship, which has been presented as a fundamental direction for future research by many scholars (Davidsson & Wiklund, 2001; Shepherd, 2011; Zahra & Wright, 2011). At the same time, we also respond to similar calls for contextualization of the entrepreneurial process, which have specifically been made in the literature on academic entrepreneurship (Djokovic & Souitaris, 2008; Lockett et al., 2005; Markman et al., 2008; Rothaermel et al., 2007). In particular, in contrast to the vast majority of studies describing single-level models, we adopt a multilevel lens and bridge the micro- and meso-level of analysis. Mapping out such cross-level relationships contributes to a more holistic understanding of (academic) entrepreneurship. Furthermore, this study overcomes the challenge to theorize multilevel effects (Kozlowski & Klein, 2000), by integrating insights from person-situation interaction theory. Second, our research extends previous academic entrepreneurship literature, which has predominantly focused on the organization as a whole (i.e. inter-university differences) and has almost neglected subunits (i.e. intra-university differences), by showing that departmental influences deserve closer scrutiny. Specifically, we provide empirical evidence that, beyond the individual-level effects, research scientists' entrepreneurial intentions are primarily dependent upon departmental characteristics rather than university factors. Third, while the organizational behavior literature has underlined the importance of subcultures (Hofstede, 1998; Schneider et al., 2013; Trice & Beyer, 1993), so far, the entrepreneurship literature has largely overlooked the impact of the cultural values of departments in which individuals reside. Our findings demonstrate that additional insights can be gained by considering the role of department culture when studying entrepreneurial outcomes, both directly and indirectly. Fourth, building upon trait activation theory, our study identifies adhocracy culture as a contextual moderator for proactive personality, as such responding to calls by Crant (2000) and Erdogan & Bauer (2005) to explore how the relationship between proactive personality and behavioral outcomes may be dependent upon situations. Finally, we also contribute to the emerging stream of studies on entrepreneurial intentions in academia, by highlighting how these can emanate from the interaction between individual and context.

From a practical point of view, especially for *university managers and policy makers*, our examination of differences in entrepreneurial intentions across the three levels of analysis is valuable in order to assign their restricted resources to the most influential factors rather than peripheral ones. Given that our results prove that the impact of the subunit level should not be underestimated, it may be desirable not to focus all efforts at the central university level. Recent studies have given attention to the different organizational structures that TTOs can take and how decentralized models, in which technology transfer officers are operationally involved in departments (possibly supplemented with a centralized TTO), have become more prevalent in universities (Bercovitz et al., 2001; Huyghe et al., 2014). By highlighting the impact of departments, our findings suggest that such decentralized TTO structures may be more conducive to entrepreneurial activities than merely centralized models. Specifically, through their interactions with industrial companies (i.e. potential customers, partners and suppliers) and research teams in other departments, decentralized TTOs could contribute to the development of externally-oriented cultures within departments, and thus enhance research scientists' entrepreneurial intentions. Correspondingly, while policy makers have mainly provided funding for infrastructure at the central university level, including TTOs, science parks and incubators (Phan et al., 2005), it could be beneficial to partly shift their attention to the support of departments. In particular, our results suggest that government initiatives that are mainly targeted towards universities are likely to have a limited impact on encouraging entrepreneurial endeavors, unless they take better account of departmental influences as well as individual attributes of academics. Finally, our research can also provide guidance for *department heads* seeking to encourage academic entrepreneurship. For instance, they could create an adhocracy culture within their department by promoting risk taking and outward thinking through their leadership style, or by launching initiatives that stimulate research scientists' active search for commercial opportunities (e.g., entrepreneurship training, collaborations with other departments or institutions, participation in university innovation clusters).

