DOCTORAL THESIS

Students in Academic Entrepreneurship:

Entrepreneurship Education and Key Actors Facilitating Student Start-ups in the University Context

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Halmstad University | School of Business, Innovation and Sustainability
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Abstract

The ongoing discussion about academic research not being sufficiently commercialized has overlooked the individual actors in the university context, not least students as potential entrepreneurs. The purpose of this thesis is *to enhance our understanding of student entrepreneurs by exploring how entrepreneurship education and key actors in the university context facilitate the formation of student start-ups.* Two overall research questions are in focus; i) How does entrepreneurship education at university facilitate start-up formation among students? ii) How and why do key actors in the university context facilitate the formation of student start-ups? These questions are answered by three sub-studies, presented in the five published and appended papers. The data were collected through postal questionnaires as well as interviews in the context of three universities, namely Halmstad University, Chalmers University of Technology and the University of Gothenburg.

This thesis makes several contributions. Firstly, it shows that entrepreneurship education at university facilitates start-ups by enabling knowledge spillovers from research to students willing to take on the entrepreneurial role, the so-called missing link in academic entrepreneurship. Secondly, it also demonstrates that entrepreneurship education contributes to the development of long-term entrepreneurial capital, which facilitates future start-ups. Thirdly, entrepreneurship education facilitates start-ups by connecting key actors with different roles; students were found to be present, prepared and persistent entrepreneurs, alumni to be resource-providers and role models, while researchers became enablers with a need for utilization of their research. The revealed reasons for these interconnected key actors to enable student start-ups were; i) students are looking for a career, have start-ups skills from entrepreneurship education and access to role-models and business opportunities in the university context; ii) alumni are anxious to pass on their business experience and maintain the mutually beneficial ties to the university; iii) researchers are reluctant to change their established career but with a strong need for utilization of their research enables students to make commercial use of it.

Key words: Student entrepreneurs, academic entrepreneurship, university spin-offs, student start-ups, entrepreneurship education

List of appended papers

This doctoral thesis is based on the five published papers listed below:

1. Lindholm Dahlstrand, Å. & Berggren, E. (2010) Linking innovation and entrepreneurship in higher education: A study of Swedish schools of entrepreneurship. In R. Oakey, A.Groen, G. Cook and P.van der Sijde (Eds.), *New Technology-Based Firms in the New Millennium, vol VIII,* (35-50), Bingley, UK: Emerald Group.
[Emerald Literati Network 2011 Awards for Excellence: Outstanding Author Contribution Award]

2. Ulvenblad, P., Berggren, E. and Winborg, J. (2013*)* The role of entrepreneurship education and start-up experience for handling communication and liability of newness. *International Journal of Entrepreneurial Behavior & Research, 19* (2), 187-209.

3. Berggren, E. & Lindholm Dahlstrand, Å. (2009) Creating an entreprenurial region: Two waves of academic spin-offs from Halmstad University. *European Planning Studies, 17 (8),* 1171-1189. Also published in (2012) B. Johannisson & Å. Lindholm Dahlstrand, (Eds.), *Enacting Regional Dynamics and Entrepreneurship: Bridging the territorial and functional rationales,* (pp. 66-84). London and New York: Routledge.

4. Berggren, E. (2011) The entrepreneurial university's influence on commercialization of academic research –the illustrative case of Chalmers University of Technology. *International Journal of Entrepreneurship and Small Business*, *12* (4), 429-444.

5. Berggren, E. (2017) Researchers as enablers of commercialization at an entrepreneurial university. *Journal of Management Development,* 36 (2), 217-232.

Contents

1 Introduction

1.1 The Topicality of Academic Entrepreneurship

Academic entrepreneurship has become a high priority among policymakers in order to create national economic growth. In response to this new pressure to demonstrate a commercial outcome, universities are keen on to prove their contribution. However, the benefit from university to society is difficult to demonstrate, as utilization of research and teaching take many forms (Jacobsson & Perez Vico, 2010; Jacobsson, Perez Vico & Hellsmark, 2014; Perez Vico & Jacobsson, 2012). Usually, most attention is focused on so-called university spin-off companies (USOs)[1], new firms that emerge directly from the research side of the university (Duruflé, Hellman & Wilson, 2018). In contrast to other forms, this outcome is possible to measure, e.g. in terms of frequency and employment figures. As USOs are one of few evident outcomes of universities' contribution to economic development, the focus is on this visible pay-off (Rasmussen, Moen & Gulbrandsen, 2006) with researchers as the central actor. When promoted as success stories, USOs can improve the institutional prestige of the university (Sine, Shane & Di Gregorio, 2003). Some universities have become acknowledged as entrepreneurial due to their history, culture and past experience of commercialization, which influence present norms and attitudes (Guerrero, Urbano, Cunningham & Organ, 2014; Rothaermel, Agung & Jiang, 2007, O'Shea, Allen, Chevalier & Roche, 2005). Some universities are regarded as more successful than others in academic

[1] In the following USOs will only be used if the start-up directly emerges to commercialize research results from a university. The broader term start-up will be employed for any new firm/business/venture/enterprise started in the university context. Start-up formation will be used for the process leading to a new firm with a legal status of its own. See also 2.1.4 for a more developed definition of USO and 2.1.5 for the distinction between the concepts of USO and start-ups. Company will be used when referring to a large and established corporation.

entrepreneurship, when measured in countable USOs, as is customary. The current discussion of academic entrepreneurship therefore holds researchers as the key actor and has largely ignored students as possible actors and academic entrepreneurs, which will be the focus of this thesis.

The Swedish Academic Paradox holds that relatively large investments from public-funded academic research do not contribute sufficiently to innovations, economic growth and competitiveness (Bitard, Edquist, Hommen & Rickne, 2008). However, the relevance of the paradox has been questioned, by pointing out that the utilization of research is too narrowly measured (Jacobsson, Lindholm Dahlstrand & Elg, 2013; Jacobsson & Rickne, 2004; Lindholm Dahlstrand, 2008). In the National Innovation Strategy for the future published in 2012 (regeringen.se/innovationsstrategi) the Swedish government admits that the previously highlighted and supported researchers' start-ups are only a minor part of how academic research contributes to innovation. In Sweden with the Professor's Privilege[2], the researcher legally owns an invention and consequently the decision to commercialize it is that of the individual researcher, not of the university as an organization. The American model is very different, with the Bayh-Dole Act giving universities ownership of intellectual property arising from federal government-funded research. This system will increases the university's ability to estimate the commercial outcomes of research but despite this, a large amount takes place without the knowledge of the university (Aldridge & Audretsch, 2011; Fini, Lacetera & Shane 2010; Markman, Gianiodis & Phan, 2008). Hence, knowledge about the actual commercial outcome of academic research is limited, even in contexts where the direct involvement of universities is regulated. In the Swedish context, which the present thesis will explore, there is reason to believe that the depth and breadth of commercial outcomes are even more severely underestimated.

[2] Also called the Teacher's Exemption

Merely considering researchers' USOs, (and sometimes patents and licensing) within the formal innovation support system as *the* channel for commercializing academic research gives too narrow a picture. If other actors, e.g. students, became visible, investments in academic research would probably show a much better pay off in society. The perceived problem is presumably not a lack of business opportunities, but a lack of researchers willing to take on the entrepreneurial role. In the latest GEM-report (Braunerhjelm, Holmquist, Larsson, Svensson & Thulin, 2019), the Swedish population (aged 18-64) was superior in identifying business opportunities compared to other countries, but had a low score for self-assessed perceived ability and skills for a start-up. It appears unrealistic to rely on a faculty that is usually inexperienced in business to make use of business opportunities stemming from academic research. In order to increase the commercial return on investments in academic research it is important to consider not only the presence of opportunities but also individuals willing to take the commercial advantages of them (Lundström & Stevenson, 2002; Rasmussen & Wright, 2015; Shane and Venkataraman, 2000).

The absence of entrepreneurs in the university context has been regarded as 'a missing link' in transforming academic knowledge to economic growth (Braunerhjelm, Acs, Audretsch & Carlsson, 2010). Consequently, involving other individuals to take on the entrepreneurial role can be an option. One alternative is to connect external (surrogate) experienced entrepreneurs to the USO (Franklin, Wright & Lockett, 2001; Lindholm Dahlstrand, 2008). Turning to existing companies already in possession of competence and resources is yet another alternative for making commercial use[3] of academic research. Lately, students have been acknowledged for playing a critical role in the establishment of USOs (Fini, Meoli, Sobrero, Ghiselli & Ferrante, 2016; Hayter, Lubynsky & Maroulis, 2017; Åstebro, Bazzazian & Braguinsky, 2012). Therefore, more research is required about the diversity of students and researchers as academic entrepreneurs and their potential roles.

