

THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Human Capital, Social Networks and New Firm Formation

- The Role of Academic and External Entrepreneurs in University Spin-offs

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Gothenburg, Sweden 2018

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ISBN 978-91-7597-689-1

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Doktorsavhandlingar vid Chalmers tekniska högskola  
Ny serie nr 4370  
ISSN 0346-718X

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Cover:

The Åbron bridge in the city of Värnamo. Värnamo is often called ‘marknadsstaden’ (the city of markets) owing to its tradition of hosting several markets each year. The author grew up in the city. Åbron illustrates the bridge across ‘the valley of death’ (p. 11) because it was a very important road to the marketplace in the city centre.

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Gothenburg, 2018

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ABSTRACT

There is a debate about the development and performance of university spin-offs, i.e. firms created to commercialize university knowledge. Teams of academic entrepreneurs (researchers) create most of these firms, but external entrepreneurs who come from outside the universities and have not necessarily developed the technology can create higher performance. However, knowledge about academic and external entrepreneurs' human capital and social networks are underdeveloped. The purpose of this thesis is to develop a conceptual framework of the imprints of academic and external entrepreneurs' human capital and social networks on the formation and development of university spin-offs. The thesis contains five research papers investigating the characteristics and performance of university spin-offs, academic and external entrepreneurs' human capital, and social networks and entrepreneurial team formation. The thesis employs a survey design in two papers and a case study design in three papers.

Paper 1 shows that networking with parent universities contributes to developing breakthrough technologies and employing university graduates. Paper 2 shows that university spin-offs with mixed (academic and industry) origins imprint long-term performance and that external entrepreneurs have the highest long-term performance. Paper 3 shows three types of external entrepreneurs, who influence firm formation in a different way than academic entrepreneurs do. Paper 4 shows that academic and external entrepreneurs produce similar and different network content, network governance and network structure. Paper 5 shows that academic and external entrepreneurs create different types of entrepreneurial teams. The thesis contributes to entrepreneurship research by: adding to the theory of organizational imprinting; extending research on human capital and social networking complementarity; extending entrepreneurial team research and nuancing the types of entrepreneurs in university spin-offs. The thesis ends with implications for researchers and policymakers.

Keywords: academic entrepreneurs, entrepreneurial team, external entrepreneurs, human capital, organisational imprinting, social networks, university spin-offs

## LIST OF PUBLICATIONS

This thesis is based on the work contained in the following papers:

- I Billström, A., Gabrielsson, J., and Politis, D. (2018). Technology Entrepreneurship and Economic Evolution: The Role and Contribution of University spin-offs in the Regional Innovation System of Scania (Sweden). The paper is presented at the 18th Nordic Conference on Small Business Research (NCSB), entitled 'Entrepreneurship and Welfare', 18–20 May 2014, Bodø, Norway.

Authors' contributions: The first and second authors jointly generated the idea of the paper, collected and analysed the data and wrote most of the paper. The third author conducted a literature review for the frame of reference and took part in the writing process of the analysis and conclusions.

Status: The second author has re-submitted the paper to an international journal.

- II Lindholm-Dahlstrand, Å, and Billström, A. (2017). Corporate and University spin-offs: A Study of Long-term Performance. The paper is presented at the conference on 'Innovations, Entrepreneurial Universities and Economic Development', organized by Entreprenörskapsforum, 17–18 May 2013, Lund, Sweden.

Authors' contribution: The first author generated the idea of the paper and collected the data from 1997. The second author collected the data for 2011. The first and second authors analysed the data jointly for the conference paper version. The first and second authors wrote the paper. The first author analysed the data of the post-conference paper version.

Status: The first author has submitted the paper to an international journal.

- III Billström, A. (2017). Academic and External Entrepreneurs' Human Capital in the Formation of University spin-offs. The paper is presented at the Triple Helix 11th International Conference, 8–10 July 2013, London, United Kingdom.

Author's contribution: The author conducted all work related to this paper.

Status: The author has re-submitted the paper to an international journal.

- IV Billström, A., Politis, D. and Gabrielsson, J. (2014). Entrepreneurial Networks in University spin-offs – An Analysis of the External-entrepreneur model.

Authors' contribution: The authors jointly generated the idea for the paper based on feedback of a previous paper presented by the first author. The second and third authors wrote the introduction, the frame of reference and the analysis. The first author collected all the data from the four firms based on six interviews, annual reports and firm documents as well as firm websites. The first author wrote the method and case descriptions. All authors worked jointly on the conclusions and implications.

Status: The paper is published in the RENT XXVI, Research in Entrepreneurship and Small Business Anthology Entrepreneurship, people and organizations, edited by R. Blackburn (Cheltenham: Edward Elgar, 2014).

- V Billström, A. (2018). The Formation of Entrepreneurial Teams in University spin-offs – A Case Comparison of Academic and External Entrepreneurs. The paper is presented at the RENT XXVII, Research in Entrepreneurship and Small Business Conference, 20–22 November 2013, Vilnius, Lithuania, and awarded with the Journal of Small Business Management (JSBM) Best Conference Paper Award.

Author's contribution: The author conducted all work related to this paper.

Status: The author has submitted the paper to an international journal.

## ACKNOWLEDGEMENT

The work of a PhD is a challenging and large task spanning several years. However, with supervisors, colleagues, friends, family and entrepreneurs, it has been a fun and rewarding journey. I am deeply grateful to a number of people and organizations who have been important pieces in my work.

To, my supervisors, thank you very much for believing in me and contributing to my personal and professional development during this process. Åsa Lindholm-Dahlstrand, who signed me up to the PhD program and was my main supervisor: I am very grateful for the shared ideas, knowledge and practical advice. The encouragement at important times, informal guidance and invitation to the Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University, were very important. Diamanto Politis, assistant supervisor: I am very grateful for thorough, sharp and constructive feedback on manuscripts, in discussions and through presentations. The genuine interest in research was inspiring. Mats Lundqvist, assistant supervisor: I am very grateful for challenging, critical and thoughtful questions on ideas, manuscripts and presentations. The questions and comments have made me think and later reflect from both practical and theoretical views.

I am sincerely thankful to a number of other people, some of whom current or past colleagues in the Knowledge Entrepreneurship and ENterprise (KEEN) research group. You have made this journey interesting and fun. I am deeply grateful to: Jonas Gabrielsson, for knowledge, inspiration and friendship at all times; Göran Svensson, for generosity, knowledge and energy over the years; Marcus Holgersson, for friendship and discussions at Chalmers; Helene Laurell, for the many fun days and late evenings of hard work (many of those in the car); Jan-Olof Muller, for friendship and wise thoughts during hours on roller-skis; Bengt Kjellgren, for friendship and discussions on and off duty; Ingemar Wictor, for curiosity and genuine interest in people; Jenny Ståhl, for commitment to pedagogy and lots of fun; Pia Ulvenblad, for support and commitment to the incubator project; Eva Berggren, for inspiration and critical reflections on our topic; Joakim Winborg, for farsighted and thoughtful reflections; and Marita Blomqvist, for inspiration and encouragement. I am very thankful for feedback on papers and presentations. Arne Söderbom, Bernd Hofmaier, Magnus Holmen, Mike Danilovic, Svante Andersson: all of you have given me important pieces for the research puzzle.

I am also thankful to the other current and past members of the Centre for Innovation, Entrepreneurship and Learning (CIEL), the Halmstad Research School in Entrepreneurship and Health at Halmstad University and colleagues in the corridor at the School of Business, Engineering and Science (Halmstad University) and CIRCLE (Lund University). You have inspired and supported me along the way.

My gratitude also goes to four very important persons in the process: Lise Aaboen and Navid Ghannad, who provided valuable feedback on my research proposal; Caroline Wigren, who asked critical questions and gave constructive feedback on my licentiate seminar; and Einar Rasmussen, who thoroughly discussed my manuscript at the end seminar.

The administrative support at Halmstad University and Chalmers University of Technology has also been very helpful. My special thanks go to Anders Sanell, Eva Inghammar and Jennie Törnblom (Halmstad University), who always found slots in the schedule and made my life manageable. My special thanks also to Yvonne Olausson (Chalmers University of Technology) for support and guidance in the preparation for the licentiate seminar and the doctoral defence.

My gratitude goes to the entrepreneurs who have shared their personal and life experience, thoughts and learnings during hours of interviews. Your generosity and great stories are a large and very important part of this work.

I would like to thank Stiftelsen för Kunskap och Kompetensutveckling (KK Stiftelsen) and Verket för Innovationssystem (Vinnova) for the financial support of my work. My sincere gratitude to Hugh Jackson, for expertise and professional work on proof reading manuscripts.

I am also thankful to my new colleagues at Nord University, who generously opened the door to sources of opportunities. You have inspired and supported me to look beyond this thesis.

Most importantly, I want to express my gratitude to my family. To my life-partner, Angeliqa, you are my love and joy. Our kids, Millie and Melwin, your curiosity and happiness are an invaluable source of inspiration. To my parents, Ing-Britt and Inge, your genuine curiosity for knowledge and true positive view of life are always present. To my sister Ulrika and her husband Peter, your love of adventure and encouragement have inspired me. Gunnel, Ingemar and Lisbeth, you are always helpful and supportive.

## TABLE OF CONTENTS

1. INTRODUCTION .....	1
2. RESEARCH PROBLEM .....	4
2.1 Relation to the general entrepreneurship literature.....	4
2.2 Specifying the research problem .....	7
2.2.1 Imprinting and new firm formation .....	8
2.2.2 Human capital and social networking.....	10
2.2.3 Academic entrepreneurs and external entrepreneurs in university spin-offs.....	13
2.3 Overall research question and purpose of the thesis.....	15
2.4 Five studies of university spin-offs .....	15
3. FRAME OF REFERENCE .....	17
3.1 Entrepreneurship studies comparing university spin-offs and corporate spin-offs ...	17
3.1.1 Motivation to study university spin-offs and corporate spin-offs.....	17
3.1.2 Characteristics of university spin-offs and corporate spin-offs .....	19
3.1.3 Performance of university spin-offs and corporate spin-offs .....	20
3.2 Academic entrepreneurs and external entrepreneurs in university spin-offs.....	23
3.3 The role of human capital and social networking in entrepreneurship.....	25
3.3.1 The role of human capital in entrepreneurship .....	26
3.3.2 The role of social networking in entrepreneurship .....	31
3.4 The formation of new firms .....	38
3.4.1 Firm transition between development phases .....	38
3.4.2 Entrepreneurial team formation and performance .....	43
3.5 Arriving at the research questions .....	47
4. RESEARCH METHODOLOGY AND RESEARCH DESIGN .....	50
4.1 Basic assumptions.....	50
4.1.1 Ontological assumptions .....	50
4.1.2 Epistemological assumptions.....	51
4.2 Research context and design.....	51
4.2.1 Study context .....	52
4.2.2 Research questions and research methods .....	54
4.3 Empirical and analytical/theoretical generalization .....	56



5	SUMMARY OF APPENDED PAPERS .....	58
6	DISCUSSION AND CONCLUSION .....	64
6.1	Theoretical and empirical contributions to entrepreneurship research.....	64
6.1.1	Typical characteristics and long-term performance of university spin-offs .....	64
6.1.2	The combination of human capital and social networking of university spin-offs	69
6.1.3	Entrepreneurial team formation of university spin-offs.....	76
6.1.4	The role of external entrepreneurs in university spin-offs.....	82
6.2	Limitations and future research .....	83
6.3	Implications for policymakers .....	86
7	REFERENCES .....	89

#### LIST OF FIGURES

Figure 1: Mainstream entrepreneurship research on human capital and social networking ....	11
Figure 2: The role of human capital and social networking in firm formation and performance.....	12
Figure 3: The role of academic entrepreneurs' and external entrepreneurs' human capital and social networks in university spin-off formation.....	49

#### LIST OF TABLES

Table 1: Characteristics of the academic environment and the industry environment .....	18
Table 2: Stereotypical characteristics of academic entrepreneurs and external entrepreneurs .....	24
Table 3: The relationship between the five papers and the eight research questions.....	48
Table 4: Typical characteristics of university spin-offs and corporate spin-offs.....	65
Table 5: Long-term performance of university spin-offs and corporate spin-offs.....	67
Table 6: Types and use of human capital in firm transition between development phases .....	71
Table 7: Academic and external entrepreneurs' social networking in university spin-offs.....	73
Table 8: Entrepreneurial team composition in university spin-offs .....	77



To My Family



## 1. INTRODUCTION

Entrepreneurship is a driving force in society and an important link between investment in new knowledge and technologies and economic growth. Two central questions in entrepreneurship are how and why new firms develop and perform. Researchers have tried to address these questions by investigating for example economic and technological conditions, institutional factors and organizational and individual characteristics.

University spin-offs, which are new firms created to commercialize university knowledge, are especially interesting in this respect. These firms are often more innovative than other technology-based firms such as spin-offs from corporations (Lindholm Dahlstrand, 2008) and they create higher economic value than licensing and patenting alone (Bray and Lee, 2000). Studies of US university spin-offs show that these firms create new jobs, develop breakthrough technologies, generate tax income and contribute to regional development (Shane, 2004). These firms also employ university graduates, become a role model for other entrepreneurs and commercialize university technologies, which otherwise would have remained in academia. In contrast, studies of European university spin-offs indicate that most of these firms remain small, grow slowly (Mustar, Wright and Clarysse, 2008) and do not perform in the same way as corporate spin-offs.

A very popular topic in entrepreneurship research is to study the entrepreneur because their actions reflect the behaviour of the firm. Entrepreneurs are important because they are responsible for firms' operations, they get things done and they propel firm development forward. Entrepreneurs also bring in human capital (i.e. knowledge and skills) and social networks to the new firm that can influence firm development and performance (Simsek, Curtis Fox and Heavey, 2015). However, most entrepreneurship research has investigated human capital and social networks separately, in small and medium-sized firms and in relation to firm performance. These studies show mixed empirical findings and create a narrow understanding of the firm development process.

This thesis addresses the debate about new firm development and performance by investigating the characteristics and performance of university spin-offs. This thesis also investigates academic and external entrepreneurs' human capital and social networks. The basic idea is that

entrepreneurs' human capital and social networks, acquired in prior employment, influence the formation and performance of the new firms.

University spin-off studies have mainly investigated academic researchers in the role of academic entrepreneurs. Academic entrepreneurs do not always have the ability or motivation to engage in university spin-offs (Berggren, 2011). One reason for this is that they have extensive technology human capital and research networks but varying degrees of business human capital and industry networks (Mosey and Wright, 2007). Another reason is that firm incubators have the challenge of providing the necessary technology and commercial resources to create viable firms (Peters, Rice and Sundarajan, 2004). These shortages create 'the valley-of-death', that is, the gap between technology and commercial resources (Barr, Baker, Markham and Kingon, 2009). However, external entrepreneurs, also called surrogate entrepreneurs, are likely to have complementary human capital and social networks because they come from outside the university and have not necessarily developed the technology but founded university spin-offs. They can create higher revenue and growth than other entrepreneurs (Lundqvist, 2014) but knowledge about the role of their human capital and social network is underdeveloped.

This thesis also addresses policy debates. Helene Hellmark Knutsson, the Swedish Minister of Education and Research, stated at the Innovation and Technology Forum 2015:

'not every scientist should be forced into becoming an entrepreneur. There will always be scientists who come up with new ideas and produce excellent research, but for different reasons do not want to take their projects outside academia. That is why there needs to be ways in which their discoveries can be picked up by other actors in the innovation system.' (Hellmark Knutsson, 2015)

To sum up, this thesis provides theoretical and policy relevant knowledge of new firm formation and performance in general and university spin-offs in particular. This thesis identifies typical characteristics and performance of university spin-offs and clarifies the role that the academic and industry environments have in firm formation and performance. This thesis also investigates the combined role of human capital and social networks of academic and external entrepreneurs in the early phases of university spin-offs and addresses the debate about how and why new firms develop and perform while other firms remain small.

The thesis includes five research papers, which this overall text discusses. This text aims to identify and discuss the overall contributions of the five research papers for researchers and policymakers. The first research paper compares university spin-offs with corporate spin-offs in terms of firm characteristics, such as networking with the university, and firm development phases. The second paper compares university spin-offs and corporate spin-offs in terms of entrepreneurial origin (i.e. previous employment) and firm performance. The third paper investigates the social networking of academic and external entrepreneurs. The fourth paper explains the role of the human capital of academic and external entrepreneurs in the transition between development phases. The fifth paper analyses the role of academic and external entrepreneurs in entrepreneurial team formation.

The outline of this overall text unfolds as follows. The ‘research problem’ chapter relates the topic of this thesis to the general entrepreneurship literature and identifies the research problem of the thesis. The ‘frame of reference’ chapter generates specific research questions for each paper based on prior entrepreneurship studies and summarizes these in a conceptual framework. The ‘methodology’ chapter discusses the ontological and epistemological assumptions, the research design and the generalization of the study. The ‘summary of the appended papers’ chapter presents an overview of the five appended papers. Finally, the conclusion discusses the contributions, limitations and implications for researchers and policymakers.

## **2. RESEARCH PROBLEM**

In this chapter, the research problem is specified and related to the entrepreneurship literature. The first section explains the position of this thesis in relation to the general entrepreneurship literature. In the second section, the research problem is specified and related to entrepreneurship literature in general and to university spin-off research in particular. The third section presents and explains the purpose of the thesis.

### **2.1 Relation to the general entrepreneurship literature**

Entrepreneurship researchers have defined entrepreneurship in several ways, but it commonly refers to an individual who creates a new firm (Shane and Venkataraman, 2000). This process has been named in various ways, such as ‘business gestation’ (Alsos and Kolvereid, 1998), ‘firm formation’ (Shane, 2001), ‘new venture creation’ (Gartner, 1985) and ‘new venture gestation’ (Liao and Welsch, 2008). The concept I will use in this thesis is ‘firm formation’ because it refers to the organizational arrangements by an entrepreneur of technology-based firms (see Shane, 2001).

Researchers from different disciplines such as economics, sociology and psychology have contributed to entrepreneurship research in different ways. Entrepreneurship research is therefore a multidisciplinary research field; some researchers even argue that this field lacks an integrated theory (Shane and Venkataraman, 2000; Phan, 2004) and that university spin-off research is an atheoretical stream of research (Nicolaou and Birley, 2003b; Shane, 2004). Therefore, this thesis uses a combination of existing theories that originate from different disciplines to develop a new conceptual framework regarding the formation of university spin-offs. This section discusses theories in entrepreneurship research in relation to the topic of the thesis. The intention is to position this thesis in relation to the main perspectives in entrepreneurship research and not to provide a complete review of entrepreneurship research.

Economic theory treats entrepreneurship as the main engine in economic development. Economists view the entrepreneur as a function that changes the economic system by introducing new goods or services, a new production method, a new market, a new source of supply and new organizational forms (Schumpeter, 1934). Economists have also seen the entrepreneur as an alert and creative producer who discovers profitable opportunities earlier



than others do, when the equilibrium between supply and demand changes (Kirzner, 1997). This thesis acknowledges that entrepreneurs can contribute to economic development if they successfully carry new technologies to the market via the creation of spin-offs. However, economic theory cannot explain the influence of the environment on firm formation.

Studies on the influence of the environment on new firm formation originate in sociology research. In entrepreneurship research, sociologists have taken into account several different levels of analysis, including nations, industries, regions and networks. Population ecology theory, also called organizational ecology theory, is an example of a theory that concerns the population of firms and proposes that new firms compete against others for resource niches and that natural selection determines the number of firms in the population (Hannan and Freeman, 1977). Institutional theory concerns the rules, procedures, formal control, social norms and culture of existing groups and organizations, which the entrepreneur is expected by institutions to follow (Bruton, Ahlstrom and Li, 2010). For example, policy decisions can either support the entrepreneur to create new firms or inhibit them from doing so (Moray and Clarysse, 2005). Another stream of studies is literature on social networking. This literature holds that entrepreneurs and new firms are embedded in social networks and relations with actors outside the firm that are important to acquire vital resources (Hite and Hesterley, 2001). Other researchers concern market actors, such as customers, suppliers and competitors, and their influence on the recognition and exploitation of opportunities (e.g. Webb, Ireland, Hitt, Kistruck and Tihanyi, 2010). Academic actors, such as faculty, researchers, graduate students, technology transfer officers, university administrators and non-academic actors, venture capitalists, industry partners, advisors and company researchers, are key network actors in university spin-offs (Hayter, 2016). This thesis acknowledges that firms who develop, and those who not develop, can be seen from a population ecology perspective or from an institutional perspective but these perspectives do not explain the role of the entrepreneur. Therefore, this thesis investigates the role of social networking in university spin-off formation. However, these actors do not take the leading role in the firm formation process per se. To create a more comprehensive picture of university spin-off formation it is important to investigate the role of the entrepreneur.

Studies of the entrepreneur have utilized psychological theories that consider the entrepreneur as an individual with typical entrepreneurial characteristics, which influence new firm formation. Entrepreneurs have a moderate risk-taking propensity but they are not significantly

different from non-entrepreneurs (Brockhaus, 1980). Entrepreneurs also have a high ‘need for achievement’ because the task itself, rather than financial return, motivates them (McClelland, 1961). In contrast, other researchers (e.g. Cassar, 2007) claim the opposite: that financial reward is important for entrepreneurial motivation. Studies have also investigated internal and external locus of control of entrepreneurs and non-entrepreneurs without finding any significant differences (Brockhaus, 1982). Other researchers concern the entrepreneur, use human capital theory (e.g. Marvel, 2011; De Cleyn, Braet and Klofsten, 2015) and investigate the influence that entrepreneurs’ previous education and work experience have on firm performance such as firm growth (Cooper, Gimeno-Cascon and Woo, 1994). Other studies (e.g. Delmar and Shane, 2006) concern not only the characteristics of entrepreneurs but also characteristics of entrepreneurial teams.

This thesis investigates the entrepreneur and entrepreneurial firms for four reasons. The entrepreneur gets things done (Schumpeter, 1934); the behaviour of the firm is a reflection of the entrepreneur’s action (O’Shea, Allen, O’Gorman and Roche, 2004); the firm often reflects the entrepreneur’s background and experience (Boeker, 1988); and psychological theories are not useful to explain the actions taken by the entrepreneur (Gartner, 1988). This thesis uses the human capital theory because there is a debate over whether it influences firm performance or not and it links task-specific activities of the firm to the entrepreneur’s human capital and (Marvel, Davis and Sproul, 2014). This thesis also uses social networking literature because there is a debate over whether or not it influences firm performance. This thesis also uses social network literature to investigate the contents, coordination and ties to academia and industry to get a more comprehensive picture of networking compared to investigating only one of these aspects (Hoang and Antoncic, 2003). This thesis also uses research on entrepreneurial teams because a group of researchers most often takes the role of the entrepreneurial team and create university spin-offs (Roberts, 1991). However, studies on human capital, social networking and entrepreneurial teams are not enough to explain the formation of university spin-offs because they have not addressed the firm formation process itself.