Our work has a number of limitations that raise opportunities for future research. First, our findings are based upon cross-sectional data, and therefore, we could not establish the

causality of our results. Longitudinal research designs would enable to add a fourth level of analysis (i.e. temporal variation) in order to give attention to causal inferences and evolutions over time, and to assess the impact of context dynamics. Second, we deliberately focused on Quinn & Rohrbaugh's (1983) competing values framework and provide insights into the influence of a department's adhocracy culture. However, as numerous models have been developed in the organizational culture literature (Detert et al., 2000), we encourage future studies to employ alternative operationalizations or to concentrate on specific key dimensions of culture. Along the same lines, future research could borrow concepts and theoretical underpinnings from the broader organizational behavior literature, such as subunit climate (strength) (Schneider et al., 2013), in order to further disentangle the impact of the department level on entrepreneurial intentions. Finally, the generalizability of our findings outside the academic entrepreneurship context warrants further research. For instance, future studies could assess to which extent our results hold for other explorative processes or behaviors, such as product innovation and corporate entrepreneurship, in settings where individuals are likely to be influenced by cues in their proximal environment (such as teams or subunits) and in the organization as a whole.

Despite these limitations, to our knowledge, our study is the first to delineate the multilevel attributes of academic entrepreneurship, thereby specifically focusing on the cross-level effects of department culture. We hope to inspire future studies to utilize multilevel theories and research designs in order to examine the intersection of the entrepreneurship and organizational behavior literatures.

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## 6. GENERAL CONCLUSION

The main objective of this dissertation was to provide insights into the early process of university research commercialization, and why some academics develop entrepreneurial intentions while others do not. In each empirical study, the primary focus lies on specific individual and/or contextual aspects of the academic entrepreneurial process. Moreover, whereas the first paper draws upon qualitative longitudinal case studies, the other three papers use a quantitative cross-sectional research design. A mixture of statistical techniques is utilized, including content analysis, hierarchical regression, moderation/mediation and multilevel analyses, in order to build towards a model for understanding entrepreneurial intentions in an academic context. This final chapter summarizes the main findings of the four dissertation studies and highlights the key academic contributions. Furthermore, we conclude by considering the implications for practitioners concerned with academic entrepreneurship.

### 6.1. MAIN FINDINGS

The first study explored the role of *technology transfer offices (TTOs)* throughout the pre-spin-off process. In particular, we examined a commonly implemented but relatively unstudied “hybrid” TTO model, which combines centralized and decentralized units. Drawing upon boundary spanning theory and proximity literature, we concentrated on how (i.e. through which activities) the two levels within such hybrid TTO structure help teams of research scientists to translate their entrepreneurial intentions into actions towards spin-off creation, and what causes TTOs to engage in these activities. Our longitudinal follow-up of six nascent spin-off cases at Ghent University revealed a dual boundary spanning role for both centralized and decentralized TTOs, namely externally (across university boundaries) and internally (within university boundaries). Yet, we identified differences in the type of boundary spanning activities that the two TTO levels perform and in the parties with whom

they interact. Furthermore, we found geographical, technological and organizational proximity to be important explanations for those differences.

The second paper advanced our knowledge of how the *university context* shapes entrepreneurial intentions in academia, and assumed a broad definition of academic entrepreneurship rather than merely the founding of university spin-offs. Particular attention was given to the influence of organizational culture and climate, thereby adopting an institutional perspective. Using a sample of 437 research scientists from Swedish and German universities and a combination of linear regression and mediation analysis, we demonstrated that universities can create an institutional setting that provokes intentions to found a spin-off, to protect or license intellectual property rights, and to carry out consulting or contract research for industry. Specifically, research scientists have greater spin-off and patenting or licensing intentions when they are embedded in universities with mission statements and/or reward systems that incorporate entrepreneurial efforts. We did not observe similar patterns for their intentions to interact with industry through consulting or contract research. Additionally, exposure to entrepreneurial role models within the university context, exerts a positive influence on individuals' propensity to engage in academic entrepreneurship, both directly and indirectly by boosting research scientists' entrepreneurial self-efficacy.

In the third study, we pointed to significant *individual determinants* of entrepreneurial intentions which have, in spite of their relevance within academia, not yet been addressed in scholarly research. Building upon passion literature and role identity theory, the central question was how research scientists' "passion orchestra" is associated with their spin-off versus start-up intentions, with particular interest in the interaction between entrepreneurial and scientific passion. Our findings were based on a dataset of 2,308 research scientists from 24 universities in 5 European countries. First, we provided empirical evidence that entrepreneurial passion is positively related to both spin-off and start-up intentions. Moreover, research scientists which display high levels of scientific passion have greater intentions to set up a spin-off company, but lower intentions to start any type of new venture. In addition to these direct effects of entrepreneurial and scientific passion on entrepreneurial intentions,

entrepreneurial self-efficacy and affective commitment towards the university also mediate these relationships. Finally, our analysis highlighted the interplay between the two types of passion, which varies depending on the type of entrepreneurial activity the research scientist intends to commence. Whilst entrepreneurial and scientific passion enhance each other in the case of spin-off intentions, we found scientific passion to weaken the positive association between entrepreneurial passion and start-up intentions.