When turning the focus from researchers' commercialization to academic research that enters into commercial use (see footnote 3), students becomes important actors (Hayter et al., 2017). Students can be regarded as the most important contribution to national competitiveness and innovativeness (Bengtsson, 2013) but this link has been ignored (Bengtsson, 2011). In Rasmussen and Wright (2015) students are mentioned as the most important channel of knowledge transfer to industry. In a comparison of Swedish universities to Stanford University and University of California Berkeley, the lack of acknowledgement of students' role in the transfer of knowledge was suggested to be a disadvantage of Swedish

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[3] The reason for the expression 'commercial use' instead of 'commercialization' of academic research in this thesis is threefold. Firstly, the latter can imply that a new business opportunity stemming from academic research is ready for launching on the market. In my understanding, academic research instead contributes a seed/fraction that often requires a long process of further development. Secondly, when other actors such as students, external entrepreneurs or existing industry are involved, the direct connection to academic research became less visible. Thirdly, this is in line with my distinction between USO and start-up, where the former emerges directly from research findings searching for commercial applications, while a start-up might originate from a customer need but can use research findings in the solution. Consequently, the expression 'commercial use' is intended to indicate a sometimes rather subtle contribution from academic research.

academia (Studieförbundet Näringsliv och Samhälle, SNS, 2014). However, in The National Innovation Strategy for the future (published in 2012) students were actually briefly mentioned for utilizing research-based knowledge in working life, through start-ups, in employment but also in practical projects during their education. So, even if students are young and lack industrial as well as business practice, their proximity to research but also to available entrepreneurship education[4] (EE) at university can make them an important actor. If entrepreneurship is defined as enterprising new ideas in established companies (so-called intrapreneurship), academic research commercialized in an established industry can also be included within academic entrepreneurship. Here, students can play an important role in transferring new research to industry. This thesis focuses on students in academic entrepreneurship and particularly their involvement in start-ups in the university context.

1.2 Research on students in Academic Entrepreneurship

Not only universities' actual entrepreneurial activity but also research about the very same phenomenon has accelerated during the recent decades. According to Rothaermel et al. (2007), most articles focus on the infrastructure of universities and how to enhance commercialization. In this line of literature (e.g. Etzkowitz, Webster, Gebhardt & Retta, 2000; Jacob, Lundqvist & Hellsmark, 2003) technology transfer and innovation support systems have been in focus. Due to the intense focus on support systems and on creating an entrepreneurial ecosystem, the individual entrepreneur who is the

[4] EE at university usually involves both practical and theoretical elements, therefore the concept of training as well as the concept of education can be relevant. Training usually relates to the development of practical skills useful for performance in the near future, while education aims at developing theoretical life-time knowledge. When the situation clearly indicates that only one or the other of the two concepts is in question, that will be used. But in general, I do not intend to distinguish between education and training in this thesis. It will simply be abbreviated to EE and applicable to both single courses and programmes. In section 2.3.2 EE will be further discussed.

main resource has been neglected. It is not available resources alone that create value, but if and how entrepreneurs chose to use them. New firm formation is a process on the individual level, but in a social context (Davidsson and Honig, 2003; Landström, 2017; Rasmussen & Wright, 2015). Therefore, the roles of individuals will also need focus in the research stream about the development of entrepreneurial universities. In the literature review by Rothaermel et al. including 173 articles about university entrepreneurship, by far the most common unit of analysis was universities. But not only the organizational design of universities needs to adapt to the new mission, as the prevailing culture, attitudes and norms of individuals will also determine the entrepreneurial activity at universities (Bercovitz & Feldman, 2008; Bergmann, Hundt, Sternberg, 2016; Etzkowitz et al., 2000; Jacob et al., 2003). However, entrepreneurial actions and opportunities are known as a social and context dependent process, which is why it is important to consider the interaction of individuals in the university context (Davey, Rossano, van der Sijde, 2016; Hayter et al., 2017; Wright, Siegel & Mustar, 2017).

Siegel and Wright (2015) raise the question of the need for a rethink about research on academic entrepreneurship, from a traditional perspective on faculty spin-offs, licensing and patents to a new emerging perspective on student and alumni start-ups. Recently, arguments have been made for an emerging second wave of ´university-based start-ups´ driven by students and alumni, in contrast to the first wave of ´academic spin-offs´ emerging from the research side of the university and driven by the faculty to commercialize research findings (Duruflé et al., 2018). Instead of viewing universities as a *source* of innovation, they suggest that universities serve as a *hub* of innovation and entrepreneurship, where a greater variety of actors play central roles. When students and alumni are included, the long-term indirect effects such as subsequent start-ups move more to the forefront and also as an issue for research (Duruflé et al., 2018; Wright Mustar, & Siegel 2020;). Grimaldi, Kenney, Siegel & Wright (2011) suggest the need for more focus upon the individual academic entrepreneur in the future, underlining student entrepreneurship as especially neglected. Rothermael et al. (2007) argue that the field of university entrepreneurship is still fragmented and lacks the understanding across different actors. A call for more research on human agency and interaction between individual roles in the entrepreneurial university context has been taken up by several researchers (Audretsch & Feldman, 2004; Etzkowits et al., 2000; Guerrero et al., 2014; Guerrero & Urbano, 2014; Lam, 2010; Siegel, Wright & Lockett, 2007). The present thesis focuses on such interaction between individuals in the university context for the benefit of student start-ups[5].

Taken together, in previous research as well as in policy and in academic debate focus has been placed on a structural level, while there is little attention to human agency[6] and the roles taken on by interacting individuals. Research about the process of new firm creation has attracted massive interest in the literature in general, but also in trying to understand the nature of university spin-offs and how to best manage the creation process in the university context (Rothermael et al., 2007). The lack of attention in previous research on individuals and their interaction limits our understanding of academic entrepreneurship. The predominant focus assuming researchers/faculty to be the key actor restricts our knowledge. Research at universities can enter commercial use in many different ways, for example by students creating new firms (Boh, De-Haan, Strom, 2016; Fini et al., 2016; Hayter et al. 2017; Åstebro et al., 2012). The expansion of entrepreneurship education (EE) at universities during the during recent decades (Gabrielsson,

[5] This thesis will use the concept of student start-up to indicate that when students are involved as founders the direct connection to research is less obvious. For a closer distinction between USOs and student start-ups see 2.1.5.

[6] This concept is used in a general sense, meaning human influence, or the capacity for individuals to act and make choices.

Landström, Politis & Hägg, 2018) ensures a substantial rise in the number of student start-ups (Wright et al., 2020).

Thus far, the role of students is scantily explained in the literature on academic entrepreneurship. In other words, there is a gap in the research concerning student start-ups. Even if academic entrepreneurship and USO have been extensively studied before (Shane, 2004), research about student entrepreneurship is sparse (Bergmann et al., 2016; Hayter et al., 2017; Klofsten & Jones-Evans, 2000; Pirnay, Surlemont & Nlemvo, 2003; Siegel & Wright, 2015; Wright et al., 2020; Åstebro et al., 2012). By not acknowledging students as actors in academic entrepreneurship, the discussion about the academic paradox becomes irrelevant when the economic impact of universities are drawn from only part of the phenomenon. Åstebro et al. (2012) argue that on an individual level students and recent university graduates are twice as likely to start a new business compared to a faculty. Even though faculty USOs are rather rare, the phenomenon has attracted a massive interest in research as well as in policy, while students' start-ups are far more common (24.3 times) but ignored and overlooked. Start-ups by students and recent university graduates not only outnumbered the faculty ones but also had a high quality (Åstebro et al., 2012). To sum up, there is a need for more empirical research to enhance our understanding of the emergence of student start-ups in the organizational context of universities. Entrepreneurship is a context dependent phenomenon (Baltzopoulos & Brostöm, 2013; Bercovitz & Feldman, 2008; Bergmann et al., 2016; Beyhan & Findik, 2018; Boh et al. 2016; Hayter, Nelson, Zayed & O´Conner, 2018; Wennberg, Wiklund & Wright, 2011) why the individual student entrepreneur[7] needs to be studied in interaction with other actors in the university context.

[7] Not to be confused with an entrepreneurship student, i.e. someone who is participating in entrepreneurship education at university. A student entrepreneur, on the other hand, can have studied any education at university in close connection to the start-up (see also 2.1.5) and may or may not have also participated in an entrepreneurship education.

Therefore, the intention of this thesis is to contribute to the understanding of student entrepreneurs in interaction with those so far regarded as the key actor, namely researchers, in the contextual perspective of universities.

1.3. Research problem and purpose of the dissertation

Based on the previous discussion, the theoretical problem motivating this doctoral thesis is the lack of attention to entrepreneurial agency in current conceptualizations and debate on how to increase the commercialization of academic knowledge and research. Current debate on academic entrepreneurship in general and entrepreneurial ecosystems in particular mainly focuses on 'structures', while there is a lack of frameworks that provide insights into the role of entrepreneurial agency and interaction between individuals in the university context. Moreover, the existing stream of research focuses on the formation of USOs by academic researchers/faculty, while other potential actors in the university context are largely ignored. Hence, there is today a limited theoretical understanding of the emergence of student start-ups within the academic entrepreneurship discipline, a conspicuous gap that will be addressed in this thesis.

Against this background, the overall purpose of this doctoral thesis is therefore:

To enhance our understanding of student entrepreneurs by exploring how entrepreneurship education and key actors in the university context facilitate the formation of student start-ups.

More specifically, the following specific research questions of the dissertation are:

- *How does entrepreneurship education at university facilitate start-up formation among students?*

- *How and why do key actors in the university context facilitate the formation of student start-ups?*

By responding to these two specific research questions and the overall purpose, the dissertation will contribute theoretical knowledge of student entrepreneurs in interaction with other key actors in the university context.