Management researchers have used life cycle theory to explain phases or stages of firm development (Bhave, 1994). In particular, entrepreneurship researchers and university spin-off researchers have investigated the formation process of new firms by using life cycle theory (e.g. Bhave, 1994; Rasmussen, 2011). From this point of view, entrepreneurship is a development process that contains phases of tasks and critical passages that the entrepreneur or the

entrepreneurial team need to cross to reach the market. Hence, this thesis uses life cycle theory to explain how and why new firms can develop and perform while other firms remain small.

In addition, some studies in the university spin-off context also concern characteristics of the technology. The radicalness of the technology, the importance of the technology and the scope of the patents influence the likelihood that an inventor will exploit the invention through the creation of a new firm (Shane, 2001). An immature technology can also hinder the commercialization process (van Burg, Georges, Romme, Gilsing and Reymen, 2008). Since technology development is a great challenge for academic entrepreneurs, this thesis focuses on the entrepreneurial challenge of crossing the ‘valley of death’, that is, bridging academia and industry to commercialize the university knowledge at a market. Hence, this thesis concerns the business development process rather than the technology development process. The technology is an important source of customer value but it does not explain the role of the entrepreneur or their human capital and social networks in the formation of entrepreneurial teams, which is the focus of this thesis.

Taken together, this thesis combines literature on human capital and social networking to explain three main and interlinked challenges in the university spin-off context. These challenges are the transition between development phases, entrepreneurial team formation and firm performance. To achieve this, this thesis compares university spin-offs with corporate spin-offs regarding (a) firm characteristics such as networks with the university and (b) firm performance. This thesis also compares academic entrepreneurs and external entrepreneurs in terms of (c) social networking, (d) firm transition between development phases and (e) entrepreneurial team formation in university spin-offs. The next section specifies the overall research problem.

## **2.2 Specifying the research problem**

This thesis addresses human capital and social network studies in entrepreneurship research in general and the role of academic entrepreneurs and external entrepreneurs in university spin-offs in particular. This section specifies the general research problem, which is the knowledge gap relating to the role and imprints of academic entrepreneurs’ and external entrepreneurs’ human capital and social networks in university spin-off formation and development. This section specifies the research problem by discussing studies that concern (a) imprinting theory

and new firm formation, (b) human capital and social networking literature and (c) academic entrepreneurs and external entrepreneurs in university spin-offs. It is important to investigate the role of human capital and social networks in new firm formation to extend our knowledge of how and why new firms develop and perform.

### **2.2.1 Imprinting and new firm formation**

This thesis focuses on new firm formation in general and university spin-off formation in particular. One reason for this is that the environment in which the firm and the entrepreneur originate can influence the subsequent development and performance of the firm (Boeker, 1989; Simsek et al., 2015). Investigating critical factors in new firm formation can therefore explain how and why new firms develop and perform. Another reason is that most entrepreneurship research has investigated small and medium-sized firms, while knowledge about new firm formation in general (Davidsson and Wiklund, 2001; Phan, 2006) and university spin-offs in particular is limited (Druilhe and Garnsey, 2004; De Cleyn, Braet and Klofsten, 2015). Consequently, the theory of organizational imprinting inspires the overall idea of this thesis.

The basic idea of organizational imprinting is that organizations pass through periods in which they are sensitive to influences from the environment (Boeker, 1988). In this way, firm and entrepreneurial characteristics reflect environmental factors and they are persistent to future changes (Marquis and Tilcsik, 2013). However, a firm can experience several short and sensitive periods, after the initial formation process, when the environment can imprint the firm a second time, a third time or even more. The second and later imprints become a layer with blueprints above the initial imprints. Thus, the initial firm formation process can contain one or several sensitive periods similar to later phases of firm development, which also can contain one or several sensitive periods of imprints. Although imprinting theory holds that entrepreneurial imprints have long-lasting effects on the firm (Simsek et al., 2015), imprints might diminish over time (Marquis and Tilcsik, 2013).

The definition of organizational imprinting is ‘a process whereby, during a brief period of susceptibility, a focal entity develops characteristics that reflect prominent features of the environment, and these characteristics continue to persist despite significant environmental changes in subsequent periods’ (Marquis and Tilcsik, 2013, p. 199). A recent literature review proposes that several elements, such as the individuals, the team and the social network, imprint

future individuals, teams, organizations and social networks of the new organization (Simsek et al., 2015). These elements imprint the organization either in proximal terms (e.g. new market entry, learning and legitimacy) or in distal terms (e.g. survival, growth and innovation).

There is a need to theorize the role of the entrepreneurial team and the leading entrepreneur of the team in phases of new firm formation (Marquis and Tilcsik, 2013; Simsek et al., 2015). Literature on organizational imprinting is limited to imprints of the firm's initial characteristics on firm strategy (Boeker, 1989) and functional composition of entrepreneurial teams on subsequent composition of board of directors (Beckman and Burton, 2008). Other studies focus narrowly on the imprints of entrepreneur's experience on firm initial strategy (Boeker, 1988), their prior employment on firm strategy and external financing (Burton, Sørensen and Beckman, 2002) and their experience on decision-making (Mathias, Williams and Smith, 2015). Researchers speculate that the interaction and interplay between individuals, such as entrepreneurs in a team, can imprint different entities within the organization but there is a need to investigate these speculations (Simsek et al., 2015).

In addition, university spin-off studies have so far only reported on the imprints in the dyad between a parent firm and its offspring (Ciuchta, Gong, Miner, Letwin and Sadler, 2016). They have also investigated the reimprinting process in university spin-offs, that is, the development of firm characteristics based on learning and response to market feedback while retaining parental blueprints (Ferriani, Garnsey and Lorenzoni, 2012). Hence, this thesis further builds on these few spin-off studies by focusing on the human capital and social networks that the entrepreneur brings to the entrepreneurial team and the new firm. Thus, this thesis does not investigate in itself the environment from where the entrepreneurial characteristics originate.

To sum up, it is likely that university spin-offs and corporate spin-offs have different characteristics, development and performance because they originate in two different environments: academia and industry. Thus, it is also likely that academic entrepreneurs and external entrepreneurs influence firm formation differently because they have acquired their human capital and social network inside and outside academia respectively.

### **2.2.2 Human capital and social networking**

Previous entrepreneurship studies that combine human capital theory and social networking literature are rare because studies usually relate to either human capital theory or social networking literature in separate studies. To provide an overview of the existing studies, I divided these studies into four categories according to whether they investigate the influence of: human capital on social networking; social networking on human capital; human capital and social networking on firm performance; or human capital and social networking on aspects other than firm performance.

The first type of study draws on the access perspective and suggests that human capital can increase access to social networks (Semrau and Hopp, 2015). Some researchers have found that human capital increases the likelihood of gaining support from both strong and weak network ties (Brüderli and Preisendorfer, 1988) and increase the propensity to utilize social networks (Zhang, Souitaris, Soh and Wong, 2008). Entrepreneurs with entrepreneurial experience can bridge more structural holes than less-experienced entrepreneurs (Bhagavatula, Elfring, van Tilburg and van de Bunt, 2010). Academic entrepreneurs with start-up experience have broader social networks and develop network ties more effectively compared to academic entrepreneurs who do not have start-up experience (Mosey and Wright, 2007). Hence, it is clear that a firm's human capital can influence its social networking.

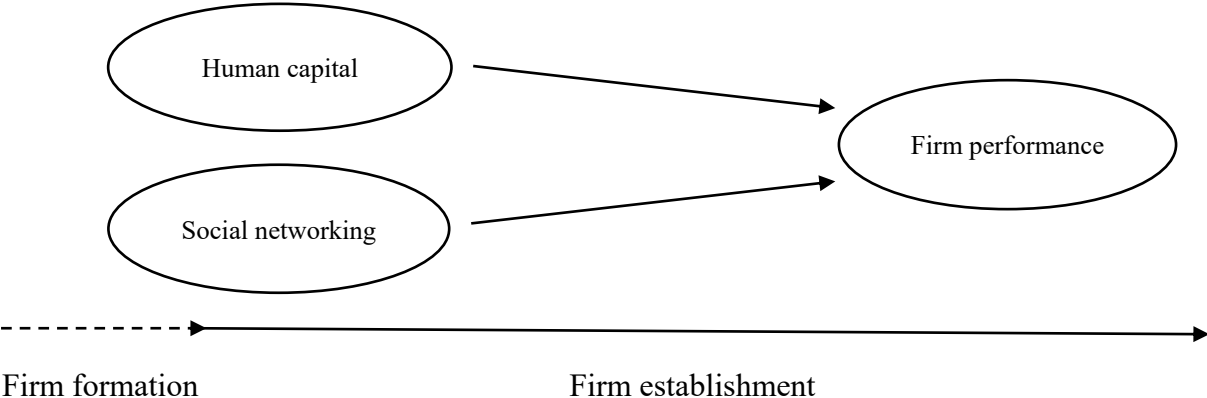
The second type of study indicates that social networking can increase firms' human capital. A firm's social networking specifically increases the knowledge of the board of directors (Bjørnåli and Gullbrandsen, 2010). Similarly, social networking with external entrepreneurs can also provide access to commercial experience (Rashid, Abro and Bhutto, 2011). In these ways, social networking compensates for, and hence can influence, new firms' lack of human capital (Semrau and Hopp, 2015).

The third type of study draws on the utilization perspective and suggests that human capital and social networks have either a complementary or a compensatory role (Semrau and Hopp, 2015). The complementary model suggests that human capital and social network add to each other, while in the compensatory model suggests that human capital and social network are redundant or do not add to each other. Researchers have investigated the effects of human capital and social networking on firm performance. Such studies support the complementary model by

indicating that some types of human capital and social networking are important for a variety of performance measures, including firm survival (Cooper et al., 1994), firm productivity (Greve, Benassi and Sti, 2010) and firm growth (Kor and Sundaramurthy, 2008; Scholten, Omta, Kemp and Elfring, 2015). However, research also supports the compensatory model by showing that other types of human capital and social networking have a negative effect on firm growth (Cooper et al., 1994). This implies that the effects of human capital and social networking on firm performance are not clear. Hence, it is reasonable to investigate the role of human capital and social networking on (a) firm performance to clarify these relationships and (b) new firm formation process as they imprint firm development and performance.

The fourth type of study investigates the role of human capital and social networking on a variety of factors in new firm formation. Entrepreneurial human capital and networking with industry partners are important to generate business ideas (Obschonka, Silbereisen and Schmitt-Rodermund, 2012). Human capital, in terms of industry experience and entrepreneurial experience and networking with government, research institutes, industry partners and family members, increases the likelihood of recognizing opportunities (Hsiao, Hung, Chen and Dong, 2013). Some types of human capital and social networks can also benefit the entrepreneur to recognize and exploit opportunities (Davidsson and Honig, 2003). This means there is scarce knowledge about the role of human capital and social networking on factors in the firm formation process. Figure 1 is a simplified illustration of prior entrepreneurship research on human capital and social networking.

Figure 1: Mainstream entrepreneurship research on human capital and social networking

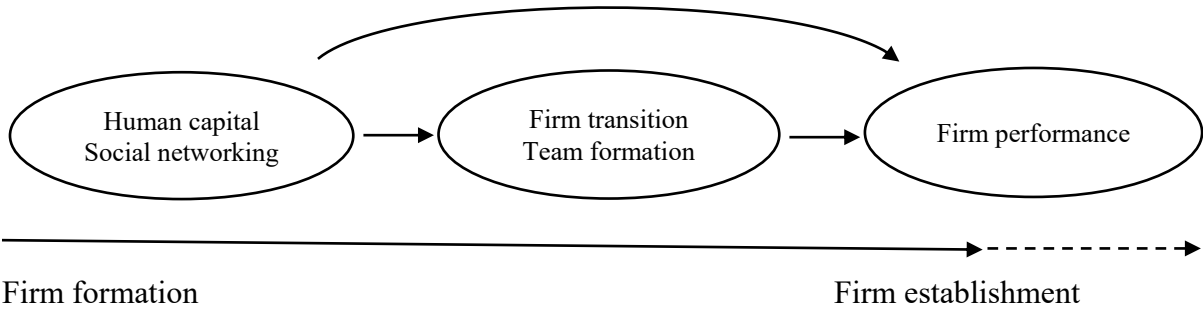


University spin-offs have the challenge of crossing the valley of death, which is the gap between technology and commercial resources (Barr, Baker, Markham and Kingon, 2009). Researchers

have also identified similar and more detailed critical events, called critical junctures, which these firms struggle to overcome (Vohora et al., 2004). These critical junctures are challenges for opportunity recognition, entrepreneurial commitment, market credibility and financial sustainability. University spin-offs have these challenges because academic researchers, with limited commercial human capital and industry networks, create most of these firms (Roberts, 1991). Another reason is that these firms emerge in a research-intensive academic environment that is traditionally not commercial (Vohora et al., 2004). The lack of necessary business and technology resources in firm incubators can also explain these challenges (Peters, Rice and Sundararajan, 2004). Overall, university spin-offs have two particular challenges: making the transition between development phases and creating an entrepreneurial team with industry and start-up human capital and industry networks.

In the university spin-off context it is clear that industry, start-up and technology human capital and social network covering both the research community and the business community are important for firm formation. Research shows that marketing experience, research and development (R&D) experience and collaboration with universities and research institutions increase the speed of innovation (Heirmann and Clarysse, 2007). Invention experience and past collaboration with industry have a positive effect on the exploitation of entrepreneurial opportunities (D’Este, Mahdi, Neely and Rentocchini, 2012). Hsu (2007) showed that entrepreneurial experience and social networks of MIT firms also increase venture capitalists’ valuations and funding. Other studies also show that human capital and social networking influence firm success and failure (Shane and Stuart, 2002). Hence, there are some empirical indications that industry and technology human capital and industry and research networks are important for the formation of university spin-offs, but the combined role in firm transition between development phases and entrepreneurial team formation is less known (see Figure 2).

Figure 2: The role of human capital and social networking in firm formation and performance





Taken together, the studies indicate that human capital and social networks can influence each other, firm performance and several factors in the early phases of firm formation. While entrepreneurship researchers have paid much attention to investigate human capital and social networking in separate studies, there is limited knowledge of the additional value of both these characteristics in the new firm formation process (Bhagavatula et al., 2010; Semrau and Hopp, 2016). There is also limited knowledge of the role of different types of entrepreneurs in the transition between the development phases and in entrepreneurial team formation. Hence, the role of the entrepreneur is important to discuss.

### **2.2.3 Academic entrepreneurs and external entrepreneurs in university spin-offs**

University spin-off studies have almost exclusively investigated academic researchers taking the role of academic entrepreneurs, while there is very limited knowledge of the role of external entrepreneurs, who in the entrepreneurship literature are sometimes called surrogate entrepreneurs. Academic entrepreneurs typically have a range of scientific knowledge, knowledge of laboratory techniques and expertise in developing scientific strategies (Murray, 2004). They also get crucial and complex technical information and advice and scientific advisory board members. They also network more with typical academic contacts such as faculty researchers, graduate students, technology transfer officers (TTOs) and university administration support than with non-academic contacts such as advisors, full-time managers and company researchers (Hayter, 2016). Academic entrepreneurs are important for solving R&D tasks and building networks with the research community (Mosey and Wright, 2007).

Recent studies indicate that external entrepreneurs can create higher revenue and sales growth than other entrepreneurs (Lundqvist, 2014). External CEOs have also a positive effect on firm success (Hayter, 2013) but the role of their human capital and social network in this relationship and in university spin-off formation is unexplored. Since external entrepreneurs come from outside the university, it is reasonable to believe that they have acquired types of human capital and social networks that are different from those of academic entrepreneurs. Empirical findings indicate that academic entrepreneurs prefer public sources of finance such as grants and government soft loans, while external entrepreneurs prefer private sources of finance such as venture capitalists and business angels (Politis, Gabrielsson and Shvekina, 2013). Hence, it is also likely that they benefit from their human capital and social networks in different ways and

that this has an implication for the firm formation process, i.e. their firms have different development paths.

In addition, a main premise of entrepreneurship research and policy is that academic entrepreneurs should commercialize university technologies by creating university spin-offs, reflected by most studies (Rothaermel, Agung and Jiang, 2007; Djokovic and Souitaris, 2008; Siegel and Wright, 2015) and policy efforts focusing on academic entrepreneurs (e.g. Mosey, Lockett and Westhead, 2006). Hence, we have a one-sided and almost stereotypical knowledge of the role of the entrepreneur in the formation of university spin-offs, which may explain why some university spin-offs grow while another group of these firms remain small.

From a theoretical point of view, external entrepreneurs are important to investigate to explain the performance differences in university spin-offs in general and in the firms created by external entrepreneurs in particular. This knowledge is important to nuance the one-sided knowledge of the role of the entrepreneur in these firms by providing empirical findings of external entrepreneurs. It is also important to investigate external entrepreneurs in relation to academic entrepreneurs because they may have complementary human capital and social networks (Wright, Hmieleski, Siegel and Ensley, 2007). This knowledge is also essential for policymakers, who invest public money into the commercialization of university technologies. Hence, this thesis attends to the calls in literature reviews and theoretical discussions for more research on external entrepreneurs (Boo, De-Haan and Strom, 2015; Siegel and Wright, 2015). It is time to investigate the human capital and social networks of both academic and external entrepreneurs in university spin-offs.

From a practical point of view, external entrepreneurs are important to investigate because they can have industry and start-up human capital and networks with industry that complement academic entrepreneurs. Business and entrepreneurial experience is valuable for solving the variety of tasks embedded in university spin-offs such as building an organization, marketing and sales (Vohora et al., 2004). Industry networks are essential to bridge the academic culture and the commercial culture (Clarysse and Moray, 2004). This knowledge is also important for policymakers to develop business support programmes such as business incubator programs because external entrepreneurs can perhaps contribute to bridging ‘the valley of death’.

### **2.3 Overall research question and purpose of the thesis**

The assumption in this thesis is that the human capital and social networks entrepreneurs bring to the new firm determine the subsequent development and performance of the firm beyond its initiation. Therefore, it is likely that academic entrepreneurs' and external entrepreneurs' human capital and social networks can explain how and why some university spin-offs develop and grow while other firms remain small. The basic idea of this thesis is that human capital and social networks from academia and industry are different and influence the formation and performance of the firm in different ways. Hence, the overall research question of this thesis is:

*How and why do university spin-offs develop and perform?*

A more specific purpose was formulated to address this overall research question:

*The purpose of this thesis is to develop a conceptual framework of the imprints of academic entrepreneurs' and external entrepreneurs' human capital and social networks on the formation and development of university spin-offs.*

### **2.4 Five studies of university spin-offs**

This thesis builds on five research papers to contribute to the purpose of this thesis. The first paper investigates the typical characteristics of university spin-offs and corporate spin-offs. The second paper investigates the imprints of entrepreneurial origin on the long-term performance of university spin-offs and corporate spin-offs. These two papers compare university spin-offs with corporate spin-offs because the environments from which the firm and the entrepreneur originate can determine the future development and growth of the firm. Therefore, it is likely that university spin-offs that originate in academia and corporate spin-offs that originate in industry have different characteristics and performance. The two first papers compare university spin-offs with corporate spin-offs because otherwise it is not possible to know whether the characteristics and long-term performance are typical for university spin-offs.

The next three studies compare academic entrepreneurs and external entrepreneurs to examine whether these two types of entrepreneurs are similar or different in their contribution to the formation process of university spin-offs. The third study investigates the role of entrepreneurs'

human capital in the transition between firm development phases. The fourth study concerns network content, network governance and the network structure of the entrepreneurs' social networking. The fifth study focuses on the role of the entrepreneurs in entrepreneurial team formation. These three papers compare academic entrepreneurs and external entrepreneurs because the environments in which the entrepreneurs originate might determine the future development and growth of the firms. Therefore, it is likely that academic entrepreneurs who usually originate in academia and external entrepreneurs who originate outside academia will have different types of human capital and social networks, which influence the transition between development phases and entrepreneurial team formation. These three papers also compare academic entrepreneurs and external entrepreneurs because otherwise it is not possible to know whether human capital and social networks and their imprints in the formation of university spin-offs are typical for external entrepreneurs.

### **3. FRAME OF REFERENCE**

This chapter contains four main types of studies: university spin-offs and corporate spin-offs; academic entrepreneurs and external entrepreneurs; human capital and social networking; firm and team formation. This chapter ends with a conceptual framework summarizing the main concepts, relationships and research questions.

#### **3.1 Entrepreneurship studies comparing university spin-offs and corporate spin-offs**

This section defines the concepts of university and corporate spin-offs. It also discusses and identifies knowledge gaps in entrepreneurship research in terms of the characteristics and performance of university spin-offs and corporate spin-offs.

##### **3.1.1 Motivation to study university spin-offs and corporate spin-offs**

Researchers have defined university spin-offs in number of ways, including academic spin-offs, academic spinouts, university spin-offs, university spinouts and research-based firms (Pirnay, Surlmont and Nlemvo, 2003). There is no one single definition of university spin-offs (Zahra, Van de Velde and Larraneta, 2007). The definitions of these firms concern whether it is the technology, the academic or both that are spinning off or out from the university. This thesis focuses on those firms, which commercialize a university technology with or without the involvement of the academic researcher. The motivation is that these firms have a higher potential to contribute to society than firms initiated by an academic researcher without technology (i.e. consulting or service-based firms) and the university indicates the environment from where the firm originates. This thesis uses the definition of university spin-offs developed by Pirnay et al. (2003). They define university spin-offs as ‘new firms created to exploit commercially some knowledge, technology or research results developed within a university’. (Pirnay et al., 2003, p. 356).

Most studies of university spin-offs have treated these firms as a homogenous group of firms in terms of the entrepreneur. While the main part of these studies assume that an academic researcher or a research team commercializes university technology, a few research articles emphasize the importance of separating these firms into different groups. Lindholm Dahlstrand (1999; 2008) identified three types of university spin-off: indirect spin-offs, which are those

firms initiated by academic researchers after having worked in industry for a while; direct spin-offs, which are those firms initiated by an academic researcher without previous employment in industry; and those firms initiated by an external entrepreneur. All of these types of firm are interesting to investigate because the entrepreneurs' employment positions were different before starting their firms.