The fourth paper elucidated the importance of *the fairly neglected department* when explaining variance in academic entrepreneurial intentions, above and in conjunction with university and individual determinants. Through the use of multilevel analysis techniques and a sample of 2,652 research scientist nested in 386 departments at 24 European universities, first, we corroborated that the departmental context must not be disregarded when studying academic entrepreneurship. Whereas research scientists' entrepreneurial intentions are predominantly driven by individual characteristics, departmental differences bring about greater variation than the university as a whole. Second, we found a department's adhocracy culture to be an explanatory factor for intra-university variation in entrepreneurial intentions. Research scientists working in departments with a value system that emphasizes flexibility and that is externally-oriented, have a greater propensity to become an entrepreneur. Ultimately, we built upon trait activation theory to develop insights into the interplay between individual and context, thereby distinguishing departmental from university effects. Specifically, we found that research scientists' proactive personality traits are more likely to lead to entrepreneurial intentions when they are embedded in departments with strong adhocracy cultures. This effect is further enhanced if the university also implements a technology transfer office with a substantial size.

## **6.2. ACADEMIC CONTRIBUTIONS**

This dissertation primarily makes a number of contributions to the *academic entrepreneurship literature*.

First, it enriches the literature by providing insights into the earliest stages of the academic entrepreneurial process. Since most prior studies were aimed at explaining differences in commercialization output or productivity, there is a gap in our knowledge about the processes that precede the generation of patents, licenses, spin-offs and consulting or contract research (Markman et al., 2008; Rothaermel et al., 2007). This dissertation complements existing research by usefully exploring the processes relating to research scientists' nascent entrepreneurial endeavors. In so doing, we also respond to more general calls by Aldrich & Martinez (2001) and Low & MacMillan (1988) to integrate process and context in the study of entrepreneurship.

Second, only recently, scholars have begun to focus on capturing entrepreneurial intentions in an academic context (Goethner et al., 2012; Mosey et al., 2012; Obschonka et al., 2012; Prodan & Drnovsek, 2010). We extend this emerging stream of studies in multiple ways. Specifically, the second study exceeds the narrow definition of spin-off creation and considers a broader range of entrepreneurial activities (Abreu & Grinewich, 2013; Wright et al., 2008). By studying intentions to engage in different forms of academic entrepreneurship, we illuminate how formal (patenting, licensing, spin-offs) versus informal (consulting, contract research) commercialization mechanisms vary in terms of determinants (Klofsten & Jones-Evans, 2000; Link et al., 2007). This specially holds in the case of university culture and climate. Next, in the third study, we introduce spin-off and start-up intentions as distinct constructs with distinct antecedents. Understanding which factors are related to intentions to found a firm initiated within a university setting and based upon university research (spin-off intentions) (Rasmussen & Borch, 2010) versus intentions to set up any type of company (start-up intentions) is particularly relevant from a practical point of view. Theoretically, prior research has shed light on different typologies of spin-offs (e.g., Druilhe & Garnsey, 2004; Nicolaou & Birley, 2003), however the contrast between spin-offs and start-ups has not yet been investigated. Finally, while the current literature is limited to individual-level explanations, this dissertation offers a richer and more grounded understanding of how research scientists' entrepreneurial intentions are also shaped by context, or originate from the interaction between individual and context. Accordingly, we respond to calls by Dohse &

Walter (2012), Fayolle & Liñan (2014), and Lee et al. (2011) to account for contextual factors when studying entrepreneurial intentions.