1.4 Structure of the thesis

This compilation thesis consists of one cover and five appended papers. The next chapter of this cover presents a frame of reference starting with definitions of central concepts. In Chapter 3 the method is presented and discussed. The appended papers are summarized in Chapter 4. In Chapter 5, the joint conclusions and contributions from the five studies are reflected upon, discussed and analysed. Chapter 5 ends with implications and suggestions for future research. The appendix contains the five published papers presenting the studies included in this thesis.

2 Frame of reference

The main concepts in the thesis will be discussed in this section, starting with definitions of entrepreneurship, innovation and university spin-off (2.1). A review and analysis of relevant literature on start-up formation linked to the university context follows (2.2). After that entrepreneurship education is discussed linked to student start-up (2.3) then key actors in academic entrepreneurship will be addressed (2.4). The chapter ends with a summary of students and researchers as entrepreneurs connected to tentative differences found in the literature.

2.1 Definitions of the main concepts

A massive discussion about the concepts of entrepreneurship and innovation has taken place in research during the recent decades. Are they the very same phenomenon, both having common roots in Schumpeter, or are they two different fields of research with some overlapping elements (Landström, Åström & Harirchi, 2015)? Is it possible to illustrate the two concepts in a framework of several detailed process models (Brem, 2011) or do we just have to accept that the concepts are intermixed and used differently (Schmitz, Urbano, Aparecida Dandolini, de Souza & Guerrero, 2017). Despite the lack of consensus in the understanding of the two concepts in the literature, I will take a stance in this blurred field in order to enhance our understanding of student start-ups/entrepreneurs.

2.1.1 The concept of entrepreneurship

In trying to define this multidisciplinary research area of entrepreneurship (Landström, 2005) most researchers refer back to Schumpeter, who certainly has played a leading role in the academic discussion. Schumpeter (1934) defined development as the carrying out of new combinations, thus breaking the equilibrium on the market, which can be done by introducing a) new goods, b) a new production method, c) a new market, d) a new source of supply or c) a new organization. By *creative destruction,* Schumpeter meant the battle between the new and the old that resulted in economic development. To combine the production resources in a new way defined the entrepreneur, according to Schumpeter. This was only an occasional condition and lasted during the realization of the new combination. Once the new organization was built and the founder was running it like other firms, the entrepreneur became an ordinary businessperson (Schumpeter, 1934). Gartner, Bird and Starr (1992) also separate entrepreneurship from already existing organizations when elaborating on how the organizational behaviour area is connected to entrepreneurship. They suggest that entrepreneurship is the process of organizational emergence when when viewing entrepreneurship as a type of organizing. Also for Gartner (1988), the creation of new organizations was central.

Other researchers have defined entrepreneurship differently, including Venkataraman (1997), meaning that entrepreneurship is about how business opportunities are recognized, created and exploited. To these researchers entrepreneurship is about identifying and creating business opportunities, organizing the necessary resources and exploiting business opportunity on the market. Kirzner (1973), on the other hand, viewed the entrepreneur as a discoverer of the existing disequilibrium in the market, using information asymmetry to identify existing market possibilities. His focus was on creating and setting up a new business by using the existing imbalance in the market instead of creating imbalance/destruction in the Schumpeterian way. Knight (1921) focused his definition of entrepreneurship on the ability[8] to handle risk under conditions of insecurity, while Casson (1982) focused on the ability to coordinate limited resources. Entrepreneurship is often related to the use of resources, making the most of available resources or allocating the

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[8] It can be discussed whether this is an ability (natural, innate) or a skill (learned, acquired). Skills will be developed through transfer of knowledge. I take a stand in that entrepreneurship can be learned, at least part of it, therefore skills will primarily be used in the following chapters of this thesis. The term competence will be used for skills and ability put into action/practice leading to performance

new resources required (Sarasvathy, 2001b). Timmons (1994) describes entrepreneurial success in terms of business opportunities, resource allocation and the entrepreneur, all necessary elements for *carrying out* entrepreneurship. Even if the focus has turned to the entrepreneurial process rather than the individual characteristics, it goes without saying that entrepreneurship cannot take place without a willing and enterprising individual. The entrepreneur as the agent of change will always be needed.

The discussion about the definition of the concept can be derived to the two main views of the role of the entrepreneur, the innovating entrepreneur and the firm-organizing entrepreneur (Landström, 1999). Some researchers have adapted Schumpeter's view of the entrepreneur as an innovator transforming inventions and ideas into economically viable entities, irrespective of whether or not the result is a new firm (the innovating entrepreneur). Others view the entrepreneur as an individual creating new business firms, regardless of the presence of innovativeness (the firm-organizing entrepreneur) (Baumol, 1993). Both roles are important for a society's development, but according to Landström, they have essentially different roles in the economy. Davidsson's (2005) well-argued choice of definition, namely the competitive behaviour that drives the market process, includes behaviour rather than disposition, i.e. *how* instead of *who*, and is therefore in line with the development within entrepreneurship research. It also focuses on the outcome and implies that entrepreneurship is connected to a market context including exploitation, for which reason inventions not carried into practice are not included in the concept of entrepreneurship. With this view, economic growth cannot take place without entrepreneurship because inventions that do not reach a market are useless.

Entrepreneurship can be conducted in existing organizations by driving projects for renewal, i.e. intrapreneurship, or in any social context in the sense of being enterprising, i.e. making things happen by carrying out new ideas. In a broad sense, Schumpeter's *carrying out* has come to involve almost any enterprising activity in human life. In a general sense, entrepreneurship can be a way of looking upon the world as full of opportunities or taking the initiative to create your own future. Any person who develops viable new ideas and believes their actions will create change can be regarded as entrepreneurial. Entrepreneurship looked upon as a general enterprising behaviour can play an essential part in societal development even if business activities are not involved. The European Commission has used this broad definition:

> Entrepreneurship refers to an individual's ability to turn ideas into action. It includes creativity, innovation and risk taking, as well as the ability to plan and manage projects in order to achieve objectives. This supports everyone in day-to-day life at home and in society; makes employees more aware of the context of their work and better able to seize opportunities, and provide a foundation for entrepreneurs establishing a social or commercial activity. (European Commission, 2012, p 7)

The definition of the word is the subject of an ongoing discussion, not only within academia. Entrepreneurship might be such a complex phenomenon that there will always be a need for different and dynamic interpretations depending on the situation. In this thesis a person involved in a process resulting in a new venture, a business-founder, is regarded as an entrepreneur, i.e. according to the firm-organizing view. One advantage with this definition is that it can easily be measured in terms of actual start-ups, without having to grade the amount of newness included in the business idea. Starting a new venture is a definite action, a visible output of the entrepreneurial process, which includes the perception of business opportunities and introduction of new ideas and change on the market. When targeting student start-ups, the narrow definition of an entrepreneur as a business founder is natural.

2.1.2 The concept of innovation

Just as the concept of entrepreneurship lacks a clear definition, so too does the concept of innovation. Innovation can also be traced back to Schumpeter, who takes a stance in the concept of invention, claiming that an innovation does not necessarily have to be an invention.

> Economic leadership in particular must hence be distinguished from "invention". As long as they are not carried into practice, inventions are economically irrelevant. And to carry any improvement into effect is a task entirely different from the inventing of it, and a task, moreover, requiring entirely different kinds of aptitudes. Although entrepreneurs of course *may* be inventors just as they may be capitalists, they are inventors not by nature of their function but by coincidence and vice versa. Besides, the innovation which it is the function of entrepreneurs to carry out need not necessarily be any inventions at all. It is, therefore, not advisable, and it may be downright misleading, to stress the element of invention as much as many writers do. (Schumpeter, 1934, p 88-89)

Hence, Schumpeter used the word innovation as the function entrepreneurs carry out, not only in connection with technology, but also for the way a company is run and organized. To him the entrepreneur is also an innovator, carrying out something new on the market, and the innovator is not distinguished from the entrepreneur. However, he clearly separated the innovator/entrepreneur from the inventor. Schumpeter (1934) made a clear distinction between an invention and an innovation, meaning that an invention was of no economic value until it was carried out in practice, becoming an innovation made useful to potential adopters. The entrepreneur introduces innovations on the market and he regarded the entrepreneur as an innovator. This can also be done as a collective act together with others and/or in existing companies, but only when the production factors are combined in a new way for the first time. Managing an established company is not entrepreneurship, according to Schumpeter, because the creation of a change in the market is lacking. Many different characteristics of administering a company compared to handling an entrepreneurial culture have been presented, for example by Stevenson and Gumpert (1985).

The two words, entrepreneurship and innovation, are often used together or more or less synonymously in many situations and it has even been discussed whether there are any differences between the concepts (e.g. Landström 2017; Schmitz et al., 2017). In the following, entrepreneurship will be seen as more closely related to the formation of a new firm, while the innovation process is closer to the development of a new invention, with the purpose of making it useful. An innovation can be regarded as the output from an innovation process, just as a new firm can be regarded as the output from the entrepreneurship process in line with the firm-organizing view (2.1.1). Innovation research is traditionally linked to universities of technology, while entrepreneurship has a stronger connection to business schools. If a discovery means finding something that already exists without anyone being aware of it, an invention is something regarded as new in the given population, while an innovation is an invention that has been developed enough to be regarded as useful. Entrepreneurship can be seen as the process of introducing an innovation on the market, in other words commercializing. Following the above view, the innovator focuses on finding the solution to a problem (exploring), while the entrepreneur's primary interest is to satisfy customer needs in order to create a demand on the market (exploiting). The innovation can involve a new product, process, market, supply or organization, as in the definition by Schumpeter. Entrepreneurship focuses on the customer and on how to pack, present, adapt and launch to get the product sold, i.e. how to commercialize the innovation. It might be possible theoretically to see a given time order between invention, innovation and entrepreneurship, even if the activities can be difficult to separate from each other. In reality, it would be even harder to define an ongoing activity, as the processes often develop iteratively, overlapping and in loops, which makes separation between the concepts complicated. Nevertheless, both exploration and exploitation are needed for entrepreneurship to exist (Davidsson, 2006; Shane & Venkataraman, 2000).