A stream of research has compared university spin-offs and corporate spin-offs, which are firms commercializing technologies developed at existing corporations. These studies provide important insights regarding firm formation and performance, which contribute to explaining how and why some university spin-offs grow while other firms remain small. Comparing university spin-offs and corporate spin-offs is interesting because these enterprises come from two different environments, which determine the initial firm characteristics, development and growth (e.g. Lindholm Dahlstrand, 2001). Entrepreneurship studies have described the academic environment and the corporate environment in terms of organizational goals, reward systems and culture (Table 1). The goal in academia is to develop knowledge for education and publication, while the goal of corporations is financial return (Nlemvo Ndonzuau, Pirnay and Sulemont, 2002; Festel, 2012). Therefore, the academic system counts the number of publications and rewards researchers with publications, while financial returns such as bonuses are of primary importance in industry (Moray and Clarysse, 2005). The academic culture is labelled in such terms as 'publish or perish' (Nlemvo Ndonzuau et al., 2002; Vohora et al., 2004) and 'technology orientation' (Radosevich, 1995a; Moray and Clarysse, 2005), while the industry culture is described using such terms as 'contracts' (Nlemvo Ndonzuau et al., 2002) and 'commercial orientation' (Radosevich, 1995a; Moray and Clarysse, 2005). This thesis compares university spin-offs and corporate spin-offs because it is likely that these characteristics influence entrepreneurs' human capital and social networks and that they in turn imprint the subsequent development and performance of the firm.

Table 1: Characteristics of the academic environment and the industry environment

	Academic environment	Industry environment
Culture	Technology orientation	Commercial orientation
Organizational goal	Knowledge production	Financial return
Reward system	Number of publications	Salary and bonus

### **3.1.2 Characteristics of university spin-offs and corporate spin-offs**

Entrepreneurship research has tried to distinguish between university spin-offs and corporate spin-offs in terms of individual characteristics (Wennberg, Wiklund and Wright, 2011; Colombo and Piva, 2012), technology characteristics (Clarysse, Wright and Van de Velde, 2011), network actors (e.g. Lindholm Dahlstrand, 1999) and firm performance (e.g. Zahra et al., 2007). Some studies have compared university spin-offs and corporate spin-offs in terms of the human capital characteristics of education and experience. Wennberg et al. (2011) used the knowledge spillover theory to explain how and why university spin-offs and corporate spin-offs perform. They show that corporate spin-offs have higher degrees of industry experience and entrepreneurial experience. Corporate spin-offs also generate higher growth in terms of number of employees and sales than university spin-offs do. In a study of Italian corporate spin-offs and university spin-offs it was found that university spin-offs had less entrepreneurial experience and industry experience in general and in the same industry compared to corporate spin-offs (Colombo and Piva, 2012). Surprisingly, they also found that corporate spin-offs had more technology experience than university spin-offs because university spin-offs originate in the academic environment. Although these studies provide important insights into the larger groups of university spin-offs and corporate spin-offs, they did not consider different subgroups of university spin-offs.

Entrepreneurship research has also investigated university spin-offs' and corporate spin-offs' networking with their parent organizations. Lindholm Dahlstrand (1999) indicates, in a study of direct and indirect university spin-offs and corporate spin-offs in Sweden, that universities and customers are the most important actors for competence development at firm start-up. In the corporate spin-off group, universities, customers and suppliers are the most important actors for competence development. Indirect spin-offs seem to have more connections outside the university at firm start-up than direct spin-offs do. Although the university is a very important actor for university spin-offs at firm start-up, the interaction decreases over time. Other studies, investigating only university spin-offs, also suggest that university spin-offs tend to accrue locally, close to their parent universities, employ university graduates and act as a role model for other entrepreneurs (Steffensen, Rogers and Speakman, 2000). Nevertheless, there is scarce knowledge regarding the use of networks in university and corporate spin-offs.

In addition, researchers have also investigated technology characteristics of university spin-offs and corporate spin-offs. Clarysse et al. (2011) investigated a sample of university spin-offs and corporate spin-offs from Flanders, Belgium, in terms of technology relatedness, scope, tacitness and newness. They found that technology relatedness and technology newness have a negative effect on university spin-off growth, while technology scope has a positive effect and technology tacitness no effect on growth. In the corporate spin-off group, the results show a negative effect of technology relatedness and technology scope, while technology tacitness has a positive effect on growth and technology newness has no effect. Although these results point at differences and thus a need for more research regarding the importance of the technology characteristics of university spin-offs and corporate spin-off, this is not the primary focus of this thesis.

This thesis addresses two gaps in previous studies of university and corporate spin-offs. First, there are indications that the environment from where the firm originates equips the entrepreneur and the new firm with certain characteristics that imprint the subsequent development and performance of the firm (Ciuchta et al., 2016). However, there is so far little knowledge about the imprinting characteristics in the university spin-off context that can separate these firms from corporate spin-offs. Second, university spin-offs seem to rely heavily on network connections to their parent universities but knowledge about their role in the firm formation process compared to corporate spin-offs is underdeveloped. Hence, this thesis proposes the following research questions.

*RQ1: What are the typical characteristics of university spin-offs and corporate spin-offs?*

*RQ2: How does entrepreneurial origin affect the formation of university spin-offs and corporate spin-offs?*

### **3.1.3 Performance of university spin-offs and corporate spin-offs**

Previous entrepreneurship research has investigated a number of different types of firm performance. The most common types of performance measure are turnover/sales, employment and combinations of measures (Delmar, 1997). Other measures are subjective measures of performance, for example in relation to other firms, market share and assets. Another very common measure in entrepreneurship and university spin-off research is survival. However,



survival is a problematic performance measure because some university spin-offs are ‘living dead’, meaning that, while the firm still exists on business registers, it is not active.

Entrepreneurship research comparing university spin-offs and corporate spin-offs in terms of performance is very diverse in terms of type of definition, performance measure and the time when performance is measured. These differences contribute to the difficulties of comparing the studies and it produces an unclear picture of the knowledge of university spin-offs’ and corporate spin-offs’ performance.

Researchers have used several different types of performance measures and between one and eight years of data collection. As the definitions of university spin-offs vary across studies, this section focuses on studies with a definition of university spin-offs that concerns the commercialization of university technologies. Lindholm Dahlstrand (2001) found in a study of spin-offs that corporate spin-offs outperform university spin-offs in terms of sales and employment growth, and indirect spin-offs generated higher performance than direct spin-offs but lower growth than corporate spin-offs. In a study of university-based high-technology start-ups in the United States, Ensley and Hmieleski (2005) revealed that corporate spin-offs generate higher firm performance in terms of net cash flow and revenue growth than university spin-offs do. They also conclude that university spin-offs have more homogeneous entrepreneurial teams than corporate spin-offs. Zahra et al. (2007) investigated the knowledge conversion capability of university spin-offs and corporate spin-offs in five states in the United States. The empirical results suggest that corporate spin-offs outperform university spin-offs in terms of return on investment and productivity over three years. However, university spin-offs generated higher revenue growth than corporate spin-offs over the same period. Bonardo, Paleardi and Vismara (2010) investigated university spin-offs and corporate spin-offs that went public. They concluded that university spin-offs received higher venture valuations at IPO but lower aftermarket valuations than independent firms. Independent firms show a significantly higher operating performance in terms of asset turnover, return on assets and return on equity than university spin-offs. In general, these studies suggest that corporate spin-offs generate higher performance and have more industry experience than university spin-offs do.

Studies have also tended to define university spin-offs more based on the person who started the firm than on the technology spinning off from the parent organization. Zhang (2009) investigated university spin-offs initiated by university employees, who received venture

capital funding between 1992 and 2011 and were located in Silicon Valley, San Francisco. University spin-offs had a higher survival rate, lower profitability and a fewer employees (at the time of the previous year's venture capital funding) than non-spin-off firms had. A study of university spin-offs and corporate spin-offs in Sweden has an impressive eight years of data (Wennberg et al., 2011). The empirical results demonstrate that corporate spin-offs have higher levels of entrepreneurial experience and industry experience than university spin-offs do. Corporate spin-offs might be able to take advantage of these resources because they have a higher survival rate after two years and five years, and after two years, they are larger than university spin-offs in terms of sales and numbers of employees. Interestingly, industry experience and entrepreneurial experience predicted employment growth in both university spin-offs and corporate spin-offs. Industry experience predicted sales growth in both university spin-offs and corporate spin-offs but entrepreneurial experience predicted only sales growth in corporate spin-offs. Hence, the corporate origin most likely provides a considerable amount of entrepreneurial and industry experience and the university environment produces highly educated and experienced engineers/scientists.

This thesis addresses three gaps in previous studies of university and corporate spin-offs. First, empirical results indicate that corporate spin-offs have performance advantages because they have more entrepreneurial experience and industry experience. However, there is scarce knowledge of whether these advantages sustain over time. It is reasonable to believe that university spin-offs do not perform until later in life because they invest in technology development (Rothaermel and Thursby, 2005), they emerge in a research-intensive academic environment that is typically not commercial (Vohora et al., 2004) and the academic entrepreneur has limited entrepreneurial and industry human capital and industry networks (Mosey and Wright, 2007). Second, entrepreneurship research treats university spin-offs largely as a homogeneous group of firms, while only a couple of empirical studies (e.g. Lindholm Dahlstrand, 2001; 2008) have investigated subgroups of university spin-offs. These subgroups are important to investigate because they are likely to have different development paths and growth patterns. Finally, although entrepreneurship studies point at the performance advantages of corporate spin-offs compared to university spin-offs, some results show the opposite (e.g. Zahra et al., 2007). This might be due to the mix of different definitions of university spin-offs, performance measures and times when performance is measured. Hence, this thesis proposes the following research question.

*Research question 3: How does entrepreneurial origin imprint the long-term performance of university spin-offs and corporate spin-offs?*

### **3.2 Academic entrepreneurs and external entrepreneurs in university spin-offs**

A major premise in university spin-off studies and policy decisions is that academic researchers should take the role of entrepreneurs and commercialize university technologies. Academic researchers in this situation have been named in various ways, including ‘academic entrepreneurs’ (Franklin, Wright and Lockett, 2001), ‘technology entrepreneurs’ (Marvel and Lumpkin, 2007) and ‘inventor entrepreneurs’ (Radosevich, 1995a). This thesis uses the term ‘academic entrepreneur’ because this indicates that these entrepreneurs come from academia. Consequently, only a few studies concern other types of entrepreneurs who are engaged in the commercialization of university technologies in terms of creating university spin-offs. Entrepreneurship research has mentioned two other types of entrepreneurs: external entrepreneurs and student entrepreneurs (Siegel and Wright, 2015). As discussed in Chapters 1 and 2, this thesis focuses on external entrepreneurs.

External entrepreneurs have also been named in various ways, including ‘external entrepreneurs’, ‘surrogate entrepreneurs’ (Radosevich, 1995a; Franklin et al., 2001), ‘external CEOs’ (van der Steen, Englis and Englis, 2013) and ‘experienced entrepreneurs’ (Boh et al., 2015). The difference between the first two concepts is only which individual or group of individuals selects the entrepreneur. Franklin et al. (2001) proposed that the technology source, i.e. the academic researcher or the research group, select the surrogate entrepreneurs and that external entrepreneurs also can take initiatives to become involved in the firm. Thus, the concept of ‘external entrepreneur’ includes the concept of ‘surrogate entrepreneur’. The drawback of the concept of ‘external CEO’ is that it does not reflect the entrepreneurial role. The disadvantage of the concept of ‘experienced entrepreneur’ is that it assumes that the entrepreneur is experienced. Hence, this thesis uses the concept of ‘external entrepreneur’ because it covers surrogate entrepreneurs and symbolizes the entrepreneurial role but not take any position or experience for granted. Drawing from Politis et al. (2013), this thesis defines an external entrepreneur as an individual who comes from outside the university and has not necessarily taken part in technology development but initiates a university spin-off.

In the seminal work of external entrepreneurs and surrogate entrepreneurs, these concepts were treated as synonymous but typically described as contrasting with academic entrepreneurs (Radosevich, 1995a). The attributes describe external entrepreneurs as having extended business and commercial experience and strong networks with the business community but little experience in research and technology development and few networks in academia (see Table 2). By contrast, academic entrepreneurs were posited to have extensive technology and research experience and strong networks in academia but low levels of business and commercial experience and weak business networks. In studies since the 1995 study, researchers have only moderately adjusted (or even confirmed) these narrow and almost stereotypical descriptions of academic entrepreneurs and external entrepreneurs.

Table 2: Stereotypical characteristics of academic entrepreneurs and external entrepreneurs

	Academic entrepreneurs	External entrepreneurs
Financial preferences	Public sources	Private sources
Focus in firm operations	R&D tasks	Business tasks
Relation to support system	Dependent of support actors	Independent of support actors
Relation to the technology	Invent the technology	Commercialize the technology
Relation to the university	Employed at the university	Not employed at the university
Type of experience	Research experience	Business experience
Type of network	Technology network	Industry network

Empirical studies indicate both similarities and differences between academic and external entrepreneurs. External entrepreneurs have management experience and an interest in financing the firm and building management teams, strategic alliances, partnerships with other organizations and industry networks (Kassicieh, 2011). By contrast, academic entrepreneurs have research and technology development experience and an interest in developing the technology. External entrepreneurs also have more entrepreneurial experience than academic entrepreneurs have, but they do not generate higher performance (van der Steen et al., 2013). External entrepreneurs prefer business angels and venture capitalists (private sources of finance) and perceive risk capital to be necessary to develop the firm (Politis et al., 2012). Thus, they are better prepared for opportunities and obstacles in financing the new firm, while academic entrepreneurs rely on seed capital and soft loans (public sources of finance) in financing the firm. Therefore, it is likely that external entrepreneurs have both human capital and social networks, which are valuable for university spin-off formation and performance.

However, external entrepreneurs can also have negative consequences for university spin-off formation. Academic researchers and the research team can have problems accepting the external entrepreneur as they come from different cultures (Clarysse and Moray, 2004; Kassicieh, 2011). Clarysse and Moray (2004) found that conflicts are usual between the research team and the external entrepreneur. In addition, Nicolaou and Birley (2003a) also propose that an external entrepreneur will increase the likelihood that the academic researcher will not continue in the firm as an employee. A recent study found that non-academic founders have a non-significant but still positive influence on conflicts in university spin-offs (Dianez-Gonzalez and Camelo-Ordaz, 2016). Hence, involving external entrepreneurs can create conflicts.

In addition, empirical studies of technology transfer offices (TTO) show that TTOs with a positive attitude towards external entrepreneurs generate more start-ups (Franklin et al., 2001) and that the strategies and use of external entrepreneurs contribute to the success of the TTO (Lockett, Wright and Franklin, 2003). As a result, these empirical findings suggest that the beliefs and practical implications of having external entrepreneurs contribute to the success of TTOs.

Taken together, literature reviews (Rothaermel et al., 2007; Djokovic and Souitaris, 2008) and some recent studies of university entrepreneurship (Siegel and Wright, 2015; Boh et al., 2015) have noticed an absence of theoretical and empirical knowledge of external entrepreneurs and called for more studies. Siegel and Wright (2015) argue that there has been a change in university entrepreneurship research from academic entrepreneurs to external entrepreneurs. Boh et al. (2015) even propose that a partnership with faculty and external entrepreneurs is the ideal arrangement for commercializing university technologies. Hence, it is time to extend the scope of knowledge and theorize the role of external entrepreneurs in university spin-offs as they may have some human capital and social networks that are required in the transition between development phases and entrepreneurial team formation.

### **3.3 The role of human capital and social networking in entrepreneurship**

Human capital and social networks are crucial to entrepreneurship in general and to university spin-offs in particular for several reasons. This section discusses, first, the importance of human

capital and social networking in entrepreneurship literature in general and second in university spin-off research in particular.

Previous research shows that entrepreneurs' human capital and social networks have different effects on new firm performance (Cooper, Gimeno, Gascon and Woo, 1994) but in general positive effects on new firm formation (Davidsson and Honig, 2003; Hsiao, Hung, Chen and Dong, 2013). There are several reasons to investigate the role of human capital and social networks in new firm formation and in relation to firm performance. Human capital and social networks are important to generate business ideas (Obschonka et al., 2012), discover and exploit opportunities (Davidsson and Honig, 2003) and increase innovation speed (Heirmann and Clarysse, 2007). Human capital and social networks are both important as they can have an imprinting effect on the subsequent development and performance of firms (Simsek et al., 2015). Hence, human capital and social networks are important in new firm formation in general.

In the university spin-off context, human capital and social networks are important for several interrelated reasons. Entrepreneurs need a mix of human capital to solve a variety of tasks, such as research, technology development, marketing and sales, to reach a market (Clarysse and Moray, 2004). Social networks are important to acquire the business and technology resources necessary to create viable firms (Pèrez Pèrez and Martínez Sánchez, 2003). Human capital and social networks from both academia and industry are essential to bridge the academic culture and the industry culture because university spin-offs originate in academia, which is typically not commercial (Vohora et al., 2004). Human capital and social networks from academia and industry are also important to cross 'the valley of death', that is, the gap between technology resources and commercial resources (Barr et al., 2009). There is a need for human capital and social networks from industry because research teams typically have extensive technology experience but varying degrees of business human capital and industry networks (Clarysse and Moray, 2004). Hence, human capital and social networks are key to solving several challenges in university spin-off formation.

### **3.3.1 The role of human capital in entrepreneurship**

Human capital is the knowledge and skills of individuals or teams of individuals (Becker, 1962). The basic idea of human capital theory is to explain the relationship between humans'

investment in ‘schooling’ (i.e. education) and ‘on-the-job training’ (i.e. work experience) and the expected increase in earnings (e.g. wages). In the management context, the idea is that firms’ investment in human capital (i.e. employees) generates higher performance such as sales and number of employees. Entrepreneurship researchers believe that human capital increases firm production (Allen, Link and Rosenbaum, 2007; Toole and Czarnitzki, 2009), firm performance (Nielsen, 2015) and the likelihood to initial public offering (Shane and Stuart, 2002; Dimov and Shepherd, 2005).

There are three main assumptions in human capital theory. The first assumption denotes that the knowledge and skills of employees increase firm production because employees are more effective in solving tasks if they have adequate knowledge and skills (Becker, 1962). Toole and Czarnitzki (2009) support this assumption by showing that biomedical academic entrepreneurs’ patent experience increases the number of patents produced. The obvious critique is that other factors, such as human motivation, also influence firm productivity (Marvel et al., 2014). The theory of the need for achievement supports this critique. This theory holds that entrepreneurs’ motivations originate from pursuing the tasks, which means that there is a link between motivation and firm productivity (McClelland, 1961). An entrepreneur cannot use motivation in itself to solve tasks and develop a new firm. Hence, this thesis is delimited to investigate human capital and leaves entrepreneurial motivation for future inquiries.

The second assumption proposes that education and work experience automatically transform into knowledge and skills (Becker, 1962). Education is the production of training produced by an institution, while experience is personnel training in the production of goods and services within firms. Knowledge is the possession and understanding of principles, facts, processes and the interactions among them; skills refer to observable applications or know-how (Marvel et al., 2014). An empirical study supports this assumption and shows that PhD education increases international knowledge (Taheri and van Geenhuizen, 2011). Several studies also show that entrepreneurs’ prior start-up experience increases the ability to discover opportunities (Shane, 2000; Davidsson and Honig, 2003; Politis, 2005). The obvious criticism of this is that prior education and work experience do not always generate knowledge and skills (Unger, Rauch, Frese and Rosenbusch, 2011). Thus, there are both empirical support for and criticism of this assumption. This thesis investigates previous work experience and leaves education for future research because entrepreneurs acquire experience in industry and this is closer to skills than education (Marvel et al., 2014).

The third assumption claims that human capital is easy to divide into general and specific experience (Becker, 1962). General human capital is experience useful in many firms, including the firm that provides it, and specific human capital is experience useful only in the firm that provides it. However, researchers have set the boundary between specific and general human capital both at the firm level (Becker, 1962) and at the industry level (Cooper et al., 1994; Nielsen, 2015). Studies are also inconsistent regarding the content of general and specific human capital. Some include education and experience in general human capital (Brüderli and Preisdorfer, 1988; Marvel, 2011) while others include either education (Cooper et al., 1994; Karlsson and Wigren, 2012) or work experience (Dimov, 2010; Knockaert, Wright, Clarysse and Lockett, 2010). Similarly, some researchers include education and work experience in specific human capital (Knockaert et al., 2010; Criaco, Minola, Migliorini, and Serarols-Tarres, 2014), while others include only experience (Brüderli and Preisdorfer, 1988; Dimov, 2010).

It appears that the boundary and content of general and specific human capital are not very clear in entrepreneurship research (Bowles and Gintis, 1975; Unger et al., 2011). In this thesis, general human capital is applied work experience that is useful to firms across industries, including the firm that provides it. Specific human capital is applied work experience that is useful only to firms within the same industry, including the firm that provides it. General and specific human capital are important to investigate because they have an institutional specificity that makes them most useful in the context where they were acquired (Toole and Czarnitski, 2009). Human capital is also important in university spin-offs because it has a positive effect on innovation (McGuirick, Lenihan and Hart, 2015).

Researchers have investigated human capital at the individual level, the team level and the firm level. This section focuses on the individual and firm levels. Studies on entrepreneurial teams' section discusses human capital at the team level. Most human capital research in entrepreneurship pays attention to the relationship between human capital and firm performance (Unger et al., 2011; Marvel et al., 2014). Empirical results show that human capital has both positive and negative effects on firm survival (Cooper et al., 1994; Criaco et al., 2014) and various types of firm performance (Cooper et al., 1993; Colombo and Grilli, 2005; Shrader and Siegel, 2007). This extent of research attention and contradictions implies that it is important to study factors between human capital and firm performance in the firm formation process (Unger et al., 2011; Marvel et al., 2014).



There are few human capital studies in entrepreneurship that have investigated factors in between human capital and firm performance. A study based on the US Panel Study of Entrepreneurial Dynamics (PSED) shows that industry experience increases the likelihood of venture emergence but entrepreneurial experience has no effect (Dimov, 2010). In contrast, several studies of patents from Massachusetts Institute of Technology (MIT) show that entrepreneurial experience leads to the creation of university spin-offs (Shane, 2000; Shane, 2001; Shane and Khurana, 2003). A Swedish study of nascent entrepreneurs indicates that start-up experience is important to discover and exploit opportunities, while managerial experience only increases the likelihood of exploiting opportunities (Davidsson and Honig, 2003). British entrepreneurs also use entrepreneurial experience and managerial experience to identify business opportunities (Uchbasaran, Westhead and Wright, 2008). In university spin-offs, academic entrepreneurs' technology experience, including patenting experience, is important to discover technology opportunities and exploit entrepreneurial opportunities, while publication experience is only important to discover technological opportunities (D'Este et al., 2012). Academic entrepreneurs' start-up experience (Marvel, 2011) and prior knowledge of markets, ways to serve markets and customer problems are essential to discover opportunities (Shane, 2000; Marvel, 2011). Hence, business experience, entrepreneurial experience and technology experience are important to discover and exploit opportunities in university spin-offs.