Third, this doctoral research adds to the literature on academic entrepreneurship by bridging the gap between the micro-level (i.e. individual, team and firm) and the meso-level (i.e. university and TTO) (Djokovic & Souitaris, 2008). Although both levels have received scholarly attention, they have typically been studied in an isolated matter, taking either a micro- or meso-perspective on the phenomenon of academic entrepreneurship (Lockett et al., 2005; Rothaermel et al., 2007). In particular, the first paper provides more fine-grained insights into how TTOs assist pre-founding teams to move forward in the earliest stages of the spin-off process. In the second and fourth dissertation study, we look at direct and indirect influences of the meso-level (e.g., university culture) on outcome variables at the micro-level (e.g., individuals' entrepreneurial intentions). In doing so, we move towards a unifying multilevel framework of academic entrepreneurship, as requested by several scholars (Djokovic & Souitaris, 2008; Lockett et al., 2005; Markman et al., 2008; Rothaermel et al., 2007). At the same time, we also respond to specific calls to analyze how universities contribute to the entrepreneurial process, by means of the activities of their TTOs (Comacchio et al., 2012; Markman et al., 2008) as well as through their culture and rewards (Djokovic & Souitaris, 2008; O'Shea et al., 2005). In sum, our empirical evidence underlines that, although individual research scientists or teams represent integral actors in the commercialization process, they should be studied in accordance with their institutional environment.

The fourth contribution of this dissertation to the academic entrepreneurship literature lies in further unraveling the meso-level or contextual influences. Strikingly, while the entrepreneurial transformation in academia occurs at multiple levels within the organization (Colyvas & Powell, 2006), the vast majority of studies has solely focused on the impact of the university as a whole. Few exceptions have alluded to the importance of the department, with attention allocated to the department chair and workplace peers (Bercovitz & Feldman, 2008; Kenney & Goe, 2004; Louis et al., 1989; Stuart & Ding, 2006), but empirical evidence is scant. This doctoral research extends prior research and our understanding of subunit effects

in two ways. Specifically, using multilevel analysis techniques and unique European data, our fourth study proves that further investigation of departmental influences is warranted, and is at least as important as the university as unit of analysis. In addition, we uncover the presence of subcultures as explanation for intra-university differences in entrepreneurial intentions. Furthermore, our qualitative analysis of Ghent University's hybrid TTO model points out that, in addition to the university and the department, both centralized and decentralized levels of TTOs should be taken into consideration.

Finally, this doctoral research enriches the academic entrepreneurship literature by shedding light on overlooked determinants at the micro-level. In particular, prior research has largely documented personal characteristics (such as entrepreneurial experience and self-efficacy) and social networks as individual-level explanations, but has to this point not explored the impact of passion. The third dissertation study addresses this knowledge gap by borrowing from social psychology literature and studying the "passion orchestra" underlying academic entrepreneurship. The notion of "passion orchestra" refers to research scientists' unique displays of scientific and entrepreneurial passion, dependent upon the salience of their respective role identities. As such, we go beyond prior dichotomous conceptualizations and operationalize the various positions that research scientists embrace on a range from "traditional scientist" to "entrepreneur", which was presented as future research avenue by Jain et al. (2009) and Lam (2010).

In parallel, the collection of papers also contributes to the *entrepreneurship literature in general*.

First, this dissertation integrates theoretical lenses and concepts from the organizational behavior literature in the study of entrepreneurship. To begin, while organizational scholars have emphasized the need for internal and external boundary spanning in other contexts, such as product management (Lyonski, 1985), we introduce the importance of this dual role for intermediaries throughout the entrepreneurial process. Further, subcultures have been recognized as pervasive drivers of human action in organizational behavior research (Adkins & Caldwell, 2004; Boisnier & Chatman, 2003; Hofstede, 1998; Schneider et al., 2013), but

have so far remained largely neglected in the entrepreneurship literature. Our results suggest that additional insights can be gained by considering the culture of subunits in which individuals reside when studying entrepreneurial outcomes.