Lundvall, Johnson, Andersen and Dalun (2002) state that one of Schumpeter's major contributions to the understanding of the innovation process is the interpretation of innovation as *a new combination*, because it brings together two contradictory but important aspects of innovation: its continuity (existing elements) and radical change (the new combination). What turns an invention into an innovation is when someone is prepared to invest resources on the invention. For Tidd, Bessant and Pavitt (1997), innovation is closely connected to change, i.e., the change of a product or process and the level of change, i.e. radical or incremental. They consider that an invention is involves coming up with good ideas, while innovation is making them work technically and commercially. They stress that innovation involves *the process of turning opportunity into new ideas and of putting these into widely used practice*. Their view, including development *and* exploitation putting the invention into *widely* practical use, also implies the inclusion of at least parts of the commercialization phase. Bessant and Tidd (2007) strongly connect innovation with spotting opportunities but also creating new ways to exploit and take advantage of them, not necessarily on new markets as it can equally apply to established and mature ones. Drucker, on the other hand, writes that: "*Innovation is the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for different business or different service"* (Drucker, 1985, p. 17). In other words, some authors include the actual commercialization on the market in the innovation process, making no distinction between the concepts of entrepreneurship and innovation. Acs (2006) actually adds that even the market introduction should be *successfully* carried out: "*Only those inventions that have been successfully introduced in the market can claim that they are innovations as well*" (Acs, 2006, p. 78). On the other hand, Fagerberg states: "*Invention is the first occurrence of an idea for a new product or process, while innovation is the first* *attempt to carry it out into practice"* (Fagerberg, 2005, p. 4). An interpretation is that it is sufficient to change how something works, even if it is not possible to sell on a market or earn money on it. In his definition, a new process applied internally within an organization, without commercialization, can be included and is therefore in line with my understanding of the innovation concept.

2.1.3 Linking Innovation and Entrepreneurship in the university context

The variation in where the process of innovation starts and finishes appears as unclear as the definition of the term entrepreneurship. If the origin of the word entrepreneurship can be traced to meaning *carry out* or *undertake;* the origin of innovation means *renew* or *make something new*. This is an original difference closely connected to my definition and use of the two concepts in the following. In this thesis, innovating focuses on the process of useful *renewal* (novelty creation), while entrepreneurship focuses on the process of taking the idea to the market, which is commercializing/exploiting (value creation) the business idea. This understanding is also in line with how people in general use the two concepts. Innovation is usually connected to newness, new technologies and R&D, while entrepreneurship is commonly connected to start-ups, commercialization and business ideas (Landström, Åström and Harirchi, 2015). So, despite the discussion on whether there are any differences between the concepts of innovation and entrepreneurship, they will be separated in the following. Innovation will be connected with a useful new way of doing something, such as introducing a new solution, method, practice, process or technique, not necessarily aimed at being commercialized on the market. Invention, on the other hand, will be regarded as a new idea that is still not developed enough to be practically useful.

By separating the inventor role from the innovator role as well as from the entrepreneurial role, the different abilities become clearer and more visible and consequently their presumed linkage in the university context. Based on this idea, some academic research can be closely connected to the innovator role, while the commercial realization is linked to the entrepreneurial role. Taken together, the innovation process can generate and result in new business opportunities, which can be developed to attract customers and introduced on a market in the process of entrepreneurship. With the conception that entrepreneurship involves commercializing/exploiting, also existing companies can be a base for launching academic inventions/innovations on the market (corporate entrepreneurship). However, in this thesis university-based innovations resulting in business opportunities that give rise to start-ups in the university context are in focus.

The roles of the innovator or entrepreneur can change over time and be represented in the same person or by different individuals. In the complex process of commercialization of academic research probably more than one person will be involved to manage the processes of both innovation and entrepreneurship (Clarysse & Moray, 2004). To understand the phenomenon of academic entrepreneurship the different sub-processes of innovation and entrepreneurship need to be separated in order to grasp how they are linked and combined in the university context. In their literature review of innovation and entrepreneurship within universities, Schmitz et al. (2017) found that the concepts are often used together instead of explicitly defined, which underlines the concepts' interrelatedness and complementary functions.

Furthermore, a new offer can accordingly be innovative (bringing to the market something that was not offered before) or imitative (similar to what other firms already offer), which is more common (Davidsson, 2006). In reality however, the distinction between the two types is less clear. The innovativeness included in a business idea does not necessarily relate to the product but could be in how resources are used or how to approach the customers. Even though an imitative or reproductive idea is often less complex and has a smaller market impact, it could still create destruction by offering new alternatives to customers, by being a new competitor on the market and by inspiring followers. It could be argued that a business idea can never be copied exactly, because it is carried out in a new context and by new individuals. It can also be argued that two firms are never identical and that one business idea is never exactly the same as an earlier one. A so-called imitative idea creates destruction by forcing competitors to use their resources more effectively, according to Davidsson (2006). With this interpretation, entrepreneurship can hardly exist without innovation, as equilibrium on the market is broken by any new firm formation or new offer, irrespective of innovativeness of the business idea. On the other hand, innovation can exist without commercialization, for example when a new idea comes into practical use by being implemented internally in the organization but not sold to customers.

Furthermore, “innovative” vs “ordinary” entrepreneurship results in different economic outcomes, according to Lundström and Stevenson (2002). This explains the present interest in academic entrepreneurship on the part of politicians. Academic research is a source of innovative business ideas and is therefore of particular interest for economic renewal, industrial change and regional development (Audretsch & Lehmann, 2005; Gilbert, Audretsch & McDougall, 2004). Innovation is important for wealth creation; innovative entrepreneurship has higher growth rates and is primary found in technology-oriented sectors. Consequently, a policy priority for governments is to foster the emergence of rapidly growing knowledge-based innovative entrepreneurship, according to Lundström and Stevenson (2005). However, in the following the innovativeness of the business idea will not be evaluated. Separating innovative from imitative ideas is a delicate matter, which I do not intend to expand further in this thesis. However, taking students’ academic education as well as research conducted in their environment into account increases the likelihood of innovative knowledge-based business ideas (SCB, 2008).

2.1.4 The concepts of University Spin-off (USO)

In research about academic entrepreneurship, the concepts of University Spin-off (USO) and University Spin-out are central. The two concepts are often used inconsistently without any clear distinction, but in the following I will separate the two for practical reasons. When distinguishing between spin-off and spin-out, a spin-off is connected to a new firm, while a spin-out is associated with technologies or products transferred from existing organizations (Lindholm Dahlstrand, 2004). Consequently, the term *spin-off* focuses on the new firm, while *spin-out* will be used to indicate a focus on the knowledge transferred. Even if the use of the terms by different authors is inconsistent this thesis will connect them to the two frequent determining factors; namely university-*founders* and university-*knowledge*. Spin-off will accordingly be applied to start-ups based on university-knowledge where at least one founder is/has recently been linked to university. Spin-out will be used for university-knowledge transferred and commercialized without the creation of any new firm, i.e. in existing companies. Elaborating on how university spin-offs and spin-outs have been defined in previous research will help to clarify to what extent students have been considered as founders or entrepreneurs in spin-offs and spin-out literature, i.e. the extent to which they are considered key actors in academic entrepreneurship. McQueen and Wallmark's frequently used definition of academic spin-offs originating from 1982 outlines that:

> -the founding team is composed of university researchers and/or university students
> -the activity of the venture is based on scientific and technical knowledge generated in the university environment
> -the transfer of knowledge has to be direct and not through intermediate employment.

In other words, academic spin-off includes the group of students starting the spin-off directly connected with their university studies. If applying their definition, students' access to technical and scientific knowledge in their education can be the base for the academic spin-off.

According to the comparison of definitions made by Wallin (2012), the term spin-off lacks a clear definition, the lowest common denominator seeming to be the 'formation of something new based on something existing'. Usually included are: 'A new firm created originating from an established firm or university'. Definitions of the assets formally transferred to the new organization vary, such as: technologies, research discoveries, rights, business ideas, capital stock, or intellectual property rights. Shane (2004) defines a university spin-off as a new company founded to exploit a piece of intellectual property created in an academic institution, a start-up company created by the students or the employees of academic institutions. According to Shane, the inventor is the faculty, staff or students, but the entrepreneur often comes from outside. Mustar et al. (2006) provide a comprehensive review of the heterogeneity of Research-based spin-offs (RBSOs), differentiating between three dimensions: type of resources, business model and institutional link.