Entrepreneurship researchers have also investigated the relationship between different types of human capital and the specific tasks: business ideas, financial capital, social networking, innovation radicalness and innovation speed. A mix of functional work experience (Gabrielsson and Politis, 2012) and entrepreneurial experience are useful to generate business ideas (Obschonka et al., 2012). In the university spin-off context, most human capital studies have investigated the human capital of academic entrepreneurs. Scholars indicate that research experience is advantageous to receive research and commercialization funds but patenting experience has no effect on funds (Toole and Czarnitzki, 2009). Others show that start-up experience (Baum and Silverman, 2004; Hsu, 2007) and management experience but not technology experience are useful to attract venture capital (Gimmon and Levie, 2010). Similarly, previous entrepreneurial experience leads to broad social networks and effectively developed network ties (Mosey and Wright, 2007). Furthermore, knowledge of the technology increases innovation radicalness (Marvel and Lumpkin, 2007), while start-up experience and various types of industry experience, including marketing experience, manufacturing

experience and financing experience, increase innovation speed (Heirmann and Clarysse, 2007). However, academic entrepreneurs' knowledge of ways to serve the market has a negative effect on innovation radicalness, and knowledge of customer problems and knowledge of market have no effect on innovation radicalness (Marvel and Lumpkin, 2007). Hence, there are mixed and unclear results regarding the role of industry experience, start-up experience and technology experience on university spin-off formation.

In addition, the discussion that external entrepreneurs perhaps have more business experience than academic entrepreneurs has only been conceptually proposed (Radosevich, 1995a), except for three empirical studies that suggest that external entrepreneurs have more business experience and entrepreneurial experience than academic entrepreneurs have (Radosevich, 1995b; Kassicieh, 2011; van der Steen et al., 2013). However, research on the role of academic entrepreneurs' and external entrepreneurs' experience is underdeveloped. To address these limitations, this thesis investigates the concepts of start-up human capital, industry human capital and technology human capital. Start-up human capital refers to skills acquired in prior work experience when creating a new firm, such as opportunity recognition and resource acquisition. Previous studies also call this type of human capital, entrepreneurial experience (e.g. Mosey and Wright, 2007). Industry human capital refers to skills acquired through prior work experience in existing firms to solve tasks like production, marketing and sales. Previous studies also call this type of human capital business experience (e.g. Radosevich, 1995a). Technology human capital refers to skills acquired through prior work experience in firms, institutes and universities to solve tasks like research and technology development.

Taken together, contradictory results in the relationship between entrepreneurs' human capital and firm performance and underdeveloped knowledge regarding the role of human capital in firm formation point to the importance to continue to investigate this relationship and factors within this relationship. Different types of human capital, including start-up experience, industry experience and technology experience, are especially important in this respect in the context of university spin-offs. Academic entrepreneurs are important providers of technology experience acquired through research and patenting, but the effectiveness of their start-up and industry experience in university spin-off formation is not evident. There is only a conceptual discussion (Radosevich, 1995a) and three empirical indications that external entrepreneurs have more business and start-up experience compared to academic entrepreneurs (Radosevich,

1995b; Kassicieh, 2011; van der Steen et al., 2013). Hence, this thesis proposes the following research question.

*Research question 4: What types of human capital have academic entrepreneurs and external entrepreneurs?*

The importance of academic entrepreneurs' and external entrepreneurs' human capital based on earlier studies is further discussed in the 'Firm transition between development phases' and 'Entrepreneurial team formation and performance' sections because of the need to combine human capital theory with other streams of research to investigate the importance of entrepreneurs' human capital.

### **3.3.2 The role of social networking in entrepreneurship**

The term 'social networks' refers to a set of actors, individuals and organizations, and a set of linkages or contacts between these actors (Brass, 1992). In this way, a social network of partners can potentially provide valuable resources for firm development and growth (Soetanto and Van Geenhuizen, 2011). The basic idea of social networking in management research is to explain an individual's interactions and exchanges with other individuals and firms. In the entrepreneurship context, entrepreneurs can get valuable resources in exchange for trust and/or contracts through strong and weak ties (Hoang and Antoncic, 2003). A concept similar to social network is social capital. Social capital is the process of creating social connections that entrepreneurs use for the exchange of information and resources (Anderson and Jack, 2002). Thus, social capital is connections between individuals embedded in social networks and is part of social networking (Cope, Jack and Rose, 2007). The concept of social networks contains both business networks and private networks (Slotte-Kock and Coviello, 2009). Hence, this thesis builds on studies of social networks to explain university spin-off formation and performance.

There are three assumptions behind social network research in social science: that network structure matters, that the position of nodes determines the opportunities and limitations, and that there is direct transmissions of resources between nodes (Borgatti, Mehra, Brass and Labianca, 2009). The assumption that structure matters builds on the idea that nodes in the environment that surrounds individuals and firms are more important for firm development than

individual or firm characteristics such as human capital. However, researchers found that both human capital and social network are important in entrepreneurship (Davidsson and Honig, 2003) and contribute to the recognition of business opportunities (Hsiao et al., 2013) and the generation of business ideas (Obschonka et al., 2012). Separate studies of social network ties show that strong network ties and weak network ties have negative and positive effects, respectively, on new firm performance (Stam, Arzlanian and Elfring, 2014). Therefore, this thesis acknowledges that network structure matters and is probably more important to new firm formation and development when combined with human capital than alone.

The assumption that the position of nodes in the network determines the opportunities and limitation means that the type and quality of network nodes determine network outcome (Borgatti et al., 2009). Parents who have started new firms and contacts with assistance agencies contribute to both opportunity discovery and exploitation, while close friends and neighbours in business increase only the likelihood of opportunity discovery (Davidsson and Honig, 2003). In a different way, friendship networks with colleagues are more powerful than advice networks with colleagues during uncertainty (Krackhardt, 2003). This indicates that the same network actor can contribute differently to the same firm. However, the usefulness of types of nodes and their quality also depends on the development phase of the firm (Rasmussen, Mosey and Wright, 2015; Hayter, 2016). These results also emphasize that the network content provided by the node, and not only the node itself, is important.

The assumption about direct transmissions holds that resources are transferrable between nodes of network actors and that these resources are useful for the individual who has the network connection (Borgatti et al., 2009). Hsu (2007) supports this and shows that founders who involve executives from their own social network receive higher venture valuations than other founders. In university spin-offs, academic contacts provide assistance related to research, co-founding, internal advocacy and IP services, while non-academic contacts provide assistance in commercialization, product development, funding, product testing, management and accounting services (Hayter, 2016). Technology resources acquired and market resources acquired are useful for product innovativeness and first sale, respectively (Sullivan and Marvel, 2011). Hence, social networks matter because the positions of network nodes determine network outcomes and there is a transmission of resources between network actors.

Entrepreneurship research show that social networking can increase firm performance (Baum, Calabrese and Silverman, 2000; Walter, Auer and Ritter, 2006) and university spin-off growth (Shane and Stuart, 2002; Soetanto and van Geenhuizen, 2011) but also reduce the failure of university spin-offs (Shane and Stuart, 2002). Results also show no or negative effects of social networking and firm performance in general (Cooper et al., 1994; Lechner, Dowling and Welpel, 2006) and in university spin-offs in particular (Baum et al., 2000; Hirai, Watanabe and Inuzuka, 2013). Research indicates that networking with non-academic individuals, venture capitalists (Hayter, 2015) and peers increases the likelihood of university spin-off success (Hayter, 2016). The mixed results regarding the relationship between social networking and firm performance imply the need to investigate the relationship between social networking and other factors in university spin-offs to explain these performance differences.

A large number of studies have investigated the role of social networking beyond firm performance. Social networking is especially important for entrepreneurs who must complement their own resources (Jack, 2005) because it is useful to mobilize resources, get support and establish business contacts (Greve, 1995). Social networks can also give access to other network actors and their social networks in first, second and even higher orders (Jack, 2005). Social networking can also increase the likelihood of firm formation (Kreiser, Patel and Fiet, 2013). Business contacts can be helpful in the discovery and exploitation of opportunities, while social support actors such as family, friends and team members are most helpful to discover opportunities (Davidsson and Honig, 2003). Technology-based firms are dependent on social networks because they enhance innovative capability (Chen and Wang, 2008). Hence, there is empirical support for the use of social networking in the new firm formation.

Social networking is especially important in university spin-offs because it influences the type of firm initiated (Nicolaou and Birley, 2003a) and the involvement of the academic researcher (Nicolaou and Birley, 2003b). Social networking is also important to handle the typical challenges related to opportunity recognition, entrepreneurial commitment, market credibility and financial sustainability (Vohora et al., 2004; Wright, Vohora and Lockett, 2004). Weak network ties contribute to develop opportunity refinement competency, while strong ties contribute to develop resource acquisition competency and championing competency (Rasmussen et al., 2015). Network contacts from academia, including faculty and graduate students, are key actors in the entrepreneurial commitment juncture, while network contacts from outside the university, including company researchers, managers, investors and advisors,

are essential players in the market credibility and financial sustainability phases (Hayter, 2016). Hence, social networking is especially important in phases of new firm formation.

More specifically, social networks can also contribute to convince venture capitalists and increase innovation speed. In a study of MIT patents, social networks are useful for capturing venture capitalists' interests (Stuart and Shane, 2002), providing them with information about the entrepreneur and increasing the probability of investment (Shane and Cable, 2002). Founders who involve executives from their own social network receive higher venture valuations (Hsu, 2007). Social networking can also benefit innovative capability (Chen and Wang, 2008). More specifically, collaboration with universities and research institutions increase innovation speed (Heirmann and Clarysse, 2007). Academic entrepreneurs perceive their industry partners as sources of business opportunities and role models (Mosey and Wright, 2007). Taken together, there are reasons to believe that social networks can provide both the technology and the market resources that are critical to university spin-off development.

Social networking does not only benefit the development of university spin-offs. Although policymakers decided to set up university incubators to pool resources and provide access to contacts, expertise and resources (van Burg et al., 2008), business incubators cannot provide all of the necessary commercial and technology resources to create viable firms (Peters et al., 2004). Researchers also indicate that incubator tenants are afraid of sharing information with other incubator tenants because they might reveal secret information about the intellectual property (McAdam and Marlow, 2008). Hence, there is a need to investigate other resource providers beyond university incubators that can contribute to the creation of university spin-offs (McAdam, Galbraith, McAdam and Humphreys, 2006).

Taken together, there are several reasons to investigate external entrepreneurs' social networking. First, they can have a positive influence on university spin-offs' success and firm performance, and one reason for this is perhaps their social networks. Second, they originate outside academia, from where they possibly have acquired industry networks that can complement the research networks of academic entrepreneurs. Third, other network actors such as university incubators cannot provide all necessary commercial resources to create viable firms. Fourth, the propositions that they have direct access to industry networks and indirect access to technology networks are only propositions (Radosevich, 1995a). Fifth, there are calls in literature reviews (Rothaermel et al., 2007; Djokovic and Souitaris, 2008) and research

discussions in academic entrepreneurship for more knowledge of the role of external entrepreneurs in university spin-offs (Boo et al., 2015; Siegel and Wright, 2015).

Hoang and Antoncic (2003) have developed a framework that contains of network content, network governance and network structure. This framework is useful for extending our current knowledge of social networking beyond prior studies, which have investigated only one or two network elements (Hoang and Antoncic, 2003; Slotte-Kock and Coviello, 2009). These elements are important to investigate simultaneously because they are interrelated. Investigating only one network element will provide a view of the complex interrelationships of social networking that is too narrow and limited. One example that shows the complex relationship is a case study of Sweden. The case study demonstrates that four firms established network relationships to build acceptance and access equipment and facilities; they coordinated the network relationships with trust but they were different regarding the strong and weak network ties (Johansson, Jacob and Hellstrom, 2005). By investigating these three network elements, this thesis can extend our knowledge of entrepreneurs networking in university spin-offs and address the limited explanations of how and why new firms develop and perform.

A popular network element to investigate is network structure, both in entrepreneurship in general (e.g. Stam et al., 2014) and in university spin-off research in particular (e.g. Nicolaou and Birley, 2003a, 2003b). Other entrepreneurship studies concern two network elements such as network structure and network content (e.g. Jack, 2005) but there is scarce knowledge of all network elements in firm formation (Hoang and Antoncic, 2003). University spin-off research in particular has focused on one, two or three network elements. Network content and network structure are the most commonly investigated network elements. It was only possible to identify two studies that addressed all network elements (see Johansson et al., 2005; Mosey and Wright, 2007). Despite this, these studies do not focus explicitly on the new firm formation process or the role of external entrepreneurs. Hence, research on social networking in university spin-off formation is underdeveloped regarding network content, governance and structure of external entrepreneurs' social networks.

*Network content* refers in general to the various resources that network actors exchange. Network content includes, for example, financial capital, emotional support and legitimacy (Hoang and Antoncic, 2003), as well as advice and expertise on patents, legal issues, business plans, product testing, technology development, market identification and internationalization

(Neergaard, 2005). Network content is useful in recruiting employees, creating an entrepreneurial team, capturing investors' interest and connecting with other network actors. Experienced entrepreneurs usually have greater access to a larger variety of resources than less-experienced entrepreneurs, who rely more on the limited resources from their social networks (Mosey et al., 2006). Although professional actors are generally the most capable of providing such resources, family members and friends can also contribute to both firm formation and reputation enhancement (Jack, 2005). Networking with universities and R&D centres are more important in the early years than in the later years of firm formation (Pèrez Pèrez and Martínez Sánchez, 2003). Firms with a technology orientation need to complement their market knowledge. Academic spin-offs gain research assistance, co-founders, establishment assistance, internal advocacy, IP services and university practice from academic networks (Hayter, 2016). These firms also gain product development, funding, testing, management and accounting services from non-academic contacts. Network diversity has a larger and more positive effect on firm performance in high-technology firms than in low-technology firms (Stam et al., 2014). Network multiplexity, i.e. access to diverse types of knowledge, increases the ability to attract external funding (Soetanto and van Geenhuizen, 2011). Hence, a mix of business and technology content from social networks is preferable in university spin-offs.

*Network governance* refers in general to the coordinating mechanisms that manage relationships between network actors (Hoang and Antoncic, 2003). Researchers have defined network governance as the duration of the relationship, but this does not have an effect on venture emergence (Newbert and Tornikoski, 2012). Formal contracts are sometimes necessary in the resource exchanges between network actors. Trust between actors is another form of network governance (Anderson, Park and Jack, 2007), which comes from respect, familiarity and confidence in their counterparts' ability and knowledge (Jack, 2005). Trust is important in maintaining goodwill when firms pool their resources, to acquire technical credibility and market credibility (Anderson et al., 2007). A long-term relationship also increases inter-firm trust (Lechner and Dowling, 2003). Hite (2005) found that three types of trust – personal goodwill trust, personal competency trust and social trust – could increase opportunity discovery, opportunity recognition, opportunity refinement, resource acquisition and relational governance. Taken together, entrepreneurs can use various types of governance mechanisms such as formal contracts and social assets (Hoang and Antoncic, 2003), including friendship, liking, trust, gratitude, obligation and other social assets, to build a social network (Starr and



MacMillan, 1990). Hence, network governance is useful to access business and technology resources in university spin-offs.

*Network structure* refers in general to the pattern of relationships between actors in social networks (Hoang and Antoncic, 2003). Network structure includes network size, centrality, density, strong/weak ties and bridging ties. Differences in network position can influence resource flows and firm development. Strong and weak ties refer to the frequency of contact and the quality and intensity of relationships (Granovetter, 1973). Strong ties connect entrepreneurs with first-order actors, while weak ties connect them to second-order actors (Jack, 2005). In other words, strong ties are direct ties or connections between two network actors, while weak ties are indirect ties or connections between more than two network actors. Network ties contribute to firm formation by linking customers, suppliers and financiers to the firm, and by providing business support, knowledge and experience to firm development. Weak ties are also important to the entrepreneur because it can bridge structural holes (Granovetter, 1983) and provide resources, enhance reputation and support firm development (Jack, 2005). Firms pursuing radical innovations use a balanced mix of weak ties and strong ties to discover opportunities and gain legitimacy, using strong ties rather than weak ties to secure resources (Elfring and Hulsink, 2003). It is especially important for university spin-offs to have first-order non-academic contacts to get a committed entrepreneurial team, market credibility and financial return (Hayter, 2016). Network structure in terms of frequency of interaction and size of the network do not relate to venture emergence (Newbert and Tornikoski, 2012). Hence, direct and indirect ties are important to provide the university spin-off with business and technology resources.

Taken together, this thesis addresses three gaps in entrepreneurship research on social networking. First, the contradictory findings in the relationship between social network and firm performance motivate research, investigating factors within this relationship. Knowledge about this relationship is important because it can explain how and why the entrepreneur can use their social network to develop the firm rather than to create only performance. Second, entrepreneurship studies investigating social networking in the firm formation process have largely investigated either network content, network governance or network structure, while there is a limited knowledge of all these network elements together. Third, entrepreneurship research on social networking in the university spin-off context have almost exclusively investigated academic entrepreneurs' social networking and networks provided by university

incubators, which are not always enough to create viable firms. Hence, there is a need to investigate external entrepreneurs' social networking.

This thesis addresses these gaps by investigating network content, network governance and the network structure of academic entrepreneurs and external entrepreneurs to explain how they use social networking in university spin-off formation. Hence, this thesis proposes the following research question.

*Research question 5: How do academic entrepreneurs and external entrepreneurs use their social networks in university spin-offs?*

### **3.4 The formation of new firms**

Firm formation is the organizational arrangements to exploit technological opportunities (Shane, 2001). Literature on life cycle theory and literature on entrepreneurial team formation are two useful research streams in a study of new firm formation. Researchers have used the life cycle theory to investigate the development phases of new firms, entrepreneurial teams and new products. Researchers have used literature on entrepreneurial team to investigate the role of the team to firm development and performance. This thesis uses life cycle theory at the firm level and literature on entrepreneurial team formation to theorize, respectively, firm transition between development phases and the role of the academic and external entrepreneurs in team formation.

#### **3.4.1 Firm transition between development phases**

The basic idea of life cycle theory is to explain the activities and tasks embedded in the life of firms. Life cycle theory is useful to investigate university spin-off formation because the theory contains both development phases and challenges (Rasmussen, 2011). A common conceptualization of the development of firms is birth, growth, maturity, revitalization and death (Greiner, 1972).

Development phases are predefined and organized sets or chunks of tasks that the entrepreneur needs to solve to develop the firm (van der Ven and Poole, 1995). The life cycle theory builds on the assumptions that organizational development is invariant, linear and imminent. The

assumption of invariance denotes that the development phases are applicable to all firms (Phelps, Adams and Bessant, 2007). The concept of linearity means that firms must complete the tasks in one development phase before they can continue to the next phase (Stubbart and Smalley, 1999). Imminence means that organizational development has the underlying logic that actions in one development phase influence the departure to the subsequent phase (van der Ven and Poole, 1995).

Entrepreneurship researchers have challenged these assumptions to different degrees. A framework that builds on all of these assumptions is the conceptual framework published by Scott Shane in 2003 (Shane, 2003). This framework contains several activities: opportunity discovery, opportunity exploitation and execution, which includes resource acquisition, organizational design and strategy. This framework is linear and imminent because the activities build upon each other and the entrepreneur must complete the activities in this order. It is also invariant because there are no chunks of activities related to a specific type of firm, for example technology-based firms.

Several studies have challenged the invariant assumption by developing conceptual frameworks specifically for technology-based firms (e.g. Bhave, 1994; Kazanjian; 1988; Phelps et al., 2007). This critique has found empirical support by showing that the development process of technology-based firms is different from non-technology-based firms (Liao and Welsch, 2008). Researchers have also developed conceptual frameworks for university spin-offs (Kazanjian, 1988; Nlemvo Ndonzuau et al., 2002; Vohora et al., 2004; Barr et al., 2009). These studies challenge the invariant assumption in the definition because they are adapted to university spin-offs but they also consider critical events. These frameworks are different from each other because they support or challenge the linear assumption and the imminent assumption.

An early framework conceptualizes four stages of the formation of university spin-offs. These four stages are the conception and development stage, the commercialization stage, the growth stage and the stability stage (Kazanjian, 1988). This framework is linear and imminent because the stages clearly build on each other and there are no explicit critical events in the framework. A narrower framework of the commercialization process embeds the critical events in the development phases (Nlemvo Ndonzuau et al., 2002). This framework contains the following stages: generating the business idea, finalizing the new venture project, launching the spin-off from the research project and strengthening economic value. This framework is also linear and

imminent because the framework is not iterative. The most recent framework contains ideation, phase I, phase II, commercialization strategy and commercialization implementation (Barr et al., 2009). This framework also embeds the critical events in the development phases but it is also iterative as the framework considers the possibility of going back to earlier phases.

The most developed conceptual framework of university spin-off formation originates from an empirical study of nine firms from seven UK universities (Vohora et al., 2004). This framework also challenges the linear assumption by providing the possibility of iterating between the development phases: the research, opportunity-framing, pre-organization, re-orientation and sustainable return phases. This framework differs from the other frameworks because it also contains critical events called ‘critical junctures’, which are detailed challenges and activities that emerge in the interstices between the development phases. The critical junctures are opportunity recognition, entrepreneurial commitment, credibility and sustainability. As a result, this thesis applies this last conceptual framework because it explicitly expresses the critical events, it is iterative between development phase and critical junctures and it focuses on detailed activities in both the development phases and critical junctures. A disadvantage is the label of the last phase, ‘the sustainable return phase’, because firms seldom if ever become ‘sustainable’ in financial terms. Nevertheless, this framework explicitly states several of the unique challenges in university spin-off formation.