A second contribution relates to the multilevel approach in the fourth dissertation study. By adopting a cross-level focus and showing that the organizational and subunit context simultaneously shape the expression of individual differences, we provide important evidence of the value of multilevel analysis to understand entrepreneurship, testifying to the gains of this approach, which has been highlighted as one of the most pertinent avenues for future entrepreneurship research (Davidsson & Wiklund, 2001; Shepherd, 2011; Zahra & Wright, 2011). In addition, we contribute to the broader longstanding person-situation debate (Epstein & O'Brian, 1985) by showing how the immediate work environment matters and interacts with personality traits for individuals to become entrepreneurs. Lastly, we also overcome the challenge to theorize multilevel relationships (Kozlowski & Klein, 2000) by drawing upon trait activation theory (Tett & Burnett, 2003).

Third, this doctoral research makes contributions to the emerging literature stream on entrepreneurial passion (Cardon et al., 2009; 2013) by revealing how a person's "passion orchestra", as opposed to passion for entrepreneurial roles exclusively, explains the transition to entrepreneurship. Consequently, our work demonstrates that individuals can hold diverse passions due to different role expectations, which should be studied in chorus to grasp a better understanding of entrepreneurial motivations and behaviors.

### **6.3. PRACTICAL IMPLICATIONS**

The findings presented in the four studies allow us to assess policy issues and develop grounded prescriptions for different parties involved in the phenomenon of academic entrepreneurship. In this final section, we set out the practical implications of the dissertation for respectively university managers and TTOs, public policy makers and department heads.

First, from the perspective of *university management*, that faces the challenge of balancing academic and commercial objectives, this doctoral research presents directions for the implementation of dual structures through (hybrid) TTOs. Specifically, decentralized TTOs should be physically located within departments, i.e. nearby research scientists and teams. In terms of recruitment policies for decentralized TTOs, we recommend hiring employees that are educated and/or experienced in fields close to those of the research teams they are expected to assist throughout the early commercialization process. This is because our findings indicate that geographical and technological proximity steer decentralized TTOs to engage in essential internal boundary spanning activities during the pre-spin-off process. Furthermore, we provide indications on how universities can signal that the development of commercial outputs is a legitimate activity or even an objective, and that it does not compromise a researchers' ability to carry on his or her academic career, in that way stimulating individuals' entrepreneurial intentions. Academic institutions could, for instance, create greater awareness of existing entrepreneurial role models among research scientists, and incorporate entrepreneurship in their mission statements and reward systems. Additionally, our results demonstrate that university managers should not underestimate the impact of the departments. Accordingly, when promoting and supporting commercialization activities, it may be desirable for universities not to invest all resources at the central university level, and to enlarge subunits' autonomy to take initiatives that strengthen the entrepreneurial agenda. Finally, this dissertation draws attention to the vital role of the individual research scientist in the early commercialization process. As a result, university managers and TTOs might benefit from applying a selection effect during the recruitment process and as they allocate their time and funding. In particular, they could actively seek and promote research scientists who possess individual characteristics that are conducive to academic entrepreneurship, for instance those who have high levels of both scientific and entrepreneurial passion. However, at the same time, research scientists with favorable traits should be placed in the right departments in order to set their entrepreneurial traits in motion.

Second, this dissertation offers insights and guidance to *policy makers* who aim to boost the volume of commercial output arising from publicly funded university research. Our

findings indicate that academic institutions can create an environment that fosters entrepreneurial intentions through their culture and climate. Consequently, policy makers could stimulate, or even legally enforce, universities to incorporate entrepreneurial activities as a criterion in their reward systems. Additionally, local and national governments in many European countries have launched a large number of programs to improve the environment for industry-science interaction and spin-off creation, such as TTOs, science parks, incubators, seed capital funds, and business plan coaching and competitions (Phan et al., 2005; Wright et al., 2007). While we acknowledge the value of investments in such initiatives and infrastructure, our results also suggest that gains could arise out of a partial reallocation of resources from the central university level to the department level.

Finally, this doctoral research also provides some practical directions for *department heads*. In order to stimulate academic entrepreneurship among the research scientists within their department, they could create an externally-oriented culture where trying new things and prospecting for opportunities is valued. This could involve exposing staff to activities and environments in which they are more likely to encounter challenges which can encourage the enactment of entrepreneurial traits (e.g., entrepreneurship training, participation in university innovation clusters, partnerships with other departments or institutions). Furthermore, adopting a leadership style that exemplifies an outward focus, innovation and risk-taking may stimulate department members to exhibit similar behavior.

#### 6.4. REFERENCES

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