Pirnay, Surlemont and Nlemvo compare existing heterogeneous definitions of USOs ending up with their own: "*new firms created to exploit commercially some knowledge, technology or research results developed within a university*" (Pirnay et al., 2003, p. 356). This definition is close to the following one: "*The formation of new firm or organization to exploit the results of the university research*" (Klofsten & Jones-Evans, 2000, p. 300). While the latter pinpoint "university research" as a basic requirement, Pirnay et al. at first sight appear broader as they include "some knowledge, technology" which is developed within a university. But Pirnay et al. specify the following criteria:

1) a new firm with its own legal status
2) the parent organization is a university, whereby their definition of a USO excludes technical schools, public/private R&D, large national laboratories and research institutes

3) the knowledge includes technological innovations, patents, scientific and technical know-how accumulated by an individual during his/her academic activities
4) it includes profit-making, that is bringing an idea into the business sphere.

Consequently, Pirnay et al. firstly base their definition on the determining factor of the nature of the knowledge transferred from the university to the new venture. This specification appears close to Klofsten´s, i.e. academic research. Secondly, Pirnay et al. show that different studies focus on different characteristics of the venture idea in the USOs. Focus varies between technology-based ideas, research results, core technology and scientific-technical know-how. Thirdly, they also outline differences in the actors focused on in USO studies. Focus varies for instance between faculty, staff, graduates, university teachers, researchers and students. The final group is targeted in this thesis. Finally, Pirnay et al. also outline differences in the entrepreneurs' current relationship to the "parent" academic organization, e.g. if the founder has left the university environment or remain affiliated.

Another issue to consider when addressing USOs is whether there needs to be a direct connection in time between the entrepreneurs' academic studies/work and the spin-off, i.e., without any intermediate employment or if indirect connections are accepted. Pirnay et al. (2003) argue in line with McQueen and Wallmark (1982) that there at least needs to be a direct knowledge transfer from university to the new venture. Nevertheless, they observe that studies have accepted a time lag for USOs of up to nine years, claiming that the business idea is derived from previous knowledge from the university. Despite the debate regarding an appropriate cut-off point, Wright et al. (2020) suggest three years as an optimal choice when students are involved, meaning it takes time for an idea from the university to become a start-up. In her study of around 20,000 newly founded firms in Germany, Mueller (2008) found that for 50 % of the

USO-founders four years or more had elapsed since they left the university. It is notable that new technology-based firms are typically created as indirect spin-offs, i.e. that the founder have worked in other organizations and gained work experience for some years after their academic studies (Lindholm Dahlstrand, 1997). Based on these studies it appears reasonable to consider both students who are still in the direct academic environment and students/alumni with a time lag between academic studies and USO when defining student entrepreneurs. EE or other knowledge gained at university can come into use in start-ups many years later. Many entrepreneurs only start their company after having gained useful industrial experience and contacts (Nabi, Linan, Fayolle, Krueger & Walmsley, 2017; Wright et al., 2020). The start-up formation will be exceptionally challenging for students during or directly after their university education (cf. Galloway & Brown, 2002).

The view of what constitutes a *genuine* spin-off varies between studies. Some scholars argue that the researcher has to have left the university for the firm to be defined as an USO. Others, like Pirney et al. (2003) include both part-time (side-line) academic entrepreneurs and external (surrogate) entrepreneurs and focus on the knowledge transfer rather than the physical environment. The criterion; *at least one founder directly from employment at university* used in earlier studies in Sweden (SOU 1996:89) can exclude not only students but also the possibility of part-time entrepreneurial engagement in the new USO.

When Nicolaou and Birley (2003) discuss the definition of university **spin-outs** they suggest that besides transfer of core technology from an academic intuition into a new company, involvement of the inventor academic(s) in the new company varies. Therefore they categorize university **spin-outs** into three types, i.e. the i) *orthodox*, involving both the academic inventor(s) and the technology, ii) *hybrid,* involving the technology but the inventor(s) partly retain their academic position iii) technology spin-outs, which only include the technology spinning out and the inventor academic has no further connection to the newly established firm. They argue that the entrepreneurs' social networks within and outside the academic institution influence the different spin-out structures (cp. 2.2.3).

In Sweden USOs are a relatively new phenomenon (SOU 1996:89), which is why studies of more long-term effects are spare. In one of the very first, Olofsson and Wahlbin (1993) studied 500 technology-based firms started by university staff. They noted how the view of combining research with business activities became more positive in Sweden in the late 1970s. The question of involving students in USOs has arisen in line with the appearance of EE at universities since the 1980s. However, existing studies from the U.S. with a longer history of USOs usually exclude students, despite the earlier availability of EEs. One explanation can be that in the U.S., the focus has been on the commercialization of intellectual property rights developed within the university and consequently, within medical and technology areas (Shane, 2004). Only lately, some interest in students in USOs has arisen in the U.S. (Beyhan & Findik, 2018; Boh, et al., 2016; Hayter et al., 2017). When students are included, it is less obvious that the kind of knowledge transferred to the start-up comes directly from university research. A critical issue to consider is the definition of academic entrepreneurship (see also 2.4.), for instance, should it include research results from an academic institution (Nicolaou & Birley, 2003), or could a USO be built on any kind of knowledge spinning off from a university, such as knowledge from an EE? Therefore, student start-ups need to be further discussed and clarified.

2.1.5 The concept of Start-up in the university context

The origin of knowledge is hard to track, besides which many start-ups are influenced by more than one knowledge source. Using the criterion that all university education should be research-based, it seems impossible to assess the impact of research on student start-ups. Whether the source of a student's business idea can be derived directly from findings from academic research conducted at the university, or to any knowledge gained at university or just inspired by the university context can be difficult to determine. To differentiate between a USO and any other start-up in the university context requires determining whether the firm emerged specifically to commercialize innovations from the research side of the university (Duruflé et al., 2018). This understanding will be adopted in the present thesis. Therefore, student start-ups might include direct commercialization of research findings (=USOs) or just be influenced by and founded in the university context. A student start-up in this thesis is simply a formation of a new firm based in the university context with a student involved as founder, in line with my definition of the student entrepreneur (see 2.1.1). Whether the business idea is influenced from research, education or maybe from interaction in the university context will not be assessed. To be deemed a student requires a close connection in time to a university education and consequently also to the university context. However, I do not intend to draw an exact time line to differentiate between a student and an alumni (previous student), as it can be a sliding scale and all alumni have been students and are therefore of interest for this theses, at least as long as the links to the university are maintained.

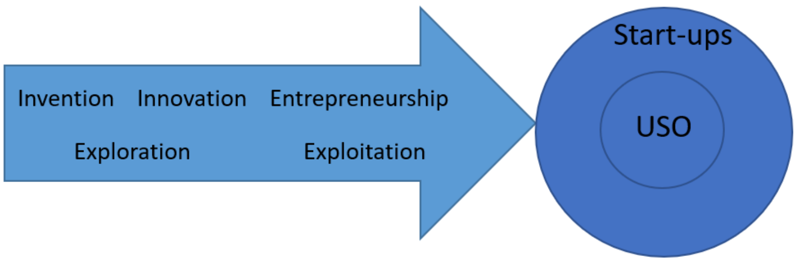

Figure 2.1 Main concepts

Without the ambition to evaluate the direct connection between the source of a business idea and academic research (or innovation) there are still two other determinates of a USO to consider and discuss, namely a new firm with a legal status of its own and with faculty/students involved in its founding. These two appear easier to define **if** there is a direct connection in time. Nonetheless, former students can establish firms far later and still be influenced by a business opportunity identified and generated from the university context. In this thesis, I will enhance our understanding of the formation of student start-ups in the university context, which assumes a connection in time between the start-up and the university education. With the above understanding of the main concepts in this thesis, I will now outline how the university context facilitates start-ups in general and for students in particular. The remainder of this chapter is structured in three parts in accordance with the three research fields, namely start-up formation (2.2), entrepreneurship education (2.3) and academic entrepreneurship (2.4).

2.2 Conditions for formation of start-ups in the university context

When trying to understand the formation of start-ups in the university context, contextual determinants in terms of the surrounding ecosystem have become a prominent topic and an important stream in research. How ecosystems emerge and evolve both around universities in general (e.g. Hayter et al., 2018) but also for student entrepreneurs in particular (e.g. Bergmann et al., 2016; Wright et al., 2017) has been investigated. The findings agree on the complexity and variation of such systems. They are dynamic and change over time, which is quite understandable as they include such contiguously changing elements as shared knowledge, experienced entrepreneurs and ´culture´. Many of these various elements in the recent explosion of studies of ecosystems can be applicable for student start-ups. Given the research questions, some essential conditions for start-ups connected to the university context are chosen and will be covered in this sub-chapter. I will start with the nature and access to business opportunities (2.2.1), followed by how critical resources can be supplemented by a network (2.2.2), how knowledge from university can be exploited through knowledge spillovers (2.2.3) and finally the importance of entrepreneurial capital in the context (2.2.4). The entrepreneurial ecosystem for students also includes entrepreneurship courses and programmes (Wright et al., 2020), which will be targeted in sub-chapter 2.3.

2.2.1 Access to business opportunities

Entrepreneurship is carried out by people, i.e. the entrepreneurs and the characteristics of these people may differ between contexts and situations. The specific prerequisites in the university context in connection with business opportunities will therefore be considered in this section. The start-up of a new business has been seen as a process including the two sub-processes of i) discovery and ii) exploitation (Shane & Venkataraman, 2000). In the discovery phase they include development of the idea (i.e. exploration, see fig. 2.1). The development phase usually continues after the exploitation phase (i.e. realization) has begun (Davidsson, 2006). Even if the two sub-processes are partly concurrent and sometimes reverse, the development/exploration of ideas usually starts before the exploitation that aims to attract customers. Innovation (exploration) without entrepreneurship (exploiting) is of limited economic value, while entrepreneurship (when regarded as new firm formation) without innovation (cp 2.1.3) has less impact on a society's economic growth and development.