The framework explains the relationship between five development phases and four critical junctures, which cover the commercialization process from academic research to market sales. Below are the main activities and challenges of this commercialization process described. In the research phase, the main activities are to publish research results, patent the technology and identify technological and commercial opportunities (Vohora et al., 2004). Academic entrepreneurs play an important role because they often have technology experience that is useful to discover technological opportunities (D’Este et al., 2012) and prior patent experience to patent the technology (Allen et al., 2007; Toole and Czarnitzki, 2009). External entrepreneurs are perhaps useful for recognizing commercial opportunities (Wright, Clarysse and Mosey, 2012). If these tasks are not solved, the firm enters the opportunity recognition juncture.

In *the opportunity-framing phase*, the key activities are evaluating the technology outside the laboratory, developing the proof of concept, framing the business opportunity, identifying a target market, defining alternative markets and involving an entrepreneur (Vohora et al., 2004).

Some academic entrepreneurs have challenges with these tasks because they have limited industry networks (Mosey and Wright, 2007). If the firm does not solve these activities, it will enter the entrepreneurial commitment juncture. This implies that it is central to involve an entrepreneur who can run the future operations of the firm such as an external entrepreneur.

In *the pre-organization phase*, the major activities are segmenting the market, identifying target customers, paying attention to customer needs, acquiring financial capital, building a management team and gaining market credibility (Vohora et al., 2004). Since venture capitalists prefer to invest in firms with both business experience and technology experience (Franke, Gruber, Harhoff and Henkel, 2008), academic researchers can have challenges in taking the firm to the next development phase. Alternative entrepreneurs to academic entrepreneurs are faculty staff, students and external entrepreneurs (Hayter, 2016). External entrepreneurs are perhaps a complement to academic entrepreneurs in this phase because they can provide industry contacts (Wright et al., 2012) and management advice (Hayter, 2016). If the firm does not meet these requirements, it will be stuck in the credibility juncture without the credibility necessary to continue its operations.

In *the re-orientation phase*, the key activities are implementing strategic plans, getting market acceptance and gaining legitimacy (Vohora et al., 2004). To succeed with these activities, it is often necessary to reconfigure resources, revise the business model, analyse competitors, re-package customer proposition and attract more financial capital. This process is an iterative decision-making process of previous development phases and, if necessary, it requires interaction with customers, suppliers, competitors and investors. Again, this can be challenging for academic entrepreneurs because they have different degrees of business experience, entrepreneurial experience and industry networks (Mosey and Wright, 2007). Company researchers, managers, investors and advisors can help the firm to gain credibility (Hayter, 2016). Since external entrepreneurs might have business experience (van der Steen et al., 2013), they can help the firm to avoid the sustainability juncture and take the firm to the sustainable return phase.

In *the sustainable return phase*, key activities are realizing the business model, acquiring market shares and scaling production (Vohora et al., 2004). Other key activities are coordinating technology development, setting up production and the supply chain, marketing and selling products. Experience in marketing, manufacturing and finance increases the speed to new

product launch (Heirmann and Clarysse, 2007). Marketing experience also increases the firm's focus on market activities (Shrader and Siegel, 2007). Hence, management teams with business experience can make the firm maintain its position in this phase and avoid returning to prior phases (Vohora et al., 2004). Thus, network actors such as company researchers, managers, investors and advisors are key actors to solve these tasks (Hayter, 2016). External entrepreneurs with management experience (Kassicieh, 2011) are possibly also central actors to solve the activities in this phase.

Finally, it is a great challenge for academic entrepreneurs to develop research results to a market-ready product that generates sales because of the various types of tasks that are involved in this process. Studies based on life cycle theory suggest a variety of ways to organize these tasks in sets or chunks that the entrepreneur and the entrepreneurial team need to solve to make the firm overcome the valley of death. Life cycle studies are important to identify the tasks, to get an idea of the order of the tasks and to identify the types of skills and networks required to bridge the valley of death and critical junctures.

Regardless of these benefits of life cycle studies, there are at least three gaps in prior research regarding university spin-off formation. First, much research uses separate theories such as life cycle theory to investigate firm formation, while there is not much knowledge generated by combining life cycle theory with other theories to explain university spin-off formation (Rasmussen, 2011). Second, there is a natural focus on the chunks of activities and critical events without explaining the transition between phases and barriers (Drazin, Glynn and Kazanjian, 2004). Third, research focuses on academic entrepreneurs (Vohora et al., 2004; Wright et al., 2004), social network actors (Vanaelst, Clarysse, Wright, Lockett, Moray and S'Jegers, 2006; Hayter, 2016) and boards of directors in firm formation (Bjørnåli and Gulbrandsen, 2010). However, there is a paucity of knowledge regarding various types of entrepreneurs (Wright and Marlow, 2011), especially external entrepreneurs in firm formation (Siegel and Wright, 2015). Hence, existing studies only provide limited explanations of the firm formation process.

This thesis addresses these gaps by combining human capital theory and life cycle theory to explain the role of academic entrepreneurs and external entrepreneurs in the transition between development phases in university spin-off formation. Hence, this thesis proposes the following research question.

*Research question 6: How and why does the human capital of academic entrepreneurs and external entrepreneurs influence the transition between development phases of university spin-offs?*

### **3.4.2 Entrepreneurial team formation and performance**

Research on entrepreneurial teams is a very young research stream, which challenges mainstream entrepreneurship research that sees entrepreneurs as lonely heroes who create new firms (Kamm, Shuman, Seeger and Nurick, 1990). An entrepreneurial team is two or more individuals who have a financial interest in and participate actively in the formation of new firms (Cooney, 2005). Some definitions of entrepreneurial teams include both founders and boards of directors, while other definitions only include founders. Although founders often take a position on the board, other people, such as venture capitalists, technology transfer officers and incubator coaches, often take a position on boards of university spin-offs (Vanaelst et al., 2006). In this thesis, an entrepreneurial team is two or more individuals who have a financial interest in and actively participate in new firm formation. This thesis excludes the board of directors because not all boards of directors actively participate in firm formation, except for board meetings.

The basic idea of entrepreneurial team studies is to theorize the role of the founders to new firm formation and firm performance. There are at least three assumptions behind team studies in general and entrepreneurial team studies in particular. These are the assumption about complementarity, the assumption about social relations and the assumption about performance (Katzenbach and Smith, 1993). The complementarity assumption means that team members complement each other in terms of, for example, knowledge, skills, abilities and networks. This assumption holds that team members create synergies when they work together that entrepreneurs on their own are not able to do. The assumption about social relations claims that team members develop social relationships to each other including mutual responsibilities, common goals and work ethics. When a group of people works together, develops social relationships and achieves a challenging goal, their cohesiveness gets stronger and they become a team. The performance assumption means that teams are more effective in solving tasks than individuals are alone and that this influences firm performance.

Most studies on teams in management research have taken the upper-echelon perspective and investigated the relationship between top management team (TMT) composition and firm performance (e.g. Hambrick and Mason, 1984). The results indicate that team members' backgrounds influence firm performance. The upper-echelon perspective is also a very popular perspective in entrepreneurship research. Empirical studies acknowledge the importance of heterogeneous TMTs in creating firm performance (Eisenhardt and Schoonhoven, 1990; Beckman and Burton, 2008). Other studies argue that team heterogeneity has negative effects on performance (Klotz, Hmieleski, Bradley and Busenitz, 2014) or no effects on performance (Chowdhury, 2005). TMT heterogeneity is also important for university spin-off performance (De Cleyn et al., 2015). As a result, TMT heterogeneity has a positive effect on firm performance, though contrasting results exist. Most of these studies support the complementarity and performance assumption because heterogeneous entrepreneurial teams perform better than homogeneous teams.

Entrepreneurial team researchers have recently started to focus on team process variables to explain firm formation and performance (Klotz et al., 2014) and have thus taken into account the social relationship assumption. Studies on conflicts between team members show positive and negative effects on firm performance (Ensley and Pearce, 2001; Ensley, Pearson and Amazon, 2002). Cognitive conflict has a positive effect on firm performance, while affective conflict has a negative effect on firm performance (Ensley and Pearce, 2001). Studies of incubated entrepreneurial teams in Austria show that the interaction between relationship conflicts and diversity in need for achievement has a negative effect on team performance (Khan, Breitenecker and Schwarz, 2015) while cognitive trust has a positive effect on team performance (Khan, Breitenecker, Gustafsson and Schwarz, 2015). Conflicts can also emerge between academic researchers and external entrepreneurs owing to different background and firm strategies and lead to team member change (Clarysse and Moray, 2004). Hence, continued investigation of conflicts in entrepreneurial teams is interesting for future studies.

The composition of the founding team, also called the entrepreneurial team or new venture team is important in new firm formation and to its performance. Entrepreneurial teams with a mix of start-up experience and industry experience increase firm sales, although the effect of start-up experience diminishes over time (Delmar and Shane, 2006). Entrepreneurial teams with heterogeneous experiences are more likely to involve TMT members with heterogeneous experiences than teams with similar experiences (Beckman and Burton, 2008). These teams



also reach milestones faster than teams with homogeneous experiences. Heterogeneity is also important for deciding firms' strategic directions (Wiersema and Bantel, 1992). Entrepreneurial teams with executive experience and start-up experience are also likely to acquire venture capital and reach initial public offerings (Beckman, Burton and O'Reilley, 2007). Similarly, teams with both business and technology human capital are more attractive to venture capitalists than teams with either business or technical human capital (Franke et al., 2008). Entrepreneurial teams with science, sales/marketing, management or business development experience are also more likely to create a top management team with the same type of experience (Beckman and Burton, 2008). In addition, entrepreneurial teams with a common prior company affiliation have both an exploration and exploitation strategy (Beckman, 2006) but teams with a diverse prior company affiliation are likely to have an exploration strategy but not an exploitation strategy. Hence, heterogeneous entrepreneurial teams composed of business and technology experience are useful to solve several challenges associated with new firm formation.

A few studies suggest that heterogeneous entrepreneurial teams are important in university spin-offs. Longitudinal empirical results show that successful firms have a high quality of science, a professional management team and funding in place, while unsuccessful firms have team members who are inexperienced in business management and lack of industry experience (Gurdon and Samsom, 2010). Technical experience and management experience are also critical in acquiring venture capital. Entrepreneurial teams with prior start-up experience and executives from their own social networks increase venture valuations and venture capital funding (Hsu, 2007). In a different way, the interaction between start-up experience and bridging ties, but also research experience and bridging ties, has a positive effect on firm growth in terms of new team member addition (Scholten et al., 2015). By contrast, entrepreneurial team members who have similar work experience have a negative effect on firm sales (Visintin and Pittino, 2014). Hence, entrepreneurial teams with a heterogeneous composition of industry, start-up and technology human capital are important to university spin-off formation and perhaps also to firm performance.

Taken together, there are three main gaps in entrepreneurial team research. First, many entrepreneurial team studies have taken the upper-echelon perspective and investigated the link between TMT composition and firm performance. Many of these studies have acknowledged the importance of heterogeneous TMTs in creating firm performance (Eisenhardt and Schoonhoven, 1990; Beckman and Burton, 2008). On the other hand, studies also argue that

team heterogeneity has negative effects on performance (Klotz et al., 2014) or no effects on firm performance (Chowdhury, 2005). This indicates a need to investigate the entrepreneurial team formation process, to increase our knowledge of how and why some teams have positive performance while other teams have negative performance.

Second, entrepreneurial team research often uses the terms ‘homogeneous’ and ‘heterogeneous’ to describe entrepreneurial team composition (e.g. Ruef, Aldrich, Carter, 2003; Uchbasaran, Lockett, Wright and Westhead, 2003; Chandler, Honig and Wiklund, 2005). These concepts provide a general idea about similarities and differences between team members in terms of, for example, work experience and education. These concepts provide a simplistic view of the several varieties of human capital that can exist in university spin-offs. Therefore, it is argued that a more nuanced picture of the different varieties of human capital composition in entrepreneurial teams is warranted.

Third, the few existing empirical studies of entrepreneurial team development in university spin-offs are based on qualitative case studies with a main focus on academic entrepreneurs as the leading entrepreneur in entrepreneurial team formation (Clarysse and Moray, 2004; Vanaelst et al., 2006). Clarysse and Moray (2004) focus on team development from a project team to an entrepreneurial team, the interrelationships and roles of the scientists and support from the university, the board of directors and market actors. Vanaelst et al. (2006) found that boards of directors and privileged witnesses, i.e. peers, technology transfer officers and business coaches, support the team of academic entrepreneurs in several ways in firm formation. The board of directors tried to attract investors and external entrepreneurs. The privileged witness screened the market for opportunities, tried to involve external entrepreneurs and took an advisory role. However, none of these studies has primarily investigated the role of external entrepreneurs in entrepreneurial team formation. Hence, it is time to extend the view of entrepreneurial team formation by also investigating the role of external entrepreneurs (Boo et al., 2015; Siegel and Wright, 2015).

The role of external entrepreneurs in entrepreneurial team formation is important to investigate for three reasons. External entrepreneurs may have a greater focus on business development and management tasks compared to academic entrepreneurs (Kassicieh, 2011). External entrepreneurs originate outside academia, in an environment where they might have acquired types of human capital and social networks that are different to those of academic entrepreneurs,

which can benefit the formation of entrepreneurial teams. External entrepreneurs contribute to the diversity of entrepreneurs in university spin-offs, which is important to develop a more nuanced picture of the varieties of entrepreneurs creating entrepreneurial teams. Hence, this thesis proposes the following research question.

*Research question 7: How and why do academic entrepreneurs and external entrepreneurs compose entrepreneurial teams?*

*Research question 8: How do the entrepreneurial teams, created by academic entrepreneurs and external entrepreneurs, influence university spin-off performance?*

### **3.5 Arriving at the research questions**

Eight research questions guide the overall purpose of this thesis. The knowledge gaps identified in the entrepreneurship literature in general and in university spin-off research in particular are the basis for these research questions. This section presents the title of the five research papers, the eight research questions and the relationship between the appended papers and the research questions (Table 3). A description and illustration of the conceptual framework follows (Figure 3). The conceptual framework illustrates the main theoretical concepts and the interrelations between these concepts and the research questions.

The conceptual framework illustrates the main theoretical concepts and interrelations between these concepts and the research questions of this thesis. More specifically, the conceptual framework illustrates the relationship between academic entrepreneurs' and external entrepreneurs' human capital and social network and the transition of firms between development phases, entrepreneurial team formation and firm performance in the formation of university spin-offs.

The main idea of this thesis is that academic entrepreneurs' and external entrepreneurs' human capital and social network, acquired inside and outside academia, influence the transition between firm development phases, entrepreneurial team formation and firm performance.

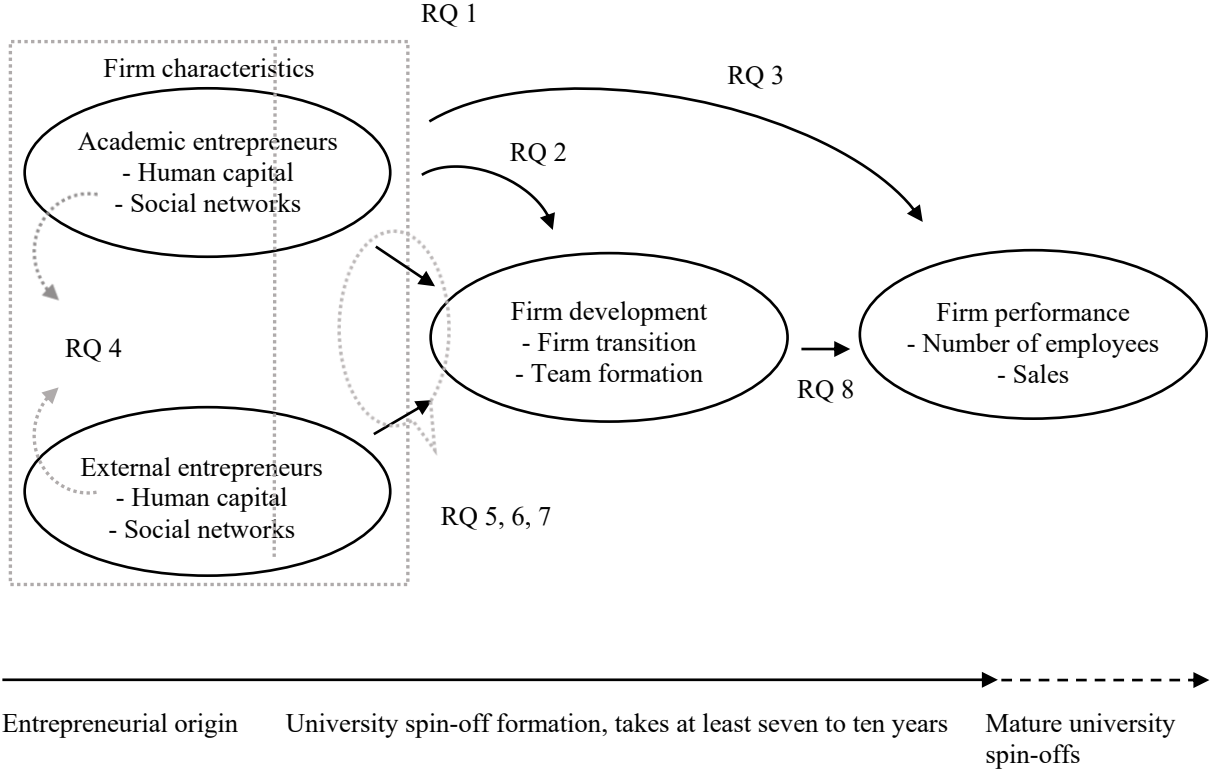
Table 3: The relationship between the five papers and the eight research questions

<p>Paper 1: Technology Entrepreneurship and Economic Evolution: The Role and Contribution of University spin-offs in the Regional Innovation System of Scania (Sweden).</p>	<p>RQ1: What are the typical characteristics of university spin-offs and corporate spin-offs?</p> <p>RQ2: How does entrepreneurial origin affect the formation of university spin-offs and corporate spin-offs?</p>
<p>Paper 2: Corporate and University spin-offs: A Study of Long-term Performance.</p>	<p>RQ3: How does entrepreneurial origin imprint the long-term performance of university spin-offs and corporate spin-offs?</p>
<p>Paper 3: Academic and External Entrepreneurs' Human Capital in the Formation of University spin-offs.</p>	<p>RQ4: What types of human capital have academic entrepreneurs and external entrepreneurs?</p> <p>RQ6: How and why does the human capital of academic entrepreneurs and external entrepreneurs influence the transition between development phases of university spin-offs?</p>
<p>Paper 4: Entrepreneurial Networks in University spin-offs – An Analysis of the External-entrepreneur model.</p>	<p>RQ5: How do academic entrepreneurs and external entrepreneurs use their social networks in university spin-offs?</p>
<p>Paper 5: The Formation of Entrepreneurial Teams in University spin-offs – A Case Comparison of Academic and External Entrepreneurs.</p>	<p>RQ7: How and why do academic entrepreneurs and external entrepreneurs compose entrepreneurial teams?</p> <p>RQ8: How do the entrepreneurial teams, created by academic entrepreneurs and external entrepreneurs, influence university spin-off performance?</p>

The first paper identifies the typical characteristics of university spin-offs by comparing them with corporate spin-offs that are likely to influence the formation of university spin-offs. The second paper tests the relationship between entrepreneurial origin (i.e. academia and industry) and the long-term performance of university spin-offs. This paper also compares university spin-offs with corporate spin-offs. The third paper builds on the first and second papers and creates a conceptual framework regarding the role of academic entrepreneurs' and external entrepreneurs' human capital in the transition between development phases. The fourth paper

also builds on the first and second papers and explains the differences between academic entrepreneurs' and external entrepreneurs' use of social networks. Finally, the fifth paper builds on the first, second and third papers and creates a typology of entrepreneurial teams created by academic entrepreneurs and external entrepreneurs. Papers 1, 3, 4 and 5 concern the firm formation process between when the firm is started and up to about seven to ten years, because this is about how long it takes before these firms start to generate significant sales. Paper 2 concerns long term performance at about 11 years of age and 25 years of age.

Figure 3: The role of academic entrepreneurs' and external entrepreneurs' human capital and social networks in university spin-off formation



## **4. RESEARCH METHODOLOGY AND RESEARCH DESIGN**

Research methodology concerns the thoughts and actions of knowledge creation and includes basic assumptions, research questions and research design. Research design refers to methods of study context, respondent selection, data collection and data analysis. Thus, this chapter will discuss basic assumptions and research design but also generalizability and limitations.

### **4.1 Basic assumptions**

The point of departure in this thesis is the basic assumptions because these influence the research questions and the research design (Bryman and Bell, 2011). Even if there are no perfect relationships between certain basic assumptions, research questions and research designs, there are tendencies of connections. Therefore, I describe the basic assumptions underlying this dissertation in the following text. Before this description, I describe the basic assumptions in business research in general. These assumptions are described in the terms of epistemology and ontology. Epistemology refers to the assumptions about the nature and limits of knowledge, i.e. the principles of knowledge creation. Ontology refers to the assumptions about the nature of existence, i.e. the principles of the existence of elements.

#### **4.1.1 Ontological assumptions**

In ontological terms, the assumption underlying this dissertation is influenced by the beliefs of both the objectivist and constructionist perspectives (see Bryman and Bell, 2011). Therefore, there is not pure objectivity or pure subjectivity (Bhaskar, 2008). This dissertation relies on three assumptions linked to ontology: that elements exist independently of social actors; that social actors produce the meaning of these elements; and that the meaning of social elements can be revised in relationships between social actors. This implies that aspects such as human capital and social networks exist independently of me as a social actor and that the language that I and other researchers use creates the meaning of these elements. Other social actors could most probably have studied these elements using other concepts, and thus come to conclusions similar to mine but expressed in other words. An example that supports this idea is a literature review of human capital studies within entrepreneurship research (Unger et al., 2011), which showed that factors such as education, start-up/owner experience, industry-specific experience, management experience, work experience, business education, parent entrepreneur, deliberate

practice etc. are indicators for human capital. As a result, other social actors such as researchers will probably also create other meanings for these elements in future research depending on the references they read and the preferences they have for different references. As a result, they will probably also revise the meanings of human capital, social networking and, probably, external entrepreneurs in interaction with other social actors such as peers, reviewers, editors and scholars in the research field.