The innovativeness in the business idea dictates the skills needed by an entrepreneur. Samuelsson (2004) found that the start-up formation is different for imitative and innovative ideas. Innovative ideas demand higher competence on the part of the entrepreneur than imitative ones. For imitative or reproductive ideas, development and exploitation have taken place previously and are possible to copy, at least to some extent. For innovative ideas both exploration and exploitation will be more demanding in the more uncertain context (Gustafsson, 2004). Statistics Sweden's study (2008) proved that the higher the education among the entrepreneurs, the higher the innovativeness of the businesses they start. University spin-offs have been found to have a significantly higher degree of innovativeness than other new technology-based firms in relation to their size (Lindholm Dahlstrand, 2001). Researchers' start-ups will therefore probably have a higher degree of innovativeness than the ones founded by students. The student start-ups in Eriksson's study (1996) were found to be based on relatively well-established technologies, usually focusing on technological improvements for small customers. Her study was, however, conducted around a newly established university with limited research resources. But according to Wallmark's study from 1997, also at Chalmers with a long history of research, several of the university spin-offs originated from undergraduate course projects and had a lower technical level than start-ups stemming from researchers.

It is vital to know more about the individual entrepreneurs for understanding the potential of the start-ups and the entrepreneurs' actions. In Shane and Venkataraman's conceptual paper (2000), entrepreneurship is defined not only in terms of opportunities, but also in terms of the individuals and the way they react to opportunities. Accordingly, it is essential to consider both the presence of opportunities as well as enterprising individuals willing to exploit the them. Through case studies of a certain MIT invention Shane (2000) has investigated how entrepreneurial opportunities are discovered. The results showed the influence of many types of previous experience such as work, personal events and education. Consequently, all individuals are not equally likely to recognize the same opportunities. The discoveries are made by recognition already possessed, rather than by the search for new knowledge (Sarasvathy, 2001; Shane, 2000). Different individuals interpret the environment differently and may see opportunities where others do not. In the context of academic entrepreneurship this might imply that entrepreneurship students trained to look for business opportunities have an advantage compared to the group of academic researchers, who are generally not specifically trained in entrepreneurship.

However, not only individual entrepreneurs' ability to recognize opportunities but also their willingness to act upon them is necessary for start-ups (Shane & Venkataraman, 2000). Intentions without action do not generate start-ups. Furthermore, Lundström and Stevenson (2002) assert that both motivation[9] and skills are needed for a start-up to take place. In line with this, Locke (2000) suggests that human action is a result of motivational but also cognitive factors such as ability and skills. In a model developed from previous research on start-up formation, Shane et al. (2003) emphasize that individuals' entrepreneurial motivation and drive as well as individual cognitive factors such as vision, knowledge, skills and abilities as well as opportunity recognition, are affected by environmental factors. The context surrounding the entrepreneur is suggested to be central for bringing forth entrepreneurship. A context rich in knowledge will provide plenty of business opportunities, that entrepreneurs can commercialize (Audretsch & Keilbach, 2007) but the will and skill to act upon them also need to be present in the context. Adapted to the university environment, research provides opportunities, while EE can provide the willingness and skills needed for action to take place. Obviously, activities introduced to promote a high start-up rate at universities would be useless without devoted and competent individuals willing to become entrepreneurs. However, the entrepreneur has been regarded as the scarce resource in the academic setting (Braunerhjelm et al., 2010) as well as the core resource for entrepreneurial ventures (Guerrero & Urbano, 2014; Landström, 2017). Therefore, entrepreneurs with willingness and skills to act on business opportunities are central in academic entrepreneurship in order to facilitate start-ups.

[9] Motivation and willingness are often used together, closely interconnected as they are. Motivation can be regarded as leading to willingness (intention) to do something. Motivation is an internal attribute that can be influenced and inspired externally and is the reason for a particular action. This being so, my use of the two concepts might not be altogether consistent.

The base for a start-up may originate from a business opportunity derived from academic research. However, the individuals involved as well as the context will influence the outline. Sarasvathy et al. (2003) discuss entrepreneurial opportunities as emerging within a process of interactive human action. In line with this reasoning, Sanz-Velasco (2006) suggests that opportunity discovery should be renamed opportunity development in order to emphasize the creative, interactive and iterative process. Therefore, opportunity development can be seen as a process of entrepreneurial learning with market needs and resources taken into account. Combining different individuals with various forms of experience can improve this process of opportunity identification, evaluation and development. Put in another way, perspectives of both innovation (new and usable ideas) and entrepreneurship (ideas carried out on the market) will be fruitful for the development process of a new business opportunity.

The formation of a new firm is dependent on the entrepreneurs´ skills to exploit opportunities, which in turn is connected to the entrepreneurs' skills to in allocating critical resources. In line with this reasoning, a business opportunity can result in many different outcomes depending on how the entrepreneur looks upon resource allocation. Sarasvathy (2001) describes two different types of decision logics used to obtain resources; causation and effectuation. Causation involves choosing between the means to create a particular effect, while effectuation implies choosing between many possible outcomes by the use of the particular set of means available. He describes the entrepreneur as an actor with imagination, who has the possibility to create several different firms from the resources available. In reality, the two logics can be used simultaneously but the theoretical model describes different ways to look upon resources: creating a business with the available resources for a flexible outcome (effectuation), or trying to obtain the required resources to reach a predetermined goal (causation). An entrepreneur tends to be closer to the effectuation-logic and to adapt the business opportunities to the resources available, as understood by Sarasvathy.

With this perspective, even if the desired resources are lacking the entrepreneur can find other ways to make progress.

The context provides the base for the entrepreneur when starting a business. The university context facilitates connecting opportunities from research to actors who are willing and able to carry them out on the market. Linking academic research to entrepreneurship students, as willing and capable actors prepared to start a new career within business, can be one way of establishing USOs. Taken together, access to business opportunities from academic research is not enough to start the entrepreneurial process; it will depend on which individuals are connected to the opportunities and their previous experience.

2.2.2 Access to a network

The task of mobilizing resources needs credibility and links to others. In the early life of a new business, legitimacy is a well-known problem and part of the so-called liability of newness (Stinchcombe, 1965). According to Garnsey (1998), the outcome of resource mobilization, which also includes elements of coincidence and luck, determines future success or failure. Venture creation is an innovative process using both the entrepreneur´s existing resources (e.g. knowledge and experience) and new ones that can be acquired in interaction between individuals. While the entrepreneur is the main actor, the surrounding network is essential for the resource allocation process. A new academic entrepreneur can find supplementary resources through available connections in the university context, such as the supply of resources provided by innovation support systems.

Accordingly, interaction facilitates entrepreneurship by linking different available resources. The social network surrounding the entrepreneur is critical for start-ups. In the social network opportunities can be transferred from individual entrepreneurs or from organizations to other individuals or organizations. Franklin et al. (2001) found that universities with a positive attitude to external (surrogate) entrepreneurs have most start-ups. Actors outside the university can be better suited to exploit the opportunity than the academics, who might lack the necessary market knowledge or business networks for commercialization. Franklin et al. suggest a combination of academics and external entrepreneurs as the best approach. Connecting actors with experience from the business world will probably improve not only the exploitation phase, but also the exploration, because foreseeing possible applications and forming various business opportunities are dependent on individuals' previous knowledge of markets (Shane, 2000).

Within research about entrepreneurship, the role of networks has been in focus for decades. Several studies have discussed the possibilities for entrepreneurship being decided by individuals belonging to social networks (e.g. Aldrich and Zimmer, 1986; Johannisson and Nilsson, 1989; Nicolaou and Birley, 2003; Witt, 2004). Entrepreneurship has been regarded as a social phenomenon in terms of a regional collective social act rather than an individual one (Johannisson, 2000). The entrepreneurial network plays many important roles, one being to supplement the new firms' limited resources, but it is also known to influence opportunity recognition, which is of catalytic importance (Nicolau and Birley, 2003). In the university context the importance of close colleagues' start-up experience has proven favourable (e.g. Bercovitz & Feldman, 2008). A small firm's learning is located in the context of close relationships, where knowledge is shared and developed collectively, i.e. learning in interaction (Gibb, 1997). If social interaction is seen as an essential ingredient in the start-up formation, developing the business network is very important for making progress (Davidsson & Honig, 2003).

In line with knowledge gaining major significance as a production factor, the transfer of knowledge, collective learning and absorptive capacity (Cohen & Levinthal, 1990; Liyanage, Elhag & Ballal, 2012) have attracted more attention for contributing to start-ups. This has also resulted in an increased interest in knowledge interchange embedded in specific regions. Acs (2006) argues that start-ups dependent on knowledge inputs are closely tied into regional networks. Regionally networked innovation systems are characterized by localized, interactive learning (Cooke, 2001). Malmberg and Maskel (1997) suggest that geographical proximity matters, not only because interaction will be smoother and less costly, but also in a social and cultural sense. Some types of knowledge interchange will require a high degree of mutual trust and understanding, related to shared values and 'culture' (Bouty, 2000; Malmberg & Maskel, 1997;). In the context of academic entrepreneurship, individuals sharing the same education and university culture might therefore have an advantage when it comes to knowledge transfer. Not only will a certain level of education be required to understand and apply specific new knowledge, but by sharing the same university background, social ties will enhance trust and communication between the stakeholders.