#### **4.1.2 Epistemological assumptions**

In epistemological terms, critical realism has most likely influenced this thesis (see Bhaskar, 2008). To create the meaning of the elements that are studied, social actors need to express themselves in terms of numbers or words. From an objectivity point of view, these expressions are not perfect, better or worse; they serve different purposes. Most social actors need both of these ways of expression, numbers and words, to create knowledge about the elements of the study (see Miles and Huberman, 1994). An example is from Papers 3, 4 and 5, which are case studies and primarily use words to create meaning about academic entrepreneurs' and external entrepreneurs' human capital and social networks. The empirical findings being collected, which mostly rely on interviews, annual reports, CVs, sketches and project descriptions, and the interpretations of these findings are expressed mostly in words but also in some numbers. In Papers 1 and 2, meaning has been created by using numbers, more than in Papers 3, 4 and 5 because I wanted to say more about the larger populations in Papers 1 and 2 compared to those in Papers 3, 4 and 5. I have also created meanings of the data collected via statistics, questionnaires and annual reports, by expressing interpretations in both words and numbers.

#### **4.2 Research context and design**

A research design contains an interaction between three major parts: the researcher's assumptions about how social actors create knowledge (i.e. epistemology) and how social actors perceive the world (i.e. ontology); research questions; and research methods, including study context, selection of respondents, data collection and analysis (Bryman and Bell, 2011). As these parts are interrelated, this section will discuss each of them and relate them to the two research designs. The designs are the case study design and the survey design.

### 4.2.1 Study context

The study was conducted in Sweden, which is a small country with about ten million inhabitants. Sweden has a high ranking in international comparisons in terms of innovation and knowledge production (Andersson, Anokhin, Autio, Ejermo, Lavesson, Lööf, Savin, Wincent and Ylinenpää, 2013). The authors argue that Sweden has a high spending of gross domestic product (GDP) on research and development (R&D) compared to other OECD countries and that this is driving innovation and knowledge production. However, Sweden has a relatively low ranking in total entrepreneurship activity compared to other Global Entrepreneurship Monitor economies (Singer, Amoros and Moska, 2014). Researchers have called this negative relationship between high spending on R&D and low numbers of firms created the ‘academic paradox’ (Edquist and McKelvey, 1998) and, recently, also the ‘European paradox’ (e.g. Jacobsson, Lindholm Dahlstrand and Elg, 2013). Although it might look like Sweden suffers from this paradox, Jacobson et al. (2013) have concluded that Sweden performs well in the commercialization of academic research.

Sweden is different from most other European countries regarding the legislation of university technology ownership. While Sweden has kept the law that allows academic employees’ rights over their own research results, which is called the teachers’ exemption or the professors’ privilege, many other European countries have adopted the US model, based on the Bayh–Dole Act, which gives ownership rights to the university. Jacobsson et al. (2013) argue that Swedish academics have created many university spin-offs for a long time and that this might be due to the teachers’ exemption. Lindholm Dahlstrand (2001, 2004) shows that, among all new firms, about 15 per cent are new technology-based firms, of which about 8 per cent of these firms are corporate spin-offs, 2.6 per cent are university spin-offs and 4.4 per cent are an external or own idea. This points to Sweden as a country with many university spin-offs and an interesting country with an interesting type of firm to investigate.

Although researchers in most previous studies have treated the group of university spin-offs as a homogenous group of firms, this group of firms is not homogenous. Lindholm Dahlstrand (2008) shows there are three types of university spin-offs in Sweden. Of these, 24 per cent are direct university spin-offs (i.e. initiated by an academic entrepreneur), 62 per cent indirect university spin-offs (i.e. initiated by an academic entrepreneur who has worked in private industry) and 14 per cent external entrepreneurial university spin-offs (i.e. initiated by an



external entrepreneur). This last group is especially interesting to study because several researchers indicate that these entrepreneurs generate higher growth and revenue compared to other entrepreneurs (Lindholm Dahlstrand, 2008; Lundqvist, 2014). As a result, university spin-offs in Sweden is an interesting type of firm to study how and why external entrepreneurs' human capital and social networks contribute to university spin-off formation, development and performance.

To explore external entrepreneurs' human capital and social networks in university spin-off formation, and to contribute to development at both the theoretical and empirical level, I took part in or conducted fully two survey study designs and three case study designs. This choice was guided by the current explorative stage, with almost no knowledge of the characteristics and long-term performance of university spin-offs and the role of external entrepreneurs. Thus, there was a need to investigate the typical characteristics and long-term performance of university spin-offs by comparing them with corporate spin-offs. These two studies guided the other three studies to investigate academic entrepreneurs' and external entrepreneurs' social networking, human capital in firm transition and entrepreneurial team formation in university spin-off formation. A reason for this was also the explorative stage and almost complete absence of knowledge regarding the role of external entrepreneurs in university spin-offs.

To explain the long-term performance of university spin-offs and their characteristics and contribute to both theoretical and empirical level, a survey design was utilized. This choice was made because there are some indications in previous research that university spin-offs initiated by groups of external entrepreneurs perform differently from other types of spin-offs (see Lundqvist, 2014). Survey design was used to study the effectiveness of external entrepreneurs and the characteristics of university spin-offs, in a regional innovation system.

Taken together, I chose a survey design to answer research questions 1 to 3 and a case study design to answer research questions 4 to 8. The advantage of using two research designs is that they can complement each other as they have different purposes, capture different types of respondents and empirical results and generate different types of knowledge. A disadvantage of survey studies is the same as the strength of the case study, and the disadvantage of the case study is same as the advantage of the survey study: the knowledge they generate. The main purpose of survey studies is to test theory, while the main purpose of case studies is to build theory. Hence, these two research designs have two completely different types of generalization

(these are discussed later in this chapter). An overview summarizes each paper in terms of research question, research purpose and unit of analysis, research design, respondents, data collection and data analysis.

#### **4.2.2 Research questions and research methods**

This section discusses the relationships between the research questions, the research methods and the research designs of the five research papers.

Paper 1 – ‘Technology entrepreneurship and economic evolution – The role and contribution of university spin-offs in the regional innovation system of Scania (Sweden)’.

The research questions are: 1. What are the typical characteristics of university spin-offs and corporate spin-offs? 2. How does entrepreneurial origin affect the formation of university spin-offs and corporate spin-offs? The research purpose in this paper is to analyse the role and contribution of university spin-offs in the regional innovation system where they operate. Therefore, the unit of analysis is the firm, i.e. the different types of technology-based firms. The research design used is a survey design. This study contains a total number of 341 technology-based firms and among these are 85 corporate spin-offs, 46 university spin-offs and 210 other new technology-based firms. Data collection is from a questionnaire. Data analysis methods are mainly chi-square tests to compare the different categories of new technology-based firms i.e. corporate spin-offs, university spin-offs and independent new technology-based firms.

Paper 2 – ‘Corporate and university spin-offs – A study of long-term performance’.

The research question is: 3. How does entrepreneurial origin imprint the long-term performance of university spin-offs and corporate spin-offs? The research purpose is to analyse the long-term performance, in terms of growth of sales and number of employees, in different categories of entrepreneurial spin-off. Therefore, the unit of analysis is on the firm level, i.e. the different types of entrepreneurial spin-off. The research design is a survey design, complemented by financial and business data. The study contains 347 entrepreneurial spin-offs and among these are 169 corporate spin-offs, 69 university spin-offs and 109 other spin-offs. Data collection is from financial and business data and a questionnaire from a previous study. Data analysis

methods are independent t-tests and regression analyses to compare the different categories of entrepreneurial spin-off.

Paper 3 – ‘Academic and external entrepreneurs’ human capital in the formation of university spin-offs’

The research questions are: 4. What types of human capital have academic entrepreneurs and external entrepreneurs? 6. How and why does the human capital of academic entrepreneurs and external entrepreneurs influence the transition between development phases of university spin-offs? The research purpose in this paper is to develop a conceptual framework of the role of academic entrepreneurs and external entrepreneurs’ human capital in the transition between development phases of university spin-offs. Therefore, the unit of analysis is the firm level, i.e. the transition between the development phases of university spin-offs. The research design is a comparative case study design, including three firms created by external entrepreneurs and three firms created by academic entrepreneurs. Data collection is from semi-structured interviews, CVs, annual reports, life cycle sketches of milestones, development phases and critical events. The data analysis is a content analysis via first- and second-order coding of firm cases i.e. within-case analysis. After that, a cross-case analysis across firms and the two groups was conducted, aimed at detecting patterns between the firms and the two groups of entrepreneurs.

Paper 4 – ‘Entrepreneurial networks in university spin-offs – An analysis of the external-entrepreneur model’.

The research question is: 5. How do academic entrepreneurs and external entrepreneurs use their social networks in university spin-offs? The research purpose is to examine the networks used by external entrepreneurs and to compare them with networks used by academic entrepreneurs. Therefore, the unit of analysis is the firm level, i.e. social network in university spin-offs. The research design is a comparative case study design, including two firms created by external entrepreneurs and two firms created by academic entrepreneurs. Data collection is semi-structured interviews, annual reports, firm life cycle sketches of milestones, development phases, critical events and network actors. The data analysis is a content analysis of firm cases, i.e. a within-case analysis. After that, a cross-case analysis across firms and the two groups was conducted, aiming at detecting patterns between the firms and the two groups of entrepreneurs.

Paper 5 – ‘The formation of entrepreneurial teams in university spin-offs – A case comparison of academic entrepreneurs and external entrepreneurs of Sweden’.

The research questions are. 7. How and why do academic entrepreneurs and external entrepreneurs compose entrepreneurial team? 8. How do the entrepreneurial teams, created by academic entrepreneurs and external entrepreneurs, influence university spin-off performance? The research purpose in this paper is to develop a typology of the composition of human capital of entrepreneurial teams in the formation of university spin-offs initiated by academic and external entrepreneurs. Therefore, the unit of analysis is at the firm level, i.e. the formation of teams in university spin-offs. The research design used was a comparative case study design, including three firms created by external entrepreneurs and three firms created by academic entrepreneurs. Data collection is semi-structured interviews, CVs, annual reports, firm life-cycle sketches of milestones, development phases, critical events and entrepreneurial team members. The data analysis is a content analysis via first- and second-order coding of firm cases, i.e. a within-case analysis. After that, a cross-case analysis across firms and the two groups was conducted, aimed at detecting patterns between the firms and the two groups of entrepreneurs.

### **4.3 Empirical and analytical/theoretical generalization**

There are two types of generalizations: empirical generalization and analytical generalization, which is called theoretical generalization. The idea with empirical generalization is to generalize across a larger sample of firms than the study has covered. The institutional context in Sweden and of university spin-offs is special, which implies that empirical generalizations should be made with caution.

The ideas with Papers 1 and 2 are to investigate imprinting between the particular sample of university spin-offs and corporate spin-offs. The specific context in Sweden and of university spin-offs constrain the possibilities to generalize empirically to a larger group of firms beyond the studied firms. The specific institutional context of Sweden, in terms of laws and regulations such as the teacher’s exemption, which is also called professors’ privilege, constrains the possibility of generalizing across samples outside Sweden. The reason for this is that entrepreneurs’ and firms’ characteristics are probably different in countries without the teacher’s exemption because the university has an ownership in the intellectual property (IP)

via a so-called technology transfer office (TTO), which influences the composition of the firm's human capital and social networks. Second, the specific institutional contexts of university spin-offs and corporate spin-offs also call for caution in generalizing across other types of firms within Sweden. Different goals, reward systems and cultures between university spin-offs and corporate spin-offs mean that the results are generalizable to the same population of firms in Sweden. Papers 1 and 2 should be seen as papers contributing to develop the theory of university spin-off formation and performance. Hence, I hope that researchers can be inspired by the results of Papers 1 and 2 and test these results on similar samples in other countries or institutional settings.

The idea with theoretical generalization, also called analytical generalization, is to generalize the results to theoretical concepts that other studies can test. Given the current explorative stage of university spin-off research regarding external entrepreneurs, the intention with Papers 3, 4 and 5 was to make analytical generalizations or theoretical generalizations rather than empirical generalizations. The purpose of analytical or theoretical generalization is to build rather than to test theory. The explorative stage of university spin-offs implies a need to build rather than test the theory of the role of external entrepreneurs in university spin-offs. Therefore, the findings in these papers contribute to build theory regarding external entrepreneurs' human capital, social networks and the role of human capital in firm transition between development phases and entrepreneurial team formation.

Papers 3, 4 and 5 have the purpose of building theory by developing conceptual frameworks of academic entrepreneurs' and external entrepreneurs' human capital and social networks in university spin-off formation. Paper 3 provides a conceptual framework of academic entrepreneurs' and external entrepreneurs' human capital across development phases. Therefore, I encourage researchers to test the types of external entrepreneurs across development phases as suggested in the paper. Paper 4 provides theoretical ideas of network content, network governance and network structure and connections between these elements, which should be tested in future studies. Paper 5 provides a typology of the human capital composition of entrepreneurial teams created by external entrepreneurs, which can be used to categorize entrepreneurial teams to continue to build or test theory regarding entrepreneurial team formation and composition. Overall, the conceptual framework constructed for this thesis is a starting point and a possibility for future studies to test in larger samples and in other countries and industries.

## 5. SUMMARY OF APPENDED PAPERS

This chapter summarizes each of the five appended papers in terms of its title, author(s), research question and purpose of the study, research methods (i.e. unit of analysis) and main findings. The summary of the five papers is in an order similar to the eight research questions.

### **Paper 1 – ‘Technology Entrepreneurship and Economic Evolution: The Role and Contribution of University Spin-Offs in the Regional Innovation System of Scania (Sweden)’**

Authors: Anders Billström, Jonas Gabrielsson and Diamanto Politis

Research question/purpose: The research questions are. What are the typical characteristics of university spin-offs and corporate spin-offs? How does entrepreneurial origin affect the formation of university spin-offs and corporate spin-offs? The purpose is to test the role and contribution of university spin-offs in a regional innovation system by comparing them to corporate spin-offs and other independent technology-based firms.

Frame of reference: The frame of reference builds upon previous research comparing corporate spin-offs, university spin-offs and other new technology-based firms. Literature on organizational imprinting is also included.

Research methods: The research design is a survey study design based on a sample of 1,052 new technology-based firms, from which 341 responded, which equates to a response rate of about 32 per cent. From the 341 firms, 85 were corporate spin-offs, 46 were university spin-offs and 210 were other new technology-based firms. Data was collected based on a questionnaire asking for firm characteristics, cooperation with universities, evolutionary process, firm functional roles, R&D and innovation activities, novelty in market offering, and position in industry life cycle. Data was analysed mainly using the chi-square method to reveal differences between the firms.

Main findings: The main findings are threefold. First, the results demonstrate that university spin-offs are much more actively involved with universities than corporate spin-offs and other new technology-based firms are. This can be seen in, for example, the number of instances of

cooperation with universities, involving employees and/or students in R&D and consulting work, joint R&D projects and recruiting employees from universities. Second, the results show that university spin-offs offer more breakthrough products, have more R&D activity and are in an earlier phase of the industry life cycle than corporate spin-offs and other new technology-based firms. Third, the results also show that corporate spin-offs have higher sales in their closest regions and that they more often take the role of subcontractors, software/system developers and consultants, while university spin-offs act more often as providers of R&D services. The paper contributes to imprinting literature and studies comparing university spin-offs and corporate spin-offs.

## **Paper 2 – ‘Corporate and university spin-offs: A study of long-term performance’**

Authors: Åsa Lindholm Dahlstrand and Anders Billström

Research question/purpose: The research question is. How does entrepreneurial origin imprint the long-term performance of university spin-offs and corporate spin-offs? The purpose is to test the imprinting effect of different types of university spin-offs on long-term performance in terms of sales growth and number of employees. To address the purpose, three questions guide the paper. Are university spin-offs (USOs) innovative firms with limited long-term growth? Are corporate spin-offs (CSOs) more likely to create long-term growth? Are entrepreneurs with mixed prior knowledge, that is, experience from both university and private firms, able to combine these skills in order to create innovative firms with long-term high growth?

Frame of reference: The frame of reference builds upon previous studies of spin-off studies including university spin-offs and corporate spin-offs. The frame of reference also includes comparative studies between corporate spin-offs and university spin-offs and different categories of university spin-offs such as direct and indirect university spin-offs and external entrepreneur firms.

Research methods: The research design was originally a survey study design used in a previous paper (i.e. Lindholm Dahlstrand, 2001) with additional firm financial and business information collected for all surviving firms in 2012. In total, 344 firms with performance data from 1997 were included in the 2012 sample. We searched for performance data for all the 344 firms but could collect data on only 231 firms. This implies that 67 per cent of the firms from the 1997

sample had survived. Out of the 113 firms that we could not find information about, only 61 (19 per cent) were out of business. The remaining 65 firms had been acquired or merged (13 of these were included in the analysis as we found performance data for them). Data was analysed mainly with independent t-tests and correlation and regression analysis.

**Main findings:** The main findings are threefold. First, the results demonstrate that firms with external entrepreneurs have the highest performance in terms of number of employees and sales in both 1997 (at about 11 years of age) and 2012 (at about 25 years of age). However, this group of firm is very small and in 2012 included only four firms. This calls for careful interpretation of the results. Second, the results show that in 1997 corporate spin-offs performed with significantly higher sales than university spin-offs, but this difference had disappeared in 2012 as the analysis showed no significant differences in terms of number of employees or sales. Third, the results show that university spin-offs with a research relationship early in their life to the parent university gives a positive long-term effect on sales while a later relationship instead has a strong negative effect on number of employees. The results contribute to the long-term perspective of the literature on university spin-off performance.

### **Paper 3 – ‘Academic and external entrepreneurs’ human capital in the formation of university spin-offs’**

Author: Anders Billström

**Research question/purpose:** The research questions are. What types of human capital have academic entrepreneurs and external entrepreneurs? How and why does the human capital of academic entrepreneurs and external entrepreneurs influence the transition between the development phases of university spin-offs? The purpose is to develop a conceptual framework of the role of academic and external entrepreneurs’ human capital in the transition between formation phases of university spin-offs.

**Frame of reference:** The frame of reference builds on entrepreneurship studies on life-cycle theory, human capital theory and literature on academic entrepreneurs and external entrepreneurs.



Research methods: The research design is a case study design of six cases, of which three case firms represent academic entrepreneurs and three case firms represent external entrepreneurs. Data collection consists mainly of semi-structured interviews, CVs and life-cycle sketches of firm development. Content analysis via first- and second-order codes and within- and cross-case analysis guided the analysis of this paper.

Main findings: The main findings are twofold. First, the results show four types of external entrepreneur: habitual external entrepreneur, industry external entrepreneur, novice external entrepreneurs and expert external entrepreneurs. Second, the entrepreneurs benefit the transition between development phases as follows. Novice external entrepreneurs benefit all development phases as apprentices because of limited start-up and industry experience. Habitual external entrepreneurs' start-up experience is useful in opportunity recognition and the pre-organization phase. Industry external entrepreneurs' industry experience is key in the pre-organization, re-orientation and sustainable return phases. Expert external entrepreneurs utilize industry and start-up experience in all development phases, except for the research phase.

#### **Paper 4 – ‘Entrepreneurial networks in university spin-offs – An analysis of the external-entrepreneur model’**

Authors: Anders Billström, Diamanto Politis and Jonas Gabrielsson

Research question/purpose: The research question is. How do academic entrepreneurs and external entrepreneurs use their social networks in university spin-offs? The purpose is to examine the social networks in terms of network content, network governance and network structure used by academic entrepreneurs and external entrepreneurs.

Frame of reference: The frame of reference builds on three network elements found to be essential for entrepreneurial firms. These network elements are network content, network governance and network structure. The paper also uses literature of academic entrepreneurs and external entrepreneurs.

Research methods: The research design is a case study design based on four cases, representing two firms with external entrepreneurs and two firms with an academic entrepreneur. The data

consists mainly of semi-structured interviews and life-cycle sketches of firm development. The data was analysed by content analysis and within- and cross-case analysis.

Main findings: The main findings are threefold. First, each type of entrepreneur gets similar content from their networks, i.e. business information, motivational support, material, equipment and legitimacy. Second, external entrepreneurs rely on informal ties with the wider business community to get access to business resources, while academic entrepreneurs use formal ties with university incubators and thus get indirect access to business resources. Third, external entrepreneurs' positions are at the centre of both business and technology networks, with direct access to both market and technology resources. Academic entrepreneurs' positions are at the centre of technology networks and at the periphery of business networks, with indirect access to market resources and direct access to technology resources.

### **Paper 5 – ‘The formation of entrepreneurial teams in university spin-offs – A case comparison of academic and external entrepreneurs’**

Author: Anders Billström

Research question/purpose: The research questions are. How and why do academic entrepreneurs and external entrepreneurs compose entrepreneurial teams? How do the entrepreneurial teams created by academic entrepreneurs and external entrepreneurs, influence university spin-off performance? The purpose is to develop a typology of entrepreneurial team composition created by academic entrepreneurs and external entrepreneurs in university spin-offs.

Frame of reference: The frame of reference builds on studies of entrepreneurial team formation, academic entrepreneurs and external entrepreneurs and human capital theory in entrepreneurship.

Research methods: The research design is a case study design of six cases, of which three firms had academic entrepreneurs and three firms had external entrepreneurs. Data consists mainly of semi-structured interviews, CVs, life-cycle sketches of firm development and annual reports. The data was analysed by content analysis via first- and second-order codes through a within-case analysis. Then data was analysed by a cross-case analysis.

Main findings: The main findings are threefold. First, the results show a typology of novice entrepreneurial teams (with general industry and start-up human capital), industry entrepreneurial teams (with specific industry and general start-up human capital), habitual entrepreneurial teams (with general industry and specific start-up human capital) and expert entrepreneurial teams (with specific industry and start-up human capital). The results also shows technology entrepreneurial teams, with general and/or specific technology human capital. Second, the results demonstrate that academic entrepreneurs mainly create technology entrepreneurial teams to develop and patent the technology. They seem to stay as a novice entrepreneurial team, in terms of general industry and start-up human capital. An external entrepreneur creates an expert entrepreneurial team to fuel and balance the industry and technology human capital. Another external entrepreneur does not develop the entrepreneurial team and remain in the small team, called habitual entrepreneurial team, to save resources due to prior start-up human capital. Finally, the third external entrepreneur tries to keep the industry entrepreneurial team together, to move the firm towards the market. Third, the formation of entrepreneurial teams is a dynamic and changing process that mainly affects firm performance in number of employees but not in sales.

## **6. DISCUSSION AND CONCLUSION**

This thesis provides a conceptual framework of the role of academic entrepreneurs' and external entrepreneurs' human capital and social networks in the formation and development of university spin-offs. The framework illustrates the key concepts, the relationship between these concepts and the two types of entrepreneurs. The key concepts are human capital, social networks, firm transition, team formation and firm performance (see Figure 3). This chapter presents the eight research questions connected to the five research papers and discusses the theoretical and empirical contributions, research limitations and suggestions for future research. This chapter also addresses the overall research question and the purpose of this thesis.