A more codified knowledge exchange might take place globally, but here absorptive capacity will also be an issue. Bathelt, Malmberg and Maskell, (2004) studied the spatiality of knowledge creation and the relation between tacit knowledge to local vs. codified to global. They found that knowledge flows not only from the local buzz, but also from global pipelines outside the region into local clusters. Consequently, being part of a local cluster give access to knowledge both from neighbouring firms but also their respective global pipelines. In their discussion, Bathelt et al. include local mediators dispatching new knowledge from global pipelines that is possible to integrate locally depending on the absorptive capacity and shared language and values. Considering how knowledge flows, location takes on a growing importance and local embeddedness becomes more central for entrepreneurs (Baltzopoulos & Broström, 2013).

Global challenges are to be solved in a local context. In this 'globalization paradox' entrepreneurship and networks are of crucial importance (Markusen, 1996). Hence, distant actors cannot compete with the advantage of proximity and clusters around a university with possibilities for cross-fertilising face-to-face meetings. In other words, the interaction between individuals in the university context becomes central in understanding academic entrepreneurship.

Academic spin-offs are typically embedded in a context focusing on knowledge creation and regional development. There are two main characteristics that distinguish university spin-offs; i) their knowledge base, and ii) their regional importance, as they tend to cluster around the university that fed them (Shane, 2004). In spite of market competition known to be increasingly globalized, the typicality of USOs in their localization close to the university is a contradiction expressed by Williams (in Lester, 2005) as *knowledge is global, but learning is local*. Knowledge most often contains a tacit element and cannot be as easily transferred as tangible production factors. The tacit knowledge accessible in local and regional supporting networks has become a competitive advantage in a globalized world (Porter, 1998). The more tacit and diffuse the knowledge, the more dependent actors become on spatial proximity and face-to-face contacts (Audretsch and Feldman, 1996). Shared identity is created and subtle knowledge exchange fostered in repeated interaction (Saxenian, 1994), which can be applied to the university context.

Entrepreneurship is a context dependent process and other individuals in the context are required for a successful start-up. Universities play a key role as entrepreneurial hubs, connecting researchers, students, graduates, potential and experienced entrepreneurs, companies and other stakeholders (Volkmann, 2009). Academia is accordingly not just a knowledge producer and diffuser, but also fulfils a function as a relation-creator, which can be equally important. Duruflé et al. (2018) characterize a new role of universities as a hub of innovation and entrepreneurship, not just a source to/of BO. Activities organized in the university context enable knowledge exchange and new ideas to develop, relationships to be formed and maintained. Saxenian (1990) explains the performance of Silicon Valley as being attributable not only to single individuals but also to interaction within formalized networks. When people meet, technical and market information will be exchanged, business contacts will be established and new enterprises conceived. Guerrero et al. (2014) regard the entrepreneurial university as a natural incubator in providing a supportive environment generating interaction, collaboration and co-operation by partnership in the network, not least with actors outside the university.

With the more conventional understanding of incubators, one of their main roles has been described as network mediation. That is, connecting to complementary knowledge and expertise that are vital for the survival of new ventures (Bergek & Norrman, 2008). Actors in the network contribute with complementary entrepreneurial resources matching the entrepreneur's own lack of resources. In a survey among academics in Sweden, personal contacts and networks of researchers and teachers were regarded as very important when starting a company (Wahlbin & Wigren, 2007). Strangely enough, despite all the support systems established, support from the university was only obtained in a minority of cases. When studying the organization of the infrastructure of Chalmers, Jacob et al. (2003) found problems with transparency and uncertainty among faculty members about how to use the different support components, even though the faculty had knowledge of their existence. At the same time, the importance of personal contacts and of turning to someone the researcher knew was stated. Hence, the importance of individuals and personal relationships was manifested above the formal support system.

The multifaceted concept of entrepreneurship has also been connected to creativity and the creative process shaped in interaction. Florida (2004) calls attention to the importance of talent exchange to unleash human creativity. In his discussion about the creative age with *Technology, Talent and Tolerance* as the new competitive advantage of the national economy, a country is under the universities' hegemony. Talented people do not choose countries but regions; they are attracted by other talented people who enable the opportunity to engage their own creative faculties. According to Florida, universities function as intellectual hubs, a natural source of diversity. The core competitiveness of a university is expressed as tolerance, openness and diversity. Divergent ideas will release innovation and opportunities. Innovation tend to occur when people and actors meet, cooperate and share knowledge over institutional barriers (Florida, 2004; Saxenian,1990). The university setting constitutes opportunities that can lead to a start-up when different actors meet and develop in interaction. Not only the talents of students and faculty members are promoted at university, but external actors can also benefit from inspiring co-operation, creative interaction and cross-fertilizing knowledge exchange. A connection to relevant network partners at university is one of the most important value-added components a university can offer to a new venture (Volkmann, 2009).

Already existing social networks influence the propensity for individuals to establish new ventures close to where they have studied. For new firms the exchange of ideas within a network is especially favourable (Lindelöf & Löfsten, 2004). Student start-ups are found to have many co-creators (Wright, Siegel & Mustar, 2017). The presence of peer entrepreneurs has a strong influence on location (Larsson, Wennberg, Wiklund & Wright, 2016). Location decisions of former academic entrepreneurs has therefore an influence on new ones (Baltzopoulos & Broström, 2013). Experienced entrepreneurs, a technically skilled labour force and proximity to universities are some factors in the environment proved to stimulate entrepreneurship in general (Bruno & Tyebjee, 1982). Therefore, university spin-offs can be regarded as having advantages compared to *other* new firms, due to their proximity to highly educated employees, research results and knowledge spillovers. However, a lack of experienced entrepreneurs in the university context might be a disadvantage.

2.2.3 Access to knowledge spillovers

Audretsch and Keilbach, (2008) refer to the Swedish paradox as an example of the statement that high investments in research do not automatically spill over into economic growth. Without entrepreneurs willing to commercially exploit opportunities, innovations are of limited economic value. The Knowledge Spillover[10] Theory of Entrepreneurship explains the discrepancy between organizations creating opportunities and those exploiting them. In this line of research, it is entrepreneurship that enables knowledge from one source to be exploited in another organization (Audretsch, 2009; Audretch & Keilbach, 2008). Entrepreneurship is consequently an important conduit for facilitating spillover of knowledge that would otherwise have been uncommercialized. As entrepreneurial activity plays a key role in knowledge spillover transmission, spillovers from university research contribute more to innovative activity in small firms than in large ones (Acs et al., 2009). They argue that the fixed social networks in older/more established firms can limit the inflow of new ideas. Aldrich and Auster (1986) maintain that there are disadvantages for large and old organizations, sometimes called the liability of ageing and bigness. Small firms' innovativeness has been explained by knowledge inputs from others, such as universities located in spatial proximity. By cultivating relationships with universities, it becomes possible to absorb and

[10] In the following, the Knowledge Theory of Entrepreneurship (Audretsch, 2009; Audretch & Keilbach, 2008) will be referred to when using the term 'knowledge spillovers' or just 'spillovers'. So far, ´knowledge transfer´ has been used and in the following it will serve to indicate knowledge transformation in a broad, more general sense.

benefit from knowledge spillovers (Audretch and Feldman, 1996). But to enable knowledge spillovers interaction between individuals is necessary with the entrepreneur as the key actor.

Spillovers are concentrated in spatial proximity to the knowledge source, which makes firms localize closely (Acs et al., 2009; Audretch & Feldman, 1996). Audretsch and Lehmann (2005) tested whether the Knowledge Spillover Theory of Entrepreneurship holds for regions as well as for industries. Their empirical study in Germany showed a link between entrepreneurial activity (the number of young high-tech firms located close to a university) and the knowledge output of universities. Their result revealed that entrepreneurial activity was greater in contexts where the knowledge investments were high and that start-ups tended to cluster close to the source of knowledge, in this case, the university. The younger the university, the more firms tended to locate within close geographic proximity. Their explanation for this was that older universities focus more on the social sciences, which is a discipline with little impact on the start-up rate. Audretsch and Lehmann use academic research as the measure of knowledge and talk about graduates as one of the most important channels for disseminating knowledge from academia. Whether they only find students important as highly educated employees or as the actual founders of the new firms is not discussed in their paper. Individuals representing the entrepreneurial activity and the founders of the knowledge-based start-ups examined are neglected in their study, in contrast to this thesis.

As new technology companies tend to cluster, the economic impact of university spin-offs is often magnified (Shane, 2005; Shane 2004). Geographic clusters of new firms in a particular technology will be catalytic for the formation of additional spin-offs. New USOs are likely to locate near the university that spawned them, one of the reasons being that the researchers want to retain their university employment and/or already live in the area. Another reason is that academic spin-offs are dependent on new research. To access advice and competence (but sometimes also equipment), the founders turn to their home institution, where they already have contacts (Johansson, 2007). The knowledge a scientist is ready to share is purely interpersonal, dependent on acquaintance and mutual trust (Bouty, 2000). For academic entrepreneurship, where knowledge is the dominant competitive advantage, proximity to the university is characteristic for the location. In order to ensure expertise in the future, it is beneficial to maintain ties with the parent university (Johansson, Jacob & Hellström, 2005). The spatial proximity permits direct exchange of knowledge, also because of the cultural affinity of enterprises and universities with compatible value concepts and behaviour patterns (Weiler, 2002). The closeness to university facilitates an ongoing interaction, bringing new academic entrepreneurs together with more experienced ones. Because a university is immobile with a long-term commitment to the region, its role as an 'engine of innovation' in the local economy is multiplied (Lester, 2005).