### **6.1 Theoretical and empirical contributions to entrepreneurship research**

This section presents the eight research questions and discusses the theoretical and empirical contributions to entrepreneurship research. The section contains four parts: (a) typical characteristics and long-term performance of university spin-offs, (b) the combination of human capital and social networking of university spin-offs, (c) entrepreneurial team formation of university spin-offs and (d) the role of external entrepreneurs. This thesis contributes to entrepreneurship research in four ways. First, the thesis identifies typical characteristics of university spin-offs and corporate spin-offs that influence the formation and imprint the long-term performance of these firms. Second, the thesis extends the knowledge of the combined value of human capital and social networking in the firm formation process. Third, the thesis also nuances entrepreneurial team research by providing a typology of entrepreneurial teams created by academic and external entrepreneurs. Fourth, the thesis granulates the one-sided and stereotypical picture of academic entrepreneurs' and external entrepreneurs' human capital and social networks in firm formation.

#### **6.1.1 Typical characteristics and long-term performance of university spin-offs**

This section, about the typical characteristics and long-term performance of university spin-offs, addresses the first and second research questions.

*RQ1: What are the characteristics of university spin-offs and corporate spin-offs?*

*RQ2: How does entrepreneurial origin imprint the formation of university spin-offs and corporate spin-offs?*

There are several typical characteristics of university spin-offs and corporate spin-offs. University spin-offs network more with their local universities, employ more university graduates, develop more breakthrough technologies and have positions at earlier development phases than corporate spin-offs do. University spin-offs also have lower sales than their corporate counterparts have. The academic experience and network most likely influence the firm to employ university graduates to develop breakthrough technologies and position the firm at an early position of development. These characteristics also influence the firm to achieve modest sales compared to corporate spin-offs. The academic origin influences the firm to focus on research and technology development, while the corporate origin influences the firm to focus on business and commercial development. Since this study only compares university spin-offs and corporate spin-offs, the relationships between the characteristics is only hypothetical. Table 4 summarizes the results of the first and second research question.

Table 4: Typical characteristics of university spin-offs and corporate spin-offs

Corporate spin-offs	University spin-offs
...have few network ties to their local university	...have many network ties to their local university
...employ few university graduates	...employ many university graduates
...develop few breakthrough technologies	...develop many breakthrough technologies
...have positions at a late development phase	...have positions at an early development phase
...have high sales	...have low sales
Industry influences corporate spin-offs to:	Academia influences university spin-offs to:
...employ fewer university graduates	...employ university graduates
...develop fewer breakthrough technologies	...develop breakthrough technologies
...have an late position in the development phases	...have an early position in the development phases
...achieve high sales	...achieve low sales

This thesis contributes extended and verified knowledge regarding typical firm characteristics of university spin-offs. The results of this thesis show that university spin-offs have network

links to their local universities and that academic entrepreneurs initiate most of these firms. These network ties are very important in the firm formation process to develop breakthrough technologies, employ university graduates, set up joint R&D collaborations and have a research-intensive organization. The understanding that university spin-offs create breakthrough technologies and employ university graduates supports previous studies of large US universities, which focus only on university spin-offs (Steffensen et al., 2000; Shane, 2004). Hence, this thesis confirms this knowledge and strengthens it because of the comparison with corporate spin-offs. The results showing details of R&D collaborations with parent universities and their positions at early phases of firm development also extend previous empirical findings showing that these firms network with their local universities more than corporate spin-offs do (Lindholm Dahlstrand, 2001). Overall, strong technology focus and network ties to the local university contribute to explaining why some university spin-offs have difficulties in crossing the valley of death (Barr et al., 2009) and in growing the firm (Mustar et al., 2008).

These theoretical and empirical contributions imply that the local university plays an important role in the formation of university spin-offs and in the regional economic system. The employment of university graduates is one example of the regional economic contribution of these firms. Still, they have lower sales in the region than their corporate counterparts do. This result confirms studies of European mid-range universities, which claim that few university spin-offs grow (Mustar et al., 2008). Hence, the parent universities from which these firms originally spun off imprint the new firm with initial networks and R&D work experience that are important mainly for the development of breakthrough technologies. These results build the foundation for testing the relationship between these entrepreneurial characteristics and long-term performance, with the intention to investigate whether these characteristics are long-lasting or whether they diminish over time. Hence, the next section addresses the third research question, about the long-term performance of university spin-offs and corporate spin-offs.

*RQ3: How does entrepreneurial origin imprint the long-term performance of university spin-offs and corporate spin-offs?*

This thesis demonstrates that entrepreneurial origin imprints the long-term performance of university spin-offs and corporate spin-offs in three ways. First, entrepreneurial origin from outside the university (i.e. external entrepreneurs) has a positive effect on long-term sales and number of employees when the firm is about 11 years and 25 years old, respectively. They

outperform other university spin-offs, i.e. those started by an academic entrepreneur *with* industry experience and those *without* industry experience, as well as corporate spin-offs. University spin-offs founded by an academic entrepreneur *with* prior industry experience have higher performance than those *without* prior industry experience. This implies that firms with mixed entrepreneurial origins have the most positive long-term performance.

Corporate spin-offs have significantly higher performance than university spin-offs at the age of about 11 years but the difference has disappeared at the age of 25 years. These results support previous findings that university spin-offs focus on R&D (e.g. Rothaermel and Thursby, 2005) while corporate spin-offs focus on business development (e.g. Bonardo et al., 2010). Hence, it takes between 11 and 25 years before university spin-offs cross the valley of death and generate significant sales. This thesis also demonstrates that networks between the university spin-off and the parent university early in the firm’s life have positive long-term effects on sales but a later research relationship has a negative effect on the number of employees. Again, the academic origin influences the firm in the very early phases of firm formation, while origin outside the university influences the firm’s later life, which extends the previous findings of the early phases of firm formation. Table 5 summarizes the results of the third research question.

Table 5: Long-term performance of corporate spin-offs and university spin-offs

Corporate spin-off performance	University spin-off performance
Corporate spin-offs have the highest sales and number of employees at the age of 11 years compared to university spin-offs.	University spin-offs with <i>external entrepreneurs</i> have the highest sales and number of employees at the firm age of 11 years and 25 years.
Corporate spin-offs do not have significantly higher sales or number of employees at the age of 25 years than mixed-origin university spin-offs do.	University spin-offs with <i>mixed-origin</i> (academic entrepreneurs with prior industry experience) have higher sales than those of an academic origin (academic entrepreneurs without prior industry experience) at the firm age of 11 years and 25 years.

The results points to the importance of treating university spin-offs as a heterogeneous group of firms, rather than a homogenous group of firms in terms of the type of founder. This also

supports previous research suggesting that external entrepreneurs play a significant role in university spin-off performance (Lindholm Dahlstrand, 2008; Lundqvist, 2014; Hayter, 2016). However, the number of external entrepreneurs in the first and second papers was too small to provide any statistically significant results. Although the results were not statistically significant, external entrepreneurs are the highest performing entrepreneurs compared to other university spin-offs and corporate spin-offs. This calls for policy attention to increase the number of external entrepreneurs in the formation of university spin-offs. It also calls for more research attention to investigate external entrepreneurs in studies with larger samples.

This thesis also demonstrates that networks between the university spin-off and the parent university early in the firm's life have positive long-term effects on sales but later research relationship has a negative effect on the number of employees. This finding also supports the theory of organizational imprinting, which claims that the environment and the entrepreneur imprint the new firm with initial characteristics (Boeker, 1988). Taken together, both mixed prior work experience and research networks with the parent university are important in the formation of university spin-offs and for long-term performance.

The long-term perspectives of 11 years and 25 years of age go beyond earlier studies, which have investigated considerably shorter time spans, such as one year (Zhang, 2009), three years (Zahra et al., 2007), eight years (Wennberg et al., 2011) and ten years (Lindholm Dahlstrand, 2001). Thus, this thesis adds knowledge regarding the imprinting effects of entrepreneurs' prior experience and network ties to the firms' parent universities by extending the time perspective. The results of entrepreneurs' prior work experience and early network ties support the main idea of organizational imprinting and the long-lasting effect over time (see e.g. Simsek et al., 2015). The result that network ties to the parent university later in the firm's life have a negative effect on long-term performance rather supports the idea that entrepreneurial characteristics also can diminish over time (Marquis and Tilcsik, 2013). Hence, the environment and the entrepreneur are two important sources of imprints in the very early phases of firm formation, when the new firm experiences sensitive periods, but the effects can take as long as 25 years to recognize.

The time span of university spin-off formation of seven to ten years investigated in prior research and presented in the conceptual framework of this thesis are very important years of firm formation. The very interesting effects of the entrepreneurial origin appear between 11



years of age and 25 years of age, when the performance of these firms reaches parity with that of corporate spin-offs. However, these findings are the result of a cross-sectional sample of firms because analysis of separate industries were not possible. Therefore, firms from one industry probably reach the commercial market faster than other firms in other industries. It is likely that, for example, an ICT firm developing computer software could reach the commercial market in a few years while med-tech firms will probably never reach any market sales because most firms could not afford the expensive clinical trials. Instead, a global medical corporation capable of affording the necessary clinical tests will perhaps acquire these firms.

To sum up, it is evident that academic entrepreneurs play an important role in interactions with the parent university and in the creation of breakthrough technologies. These entrepreneurs are important carriers of blueprints from the parent university in the formation of university spin-offs. It is also clear that university spin-offs with entrepreneurs of mixed experience have performance benefits later in the firms' lives. In other words, entrepreneurs' prior experience and networks influence firm formation and imprint long-term performance. The results support studies indicating that prior industry experience is essential for firm performance across time (Ensley and Hmieleski, 2005; Wennberg et al., 2011). This result confirms the proposition of several researchers that it takes a long time before university spin-offs generate significant performance and that external entrepreneurs play a key role in this process. Therefore, this thesis continues to investigate the role of academic entrepreneurs and external entrepreneurs in university spin-off formation in terms of human capital, social networking and role in firm transition between development phases and role in entrepreneurial team formation.

### **6.1.2 The combination of human capital and social networking of university spin-offs**

This section, about the complementary and compensatory nature of the human capital and social networking of university spin-offs, addresses the fourth, fifth and sixth research questions. The fourth research question is:

*RQ4: What types of human capital have academic entrepreneurs and external entrepreneurs?*

The thesis demonstrates both similarities and differences between academic entrepreneurs' and external entrepreneurs' human capital. Academic entrepreneurs have general but not specific start-up and industry human capital. Even though they have start-up and industry experience,

they use them to a low degree in the firms. External entrepreneurs also have general but also specific start-up and industry human capital. This creates four types of external entrepreneurs: (a) novice external entrepreneurs, with general start-up and industry human capital, (b) expert external entrepreneurs with specific start-up and industry human capital, (c) industry external entrepreneurs with general start-up and specific industry human capital and (d) habitual external entrepreneurs with specific start-up and general industry human capital. The results also show that academic entrepreneurs have general and specific technology human capital, while external entrepreneurs only have some general technology human capital. Therefore, academic entrepreneurs are key individuals in the performance of R&D tasks and external entrepreneurs are important in solving entrepreneurial and industry tasks. These findings support the empirical results of Papers 1 and 2 that academic entrepreneurs are important to develop breakthrough technologies and explain why external entrepreneurs perform the highest sales and number of employees in the long term. The next paragraph addresses the sixth research question, about the role of human capital in university spin-off formation.

*RQ6: How and why does the human capital of academic entrepreneurs and external entrepreneurs influence the transition between development phases of university spin-offs?*

Academic and external entrepreneurs' human capital partly overlaps in the firm transition between formation phases. Academic entrepreneurs provide technology human capital and move the firm from the research phase to the opportunity-framing phase and from the opportunity-framing phase to the pre-organisation phase. Habitual external entrepreneurs support the firm in the transition from the opportunity-framing phase to the pre-organisation phase and from the pre-organization phase to the re-orientation phase. Since academic entrepreneurs also have some start-up human capital, though this is seldom as extensive as that of external entrepreneurs, they are also useful in the transition to the pre-organisation and the re-orientation phases. Industry external entrepreneurs contribute to firm transition from the pre-organisation phase to the re-orientation phase and from the re-orientation phase to the sustainable return phase. Expert external entrepreneurs are useful in all phases of firm formation, except for the research phase, owing to the various types of human capital. Finally, this thesis also shows that student entrepreneurs have less industry and start-up human capital and therefore several academic entrepreneurs perceived them to be less useful in firm formation. This is probably because they are still young and have not had time to acquire such work

experience. Instead, the academic entrepreneurs hired external entrepreneurs with more human capital.

Academic and external entrepreneurs complement each other in terms of start-up, industry and technology human capital. This thesis confirms and explains prior speculations of complementary human capital and social networks between academic entrepreneurs and external entrepreneurs (Wright et al., 2007). However, they do not complement each other perfectly in each entrepreneurial team because not all academic entrepreneurs have both start-up and industry human capital. Another reason is that not all of the external entrepreneurs have a complete set of general and specific start-up and industry human capital. These findings explain that university spin-offs with mixed entrepreneurial origins have higher performances than university spin-offs that only have academic origins, because they have complementary human capital. Table 6 summarizes academic entrepreneurs' and external entrepreneurs' human capital and how and why they contribute to the transition between formation phases.

Table 6: Types and use of human capital in firm transition between development phases

Academic entrepreneurs' human capital	External entrepreneurs' human capital
General <i>but not</i> specific start-up and industry human capital	General <i>and</i> specific start-up and industry human capital
General <i>and</i> specific technology human capital	General <i>but not</i> specific technology human capital
How?	
<i>Industry human capital</i> contributes to cross the pre-organization and re-orientation phases	
<i>Start-up human capital</i> contributes to cross the opportunity framing and pre-organization phases	
<i>Technology human capital</i> contributes to cross the research and opportunity-framing phases	
Why?	
<i>Academic entrepreneurs</i> solve tasks in the research and opportunity-framing phases.	
<i>Habitual external entrepreneurs</i> solve tasks in the opportunity-framing and pre-organization phases.	
<i>Industry external entrepreneurs</i> solve tasks in the pre-organization, re-orientation and sustainable return phases.	
<i>Expert external entrepreneurs</i> solve tasks in all phase of firm formation, except the research phase.	
<i>Novice external entrepreneurs</i> have limited start-up and industry human capital.	

Finally, the results point to external entrepreneurs being better prepared and suited for business decisions than academic entrepreneurs, but there are several challenges with involving external entrepreneurs. Since they originate outside academia, often in a business-intensive environment that is different from academia, they can create conflicts with the academic entrepreneurs in the entrepreneurial team (Clarysse and Moray, 2004). External entrepreneurs have a large focus on business operations and lower priority on R&D, which may lead to underdeveloped technologies and a loss of novelty in relation to other firms. External entrepreneurs have different types and degrees of start-up and industry human capital, which create the challenge to find the fit between the current and future needs for human capital in the firm. Hence, the dynamics of the entrepreneurial team are a great challenge (Clarysse and Moray, 2004; Vanaelst et al., 2006; Wright et al., 2007). The next section addresses the fifth research question, about the academic and external entrepreneurs' use of social networks in university spin-offs.

*RQ5: How do academic entrepreneurs and external entrepreneurs use their social networks in university spin-offs?*

The thesis demonstrates both similarities and differences between academic entrepreneurs' and external entrepreneurs' use of social networks. This thesis investigated network content, network governance and network structure. Academic and external entrepreneurs use the networks similarly in terms of the content they gain from them. They gain business information, motivational support, material, equipment and legitimacy but external entrepreneurs get more market information. The differences are in network governance and network structure. External entrepreneurs rely on informal ties with the business community to get access to business resources and academic entrepreneurs use formal ties with university incubators to get access to business resources. The network structure shows that external entrepreneurs have a position at the centre of both business and technology networks, with direct access to market and technology resources. Academic entrepreneurs have a position at the centre of technology networks but at the periphery of business networks, with indirect access to market resources and direct access to technology resources.

These results support the findings of Paper 2, that university spin-offs have positive exchanges with their local and parent universities early in the firms' lives. The detailed findings explain the importance of the incubator for academic entrepreneurs' and external entrepreneurs' independence. The direct access to business resources is probably helpful together with industry

and start-up human capital in the development of the entrepreneurial team and for crossing the pre-organization phase. Academic entrepreneurs' strong networks to academia and the acquisition of useful resources for R&D activities confirm prior conceptual and empirical indications of academic entrepreneurs' network ties to academia (e.g. Radosevich, 1995a; Hayter, 2016). External entrepreneurs' central position in business networks confirms prior conceptual and empirical indications that they most likely have industry networks (Radosevich, 1995a; 1995b; Kassicieh, 2011). External entrepreneurs' central position in technology networks also contrasts and extends these three indications because they are both similar and different to academic entrepreneurs. External entrepreneurs' position in business and technology networks also adds to prior findings regarding their financial preferences. External entrepreneurs prefer private sources of finance such as venture capitalists and business angels, while they have a lower proclivity for public sources of finance like grants and government soft loans (Politis et al., 2013). This implies that even though they have networks to academia and industry they are selective in using the resources. Table 7 summarizes the results.

Table 7: Academic and external entrepreneurs' social networking in university spin-offs

	Academic entrepreneurs	External entrepreneurs
Network content	Business information, motivation, material, equipment and legitimacy	Business information, motivation, material, equipment, legitimacy and market information
Network governance	Formal ties to university incubator to get access to (indirect) resources	Informal ties to business community to get access to (direct) resources
Network structure	Central position in technology networks but a peripheral position of business networks	Central position in business and technology networks

This thesis extends earlier research in entrepreneurship that has investigated the value of both human capital and social networking in the firm formation process (Davidsson and Honig, 2003; Obschonka et al., 2012; Hsiao et al., 2013; Scholten et al., 2015; Semrau and Hopp, 2015). The empirical findings support and extend the complementary model, i.e. when human capital and networking add to each other. The findings also illustrate and extend the compensatory model, i.e. when human capital and social networking do not add to each other. This implies that the combination of human capital and social networks in the formation process is neither always complementary nor always compensatory but complementary in some

situations and compensatory in others. Overall, this thesis nuances the complementary and compensatory models across development phases.

Academic entrepreneurs' human capital and social networks are complementary in the early phases of research and opportunity framing and compensatory in the later phases of university spin-off formation. Academic entrepreneurs obviously use their research experience and direct access to technology networks in the research phase. They also use their research experience and direct access to technology networks to get access to equipment, create the technology and frame the opportunity. Framing the opportunity is very similar to framing a research idea, says one of the academic entrepreneurs. Academic entrepreneurs' human capital and social networks are also compensatory in the later pre-organization, re-orientation and sustainable return phases. The reason for this is that they have a central position in research networks and extensive technology human capital that they cannot use in these later phases as much as in earlier phases. On the other hand, if one of the academic entrepreneurs has prior start-up human capital and another has industry human capital, one of these types of human capital can complement a position in the outskirts of industry networks. In the research phase, these experiences and indirect access to business networks have little value and is thus compensatory.

However, the indirect access to and position at the periphery of the business network can explain why academic entrepreneurs have challenges in building network ties with the business community (see Mosey and Wright, 2007). It can also explain why they have challenges in involving people other than engineers and researchers to the entrepreneurial team (Clarysse and Moray, 2004; Vanaelst et al., 2006). Overall, technology human capital and research networks are especially important in moving the firm between the research phase and the opportunity-framing phase. One reason for this is that the entrepreneur can combine the human capital and social networks to solve R&D tasks (Clarysse and Moray, 2004). Another explanation is that they can use research experience together with bridging ties to involve more entrepreneurs (Scholten et al., 2015). In the later phases, limited industry and start-up human capital and business networks are seldom enough to cross the entrepreneurial commitment juncture and reach the pre-organization phase. In other words, academic entrepreneurs sometimes have the challenge in crossing the valley of death (Barr et al., 2009).

The external entrepreneurs' human capital and social networks are also both complementary and compensatory across development phases. They are complementary because the

entrepreneurs' central location in both business networks and technology networks adds to the lack of technology human capital. The external entrepreneurs sometimes use the academic entrepreneur or researchers in technology, and business discussions with different actors, to complement their lack of technology human capital. This complementary role of external entrepreneurs' networks is important in the opportunity framing, pre-organization and re-orientation phases. This can explain why university spin-offs with external entrepreneurs can make the transition between the opportunity-framing phase and pre-organisation phase and further on to the re-orientation phase (see Vohora et al., 2004).

External entrepreneurs' industry networks complement the start-up and industry human capital in the later phases of university spin-off formation. This explain why external entrepreneurs are not equally dependent on business incubators as academic researchers. For example, one of the external entrepreneurs utilizes his and the central position of business networks to search for and establish market contacts. Another external entrepreneur utilizes their start-up human capital to decide not to involve more entrepreneurial team members to save money for the firm. This example shows that start-up human capital is useful to decide not to use the business and technology networks and potentially involve new team members. These cases illustrate the complementary model and shows that the human capital and social network add value to each other (Semrau and Hopp, 2015; Scholten et al., 2015). The other external entrepreneur is an example of the compensatory model because of the unused industry and start-up human capital and business networks. The firm can potentially use this buffer of human capital and social networks if it reaches the later sustainable return phase of firm formation.

Overall, the human capital and business networks are useful for solving start-up and management tasks, such as identifying markets and interacting with potential customers and industry partners but also creating an entrepreneurial team with industry and technology human capital. The industry human capital and business network of external entrepreneurs contribute to market credibility, market strategies and firm establishment, which are important tasks in the pre-organization, re-orientation and sustainable return phases.

Taken together, the empirical findings that academic entrepreneurs' and external entrepreneurs' human capital and social networks are complementary in the firm formation process strengthen and add to the complementary model (Semrau and Hopp, 2015) and confirm prior speculations (Wright et al., 2007). The complementary model contributes to explaining why academic

entrepreneurs are able to make the firm transition from the research phase to the opportunity-framing phase and why external entrepreneurs are able to make the firm transition from the opportunity-framing, pre-organization and re-orientation phases. Hence, this thesis adds to the recent findings of the complementarity between research and start-up experience and bridging ties for adding new team members in the university spin-off context (Scholten et al., 2015). In the phases when the human capital and social network are not complementary, they are compensatory, i.e. they do not add to each other. There is no empirical support of the transition to the sustainable return phase because none of the external entrepreneurs has reached this phase.

### **6.1.3 Entrepreneurial team formation of university spin-offs**

This section is about how and why academic and external entrepreneurs compose entrepreneurial teams. The section presents and addresses the seventh and the eighth research questions.

*RQ7: How and why do academic entrepreneurs and external entrepreneurs compose entrepreneurial teams?*

*RQ8: How do the entrepreneurial teams, created by academic entrepreneurs and external entrepreneurs, influence university spin-off performance?*

The thesis demonstrates a typology of four different types of entrepreneurial teams based on the teams' composition of start-up and industry human capital. *The novice entrepreneurial team* has general start-up and/or general industry human capital. Academic entrepreneurs developed the technology entrepreneurial team and the novice entrepreneurial team when they involved student entrepreneurs to investigate the market. *The expert entrepreneurial team* has specific start-up and specific industry human capital. The external entrepreneur involved engineers but no individuals with start-up or industry human capital because the firm has a patenting strategy. *The habitual entrepreneurial team* has specific start-up and general industry human capital. The external entrepreneur decided not to involve any team members to save resources and investigate the market himself. *The industry entrepreneurial team* has general start-up and specific industry human capital. The external entrepreneur involved salespeople and engineers to balance the industry and technology human capital and to prepare the firm for the market.



Hence, all teams except for the habitual team contributed to university spin-off performance in terms of number of employees. Table 8 summarizes the results.

Table 8: Entrepreneurial team formation in university spin-offs

Teams created by academic entrepreneurs	Teams created by external entrepreneurs
Novice entrepreneurial team (general industry and/or general start-up human capital)	Expert entrepreneurial team (specific industry and specific start-up human capital)
Technology entrepreneurial team (specific technology human capital)	Habitual entrepreneurial team (general industry and specific start-up human capital)
	Industry entrepreneurial team (specific industry and general start-up human capital)

This thesis contributes to entrepreneurial team research in three ways. First, the thesis addresses entrepreneurial team research, by investigating the entrepreneurial team formation process. This contrasts with previous team studies, which have mainly investigated the effects of top management teams on firm performance (e.g. Hambrick and Mason, 1984; Eisenhardt and Schoonhoven, 1990; Chowdhury, 2005) but it also complements the few entrepreneurial team formation studies (e.g. Beckman, 2008; Beckman and Burton, 2008). Second, the thesis addresses entrepreneurial team research in the context of university spin-offs, by investigating the role of academic and external entrepreneurs in the team formation process. This nuances and complements the few team studies in the university spin-off context that have predominantly focused on the role of academic entrepreneurs in teams (Clarysse and Moray, 2004; Vanaelst et al., 2006). Third, the thesis also addresses the debate about homogeneous and heterogeneous entrepreneurial teams (e.g. Ruef et al., 2003; Beckman and Burton, 2008) by providing the concepts of novice entrepreneurial team, expert entrepreneurial team, habitual entrepreneurial team and industry entrepreneurial team.

The thesis addresses entrepreneurial team research by investigating the entrepreneurial team formation process. The process has several critical events and links to the theory of organisational imprinting. In particular, two critical events influenced the team formation

process, when academic entrepreneurs decided to involve external entrepreneurs and when the external entrepreneurs decided to involve other team members.

The first critical event, the academic entrepreneurs' decision to involve external entrepreneurs, happened in what imprinting theory calls 'a sensitive period'. A sensitive period is when the firm is sensitive to influences from the entrepreneur and the environment (Boeker, 1988; 1989). The academic entrepreneurs' common and negative experience of student entrepreneurs triggered them to involve the external entrepreneurs because they realized that the firm needed other types of human capital and social networks to develop. The other academic entrepreneurs had no negative experience of student entrepreneurs and decided to prioritize other activities besides involving external entrepreneurs. The academic entrepreneurs' decision formed a 'layer of imprints', which contained blueprints or traces of industry and start-up human capital in the external entrepreneurial teams. In the teams without an external entrepreneur, the 'layer of imprints' contained blueprints associated with technology human capital and little or no industry and start-up human capital. Hence, the very first academic entrepreneurs are key in the decision to involve or not involve an external entrepreneur.

The second critical event, the external entrepreneurs' decision to involve more team members, was also very important for the team formation process. The external entrepreneurs made this decision based upon prior human capital and social networks and created 'a new layer of imprints'. However, the firm's strategy also influenced the team formation process, which supports imprinting studies showing that the initial strategy imprints the subsequent strategic decision (Boeker, 1989). This implies that external entrepreneurs' human capital and social networks are not the only factors that can imprint the subsequent firm development. This also corresponds to previous team studies holding that several factors influence the team formation process (Klotz et al., 2014). Hence, it is important to investigate both the entrepreneur and the strategy in future research.

Taken together, the findings show that entrepreneurs create layers of imprint in the firm formation process because the firm is very sensitive to influences from the entrepreneur and the environment (Marquis and Tilcsik, 2015). This complements previous quantitative studies on team formation (e.g. Beckman, 2008; Beckman and Burton, 2008). Hence, both the academic and the external entrepreneurs contribute to the team formation process.

The thesis also addresses team formation in the university spin-off context, by investigating teams created by academic and external entrepreneurs. This thesis shows that academic entrepreneurs create a technology entrepreneurial team and a novice entrepreneurial team. They create the technology team by involving research colleagues and utilizing the direct network ties to the parent university and the research community. They create the novice team by involving students. Technology teams and novice teams are favourable to research activities, to recognizing opportunities and to framing the opportunity but they are limited in the pre-organization, re-orientation and sustainable return phases. The firm can acquire human capital by involving an external or student entrepreneur, by learning entrepreneurial and management skills (Clarysse and Moray, 2004) or by engaging a privileged witness (Vanelst et al., 2006). Despite that the technology team still contributes to firm performance in number of employees, university spin-offs with pure academic origins do not perform as well as university spin-offs with mixed origins in the long turn. This confirms university spin-off studies investigating entrepreneurial teams and firm performance (Criaco et al., 2014; Visintin and Pittino, 2014; De Cleyn et al., 2015).

This thesis also shows that external entrepreneurs create a habitual entrepreneurial team and an industry entrepreneurial team and are part of, but have not created, an expert entrepreneurial team. External entrepreneurs create the habitual and industry teams by using their start-up and industry human capital and direct network ties to the business community. For example, one of the external entrepreneurs decided not to involve any permanent team member because of the limited financial resources and the familiarity of the tasks they needed to solve. Another example is the external entrepreneur who used the direct ties to industry and industry experience to involve a previous colleague. While the habitual team is favourable in the opportunity framing and pre-organisation phases the industry team is most useful in the re-orientation and sustainable return phases. However, the expert team is useful across all these phases. The usefulness of the types of human capital these teams have, has support in previous studies (e.g. Clarysse and Moray, 2004; Vohora et al., 2004; Barr et al., 2009). Hence, the composition of these teams can explain how and why these firms reached the development phases.

Consequently, the academic and external entrepreneurs influence the entrepreneurial team formation process because they utilized their human capital and social networks. The teams they compose also reflect their human capital and social networks. Thus, the academic and external entrepreneurs leave traces in the teams. For example, an academic entrepreneur

involved mainly other academic entrepreneurs with similar human capital and social networks. The theory of homophily explains this finding as people involve similar people to themselves in the team (Ruef et al., 2003). The result that earlier founders and teams leave traces and marks in the subsequent team supports the few studies of team formation (Burton et al., 2002; Beckman, 2008; Beckman and Burton, 2008) and the theory of organisational imprinting (Boeker, 1989; Marquis and Tilcsik, 2015). However, the cases revealing this finding do not show whether these initial marks or blueprints are long lasting or whether they diminish over time because this study only followed the case firms for two to five years. Hence, it requires more longitudinal studies to develop knowledge and to follow-up on these blueprints later in firms' lives.

The thesis also demonstrates that the interplay between the academic entrepreneur and the external entrepreneur influenced the subsequent team composition. This supports team formation studies, which show for example, that heterogeneous founding teams involve more heterogeneous top management teams than homogeneous teams (Beckman and Burton, 2008). External entrepreneurs were involved in the firms between one and four years after the firms' legal establishment. Since they were involved in the firm before the age of seven to ten years, when these firms usually reach significant sales (see Wennberg et al., 2011), they could take actively part in the team formation process. They could also take part in the team formation process because they received the necessary power and trust from the academic entrepreneur and the board of directors. Hence, there was an interplay between the academic and the external entrepreneur in the decision to involve or not to involve more team members.

In addition, this thesis addresses the debate about homogeneous and heterogeneous entrepreneurial teams (e.g. Ruef et al., 2003; Beckman and Burton, 2008) by providing the four entrepreneurial team concepts: the novice entrepreneurial team, the expert entrepreneurial team, the habitual entrepreneurial team and the industry entrepreneurial team. These concepts nuance the discussion about homogeneous and heterogeneous entrepreneurial teams because of the large variety of heterogeneous teams. These concepts granulate the concept of heterogeneous entrepreneurial teams because they show four types of teams. These concepts emerged in the combinations of general and specific start-up and industry human capital. These team concepts are also important in the formation process of university spin-offs because they point to the human capital the team possesses but also the human capital the team not possesses. These concepts also nuance the very general team concepts such as entrepreneurial teams, start-up

teams and new venture teams (Cooney, 2005; Klotz et al., 2014). Hence, these concepts are beneficial to go beyond the debate about the single entrepreneur versus the entrepreneurial team that appear in the early work on entrepreneurial teams (e.g. Kamm et al., 1990).

Overall, this thesis demonstrates that the entrepreneurs' human capital and social networks influence the composition of the entrepreneurial teams. The results show clearly that academic entrepreneurs influence the formation of technology entrepreneurial teams and novice entrepreneurial teams while the external entrepreneurs influence the formation of habitual entrepreneurial teams and industry entrepreneurial teams. It is also clear that the firm's strategy affects the team formation process and that the academic and external entrepreneurs create different layers of imprints based upon the decisions to involve or not to involve new team members. Hence, the human capital and social network literature cannot completely explain the team formation process alone. Instead, there is an interplay between the different entrepreneurs (and their resources) and the firm's strategy. As a result, there is a need to continue to investigate the role of the strategy together with the entrepreneurs' human capital and social networks. In conclusion, the empirical findings of this thesis broadly support the entrepreneurial team and organizational imprinting research.

This thesis has five conclusions on entrepreneurial team formation. First, entrepreneurs' human capital and social networks influence the team formation process and composition of the team. Second, the team formation process is seldom straightforward because the firm's strategy influences the composition of the entrepreneurial team together with entrepreneurs' human capital and social networks. Third, the interplay between the initial entrepreneurial team members with either academic and external entrepreneurs or several academic entrepreneurs creates layers of imprints in the early phases of team formation. These layers of imprint can influence and perhaps even imprint later events in firms' lives. Fourth, academic entrepreneurs influence the strategy of the firm more than external entrepreneurs, most likely because they have entered the firm before the external entrepreneurs. Hence, the academic and external entrepreneurs need to agree on decisions regarding team formation to make it happen. Finally, the interplay between the initial team members especially that of academic entrepreneurs and external entrepreneurs is of key importance in the university spin-off context, because these firms require human capital and social networks from academia and industry to bridge the valley of death.

#### **6.1.4 The role of external entrepreneurs in university spin-offs**

This thesis contributes to the very few entrepreneurship studies of external entrepreneurs by theorizing their role in the formation of university spin-offs. This is achieved by empirically investigating external entrepreneurs' role in long-term performance, their social networking, their human capital and its role in firm transition between development phases, and their role in entrepreneurial team formation. These different aspects of external entrepreneurs contribute to previous university spin-off research as they contrast the main premise in current research that academic researchers are supposed to take the role of an academic entrepreneur and create university spin-offs. This is clear in terms of the number of research papers written on academic entrepreneurs in comparison to the small number of papers on external entrepreneurs. This thesis also takes into account the calls for more research about the role of external entrepreneurs in university spin-offs (e.g. Rothaermel et al., 2007; Djokovic and Souitaris, 2008; Boh et al., 2015; Siegel and Wright, 2015).

The empirical results of external entrepreneurs' human capital and social networking contribute to nuance the almost stereotypical knowledge that academic entrepreneurs and external entrepreneurs are two opposing types of entrepreneurs in terms of human capital and social networks (Radosevich, 1995a). This thesis demonstrates that some academic entrepreneurs have general industry and start-up human capital, while some external entrepreneurs have general technology human capital. External entrepreneurs can also (but do not always) have specific industry and start-up human capital. This thesis also shows that academic entrepreneurs and external entrepreneurs get very similar resources from their social networks but they coordinate their social network contacts differently and they have different positions in the business network. As a result, academic entrepreneurs and external entrepreneurs are not completely different from or opposed to each other in terms of human capital and social networking, as is proposed in the original conceptual description (Radosevich, 1995a). Hence, this thesis complements and extends the very few empirical studies that indicate that external entrepreneurs have some business experience (Radosevich, 1995b; Clarysse and Moray, 2004; Kassicieh, 2011; van der Steen et al., 2013).

Academic entrepreneurs and external entrepreneurs are not only similar in terms of human capital and social networks but partly overlap each other in firm transition between development phases. They can discover opportunities, they can evaluate the market and they

can build an entrepreneurial team, but the type of human capital and quality of social networks determine the results of these actions. The four types of external entrepreneurs created in this thesis describe their human capital and nuance the general concept of the external entrepreneur. The four theoretical concepts of this thesis are habitual external entrepreneur, industry external entrepreneur, expert external entrepreneur and novice external entrepreneur. These four types of entrepreneur contribute differently to university spin-off transition between development phases because they represent different types of previous work experience (i.e. human capital) that are appropriate for solving different types of tasks. These concepts complement previous knowledge about firm formation in general (e.g. Bhave, 1994; Drazin et al., 2004) and university spin-off formation in particular (e.g. Vohora et al., 2004; Wright et al., 2004; Rasmussen, 2011) because they can explain why some university spin-offs overcome or get stuck in transition between development phases.

Taken together, there are different types of external entrepreneurs, each of which clearly contribute to different aspects of university spin-off formation, such as the transition of the firm between developmental phases and entrepreneurial team formation. Their role is complementary to, rather than a substitute for, academic entrepreneurs.

## **6.2 Limitations and future research**

This thesis is not without limitations. The limitations relate to choices of theoretical approach and methodology approach to investigate the new firm formation process. The entrepreneur is certainly the driving force, making something happen inside a new firm (Schumpeter, 1934), but other factors such as institutional conditions, the technology and market actors are likely to influence the new firm formation process. It is debated whether the teacher's exemption, also called professor's privilege, influences the creation of university spin-offs in Sweden. Jacobsen et al. (2013) showed that Swedish academia performs well in comparison to other countries in terms of patenting and university spin-off creation. This indicates that institutional conditions might be favourable for the involvement of external entrepreneurs because the inventor can decide without the involvement of the university or the technology transfer office to involve an external entrepreneur in the firm. This is perhaps positive for the number of external entrepreneurs in university spin-offs because not all TTOs have a positive view of external entrepreneurs (Franklin et al., 2001). However, this is worth investigating in future research.

Although human capital is important for solving different tasks and social networks are useful for acquiring resources, they cannot fully explain entrepreneurs' actions in the creation of new firms. Entrepreneurs' motivations are an interesting area for future research because it is likely that academic entrepreneurs and external entrepreneurs have different motives for becoming involved in university spin-offs. Academic entrepreneurs are motivated by, for example, technology diffusion, technology development, personal financial gain, public service and peer effects (Hayter, 2011). Since there is a lack of knowledge of external entrepreneurs' motivations for becoming involved in university spin-offs, this is a relevant topic for future studies. Another important aspect of the entrepreneur is their values, norms and cognitions. There are indications that academic entrepreneurs and external entrepreneurs have different mindsets that also influence their preferences regarding financial sources (Politis et al., 2013). Researchers also suggest that academic entrepreneurs and external entrepreneurs have very different values and norms, creating conflicts and problems to collaborate and develop the firm (Clarysse and Moray, 2004). This would be interesting to investigate in future research. Increasing the knowledge of academic entrepreneurs' and external entrepreneurs' motivations, values, norms and cognition can perhaps also contribute to explain why some university spin-offs develop and grow while other firms remain small.

The thesis highlights that different types of entrepreneur create different types of entrepreneurial teams and that they influence firm performance, in terms of number of employees. However, this thesis does not investigate entrepreneurial team processes per se. Important aspects in entrepreneurial team processes are, for example, cognitive and affective conflicts (Ensley and Pearce, 2001), goal setting and motivation (Klotz et al., 2014), team member entry and exit (Forbes, Borchert, Zellmer-Bruhn and Sapienza, 2006) and relationship to board member composition (Beckman and Burton, 2008). All of these aspects are essential because they influence teamwork, firm financing and firm performance. It would be interesting to investigate, for example, conflicts, cognitions, goal setting and motivation at the entrepreneurial team level. In this respect, it would also be interesting to investigate entrepreneurial teams composed only of academic entrepreneurs and those teams composed of both academic entrepreneurs and external entrepreneurs. By investigating such aspects of the entrepreneurial team and board of directors, it is possible to theorize entrepreneurial team processes with contributions to the university spin-off context, to the entrepreneurial team context and to the management context.



Future researchers are also encouraged to investigate the frequency and role of these entrepreneurial teams in relation to both factors in the formation of new firms and firm performance. Another avenue for future research is to investigate the role of different entrepreneurial teams over time. In this respect, important questions are, for example, how and why these entrepreneurial teams change over time and influence the composition of the board of directors and long-term performance.

This thesis has investigated the role of the entrepreneur in firm formation but has not taken into account the characteristics of the technology. This would be interesting to investigate in future studies because technology radicalness and patent scope are likely to influence the likelihood that an entrepreneur will commercialize the technology in terms of new firm formation (Shane, 2001). It is also likely that the technology influences the success of the firm, especially university spin-offs, because university technologies are seldom market-ready products (Nlemvo Ndonzuau et al., 2002). Another interesting aspect is to investigate the influence of external entrepreneurs and academic entrepreneurs on not only market performance but also technology performance. As a result, researchers need to investigate the relationship between the type of entrepreneur and technology performance.

Although a university spin-off might have a heterogeneous entrepreneurial team with commercial and technology resources to cross the valley of death, it might not have any customers who want to buy the very novel technology. Since university spin-off researchers have investigated the role of academic entrepreneurs, institutional factors and environmental factors such as the role of the university, the TTO and the incubator, it would also be interesting to investigate the role of market actors such as customers, suppliers and potential competitors in university spin-off formation.

This thesis investigated the very common performance measures of sales and number of employees. Although these are very common in entrepreneurship research (Delmar, 1997), other measures such as technology performance measures and social performance measures including public health and environment are relevant. The reasons are that most university spin-offs do not grow or perhaps do not even want to grow, and these firms represent a wide variety of technologies such as ICT, med-tech, biotech and clean-tech, which are relevant to society in ways other than merely financial. It is also relevant to investigate the acquisition and failure of university spin-offs because some of these firms have challenges in establishing market sales.

Finally, there are also some limitations in relation to the methods of this thesis. Since the case studies of this thesis focused on one single university incubator, it was difficult to find external entrepreneurs representing other industries because of the few numbers of external entrepreneurs at the incubator. Firms in the medical technology industry seldom transfer the technology to the market themselves because of capital-intensive clinical trials. Nevertheless, it would be interesting to investigate the role of external entrepreneurs and the entrepreneurial team even in these types of firms and in other university incubators. This thesis focused on university spin-offs in Sweden, which has limitations regarding empirical generalization. Future research is encouraged to investigate the role of academic entrepreneurs and external entrepreneurs in other countries and institutional settings. Although this thesis only had the opportunity to follow some of the firms between one and three years of age, and 25 years of age in the second paper, future researchers should conduct more longitudinal case studies, survey and database studies to create knowledge about university spin-off formation over time. This is important because it obviously takes a considerable time for these firms to generate significant performance.

### **6.3 Implications for policymakers**

This thesis has implications for policymakers. For policymakers, such as incubator management and TTOs, this thesis provides recommendations about academic entrepreneurs, external entrepreneurs, human capital, social networking and entrepreneurial team formation. Incubator management is encouraged to consider how and when they can support an academic researcher or a team of researchers to involve external entrepreneurs in the formation of university spin-offs. The idea should be to complement rather than to compensate for the human capital and social networks of the academic entrepreneurs, if the academic entrepreneurs want to be involved in the firm.

Another implication is that incubators should consider the involvement and levels of human capital and social networks of student entrepreneurs, who can be but are not always appreciated by academic entrepreneurs. Several academic entrepreneurs in this thesis claimed that student entrepreneurs do not have enough knowledge, skills and networks to develop the firm. That was the reason why several academic entrepreneurs involved external entrepreneurs. This is

also a reason why student entrepreneurs perhaps should take the role of an apprentice and work together with more experienced external entrepreneurs.

A potentially successful way to involve external entrepreneurs is by matching the entrepreneurial team members and evaluating the current and future need for human capital and social network over the short and long term. In this respect, it is important to take into account the type of tasks the firm need to solve in the short and long term when involving external entrepreneurs. Although there is a need for more research regarding values, norms, cognitions, motives etc. at the individual and team levels, it is also important to consider the group dynamics of entrepreneurial teams with both academic and external entrepreneurs. Without matching team members, a risk is that the entrepreneurial team is homogeneously composed and that they will have challenges in solving the tasks necessary to develop the firm.

On the other hand, a potential challenge of involving an external entrepreneur is that conflicts emerge that incubator management should be aware of. Thus, educating incubator staff and entrepreneurs in conflict management might be beneficial for personal and firm development. Incubator management should also notice the long time it takes to develop these firms. Some incubators have programmes that are short and time-limited to only a few years, whereas the commercialization process in practice takes at least seven to ten years and even up to 25 years to create sales comparable to corporate spin-offs. The consequence of sticking to short time incubator periods is that most university spin-offs will most likely not reach the market during the incubation process.

Policymakers at regional and national levels should continue to promote collaboration between academia and industry with the aim of commercializing university technologies. One way of doing that is to encourage potential external entrepreneurs to involve in this process. Another way is to facilitate the creation of new firms by encouraging collaboration between academia and industry. One reason for this is that corporate spin-offs show higher performance than university spin-offs up to 11 years of age. This indicates that creating a university spin-off is not the only or even the most effective mode of commercializing university technology. The involvement of policymakers is important because institutional conditions influence the actions of incubators/TTOs, researchers, students and external entrepreneurs and corporations. Hence, policymakers are encouraged to take different perspectives of the commercialization process beyond the traditional focus on academic researchers, incubators and TTOs.

Policy decisions towards creating pools of entrepreneurs and technologies are an option to increase the opportunities to commercialize university technologies and make academia attractive to mature firms. In this way, synergies between academia and corporations are possible to create. This can potentially lead to bridges between academia and industry that might nurture university spin-off formation and bridge the valley of death.

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