A continuous relationship between established USOs in the region and the university are mutually beneficial and they are likely to become long-term partners. USOs provide a visible output of the university's activity, which helps to improve their image (Rasmussen et al., 2006). Positive effects are thus generated in both directions, from university to society as well as the other way around, from the surrounding region back to the university (Audretsch & Lehman, 2005; Cooke, 2001; Etzcowitz et al., 2000; Rothaermel et al., 2007). This 'two-way flow' will result in an increasingly knowledge-based society and global evolution, when the university system will be renewed and affected by feed-back loops from industry and society (Etzcowitz et al., 2000). In other words, the cumulative effects of academic entrepreneurship first arise after a considerable time lag and are not easily evident. Additionally, multiple and long-term effects in the region will be generated when one start-up influences followers. In the long run the entrepreneurial capital in the region will develop and foster further entrepreneurial activity taking advantage of knowledge spillovers. Leitch & Harrisson (2005) proved the existence of long-term effects in terms of the development of second-order commercialization activities from USOs. For student entrepreneurs, indirect and multiplied effects appear especially relevant considered their long future career.

When investigating the link between universities and entrepreneurship Audretsch (2017) suggested distinguishing between three different ways; i) technology transfer, ii) knowledge spillovers and iii) entrepreneurship capital. Technology transfer is here understood as technology owned by the university but commercialized by private interests, mainly through patenting and licensing. Using this definition technology transfer is hardly relevant in Sweden, where professors' privilege is the rule. Audretsch understands knowledge spillovers as connected to knowledge created in one organization but accessed and utilized in another, without any purchase involved. This is relevant for knowledge from a university utilized in a new venture, defined as a USO in this thesis. Audretsch notes that knowledge spillovers have been viewed both as a source for entrepreneurship and as a conduit between two organizations. The organizational level has been dominant in this line of research, but there are some attempts to view knowledge spillovers on an individual level (e.g. Guerrero & Urbano, 2014). So, even if the individual academic entrepreneur is the key actor in transferring, absorbing and making knowledge economically useful, the involvement of such individuals has largely been ignored. Recently, Caiazza, Belitski & Audretsch (2020) have highlighted the strategic role of the entrepreneur in each step of the process from latent to emergent entrepreneurship, the so-called knowledge spillover construction circle. When the lens is shifted from the firm to the individual as the relevant unit of observation, the missing link in terms of entrepreneurs in the university context (Braunerhjelm et al., 2010) becomes obvious.

2.2.4 Access to entrepreneurial capital

When including individuals in the knowledge spillover theory, resources such as social capital and entrepreneurial capital will help to shed light on the emergence of USOs. Entrepreneurial capital is closely related to social capital, but with a conduit to entrepreneurship and knowledge spillovers (Audretsch, 2017). Taking Silicon Valley as an example of the linkage and exchange between individuals, Audretsch and Keilbach (2004) introduce the concept of entrepreneurial capital as an important new production factor. It is connected to a region's capacity for creating new businesses as well as individuals' willingness to take the risks involved in starting a new business. A general social acceptance of entrepreneurial activity that is supportive of start-ups is also pointed out as important characteristic of entrepreneurial capital. Erikson (2002) views entrepreneurial capital as a multiplicative function of entrepreneurial competence and commitment by individuals. He discusses the concept as the present value of future entrepreneurial behaviour. Erikson also relates entrepreneurial capital to age, meaning that the potential for future entrepreneurial behaviour is influenced by age: competence and resource allocation increase with advancing age, while commitment decreases. Commitment is understood as not giving up during the venture creation process, while competence includes identifying and pursuing opportunities.

However, entrepreneurial capital is not an actual individual ability but something subtle `in the air` in the surroundings. Even if social capital is regarded as the sum of resources in the network, it is not equal to entrepreneurial capital. Entrepreneurial capital is created in multiplicative interaction and makes individuals perceive themselves as entrepreneurially capable. It will increase self-efficacy, which makes individuals more sensitive to opportunities and able to take advantage of them. The entrepreneurial capital in the context will influence individuals' behaviour. Chandler & Hanks (1994) show empirical evidence for the fact that the founders' competence in interaction with environmental characteristics is significantly related to venture performance. Interaction between individuals in the university context is consequently of decisive importance for the performance of the start-up as well as for fostering entrepreneurial capital.

To foster entrepreneurial capital requires diversity among individuals in the context. Entrepreneurial capital is a heterogeneous resource, dependent on complementary human capacities shaped by diversity in interaction (Erikson, 2002). Audretsch (2017) suggests that universities can enhance entrepreneurial capital in two ways; through education in a wide range of academic subjects and by attracting and nurturing diversity. Diversity enhances entrepreneurial capital by injecting heterogeneity in both thinking and backgrounds, which will fuel entrepreneurship. It is repeated interaction and relationship between heterogeneous actors that fosters entrepreneurial capital (Audretsch & Keilbach, 2004), therefore universities' role as a meeting-place and relation-creator becomes most important (Volkmann, 2009). Individuals stimulate each other, new ideas flow and grow and if venture creation is a visible opportunity in the context, individuals might act upon opportunities. However, entrepreneurial classes affect not only participants but also fellow students by providing role models and changing the university culture (Bergmann et al., 2016; Hayter et al., 2018). One essential basis for entrepreneurial capital is academic peers in order to learn from classmates and alumni with entrepreneurial experience (Hayter et al., 2018; Wright et al. 2017). Students are likely to stay in the region and start their firms close to where they completed their studies. (Baltzopoulos & Brostom, 2013). Therefore, EE can increase the entrepreneurial capital in the university context, especially if heterogeneous actors are involved.

Introducing EE at university will generate effects on the surrounding entrepreneurial capital in the future. According to Volkmann (2009), the general consensus is that EE constitutes an essential contribution to the development of an entrepreneurial culture in countries, regions and educational institutions. This culture is first and foremost the breeding ground for new start-ups, but also the basis for entrepreneurial thinking and activity, e.g. in existing companies. By influencing the context EE can therefore be regarded as a societal change agent. However, the review by Nabi et al. (2017) points out that research on the impact of EE has so far failed to implement contextual measures. Recently, scholars have suggested that the role of students can serve as a catalyst for USOs (Hayter et al., 2017). Students, and especially entrepreneurship students, represent available and potential entrepreneurs in the university context ready to exploit business opportunities. As willing entrepreneurs in the university context, they represent the essential conduit for the spillover theory of entrepreneurship (Audretsch, 2017) as well as the missing link in the university context (Braunerhjelm et al., 2010). In the conversation of EE and academic entrepreneurship, the concept of entrepreneurial capital will help me to understand student entrepreneurs in interaction with others in the context.

2.3 How does entrepreneurship education facilitates student start-ups?

With a purpose of understanding the formation of student start-ups, the most obvious point of departure is EE at university. EE at universities has exploded in the past few decades (e.g. Nabi et al., 2017) after having started to slowly develop in the early 1970s in Europe (Gabrielsson et al., 2018). The U.S. has a longer and stronger focus on how to influence start-up formation. In Europe, there is a broader perspective on entrepreneurship, i.e. taking initiatives, creating one's own future and autonomy have received more emphasis, especially when introduced in primary schools. In pace with the introduction and growth of EE, research about it has developed into its own specific research field related to pedagogic and learning, distinct from the scholarly field of entrepreneurship (Gabrielsson et al., 2018; Pittaway and Cope, 2007). But, in line with different perspectives on the definition of entrepreneurship, the pedagogical objectives and outcome are difficult to define, which complicates research in the field (Fayolle, Verzats & Wapshott, 2016). Is EE at university about developing creative entrepreneurial individuals for the future, or to increase immediate start-ups around the university and thereby improve the university's reputation as entrepreneurial? Anyhow, it is evident that the introduction of EE at universities has accelerated simultaneously with the pressure on universities to become commercially responsible.

2.3.1 Outcome from entrepreneurship education - a long-term matter

From a view of the entrepreneur as a more or less predetermined career depending on individual traits and upbringing, there has been a change to a view that entrepreneurial behaviour is possible to influence by experience and learning (Gartner, 1988). Kilby introduced the metaphor of the *Heffalump* in 1971, illustrating how for many years researchers had searched for specific pre-existing characteristics of entrepreneurs, ending up finding very different entrepreneurs. Since then research interest in entrepreneurs has changed from *who* to *how,* or from psychological characteristics to behavioural action. Nowadays, many researchers agree that it is possible to stimulate entrepreneurial behaviour, at least some parts of it (Fiet, 2001; Kirby, 2007; Kuratko, 2005). However, the diverse pedagogies and intended outcomes make it complicated to establish the impact of EE (Nabi et al., 2017).

There are several challenges involved in trying to measure the outcome of EE on individuals. EE can influence students in many ways, not only by promoting an immediate start-up of their own (Galloway & Brown, 2002). Even if some young graduates create start-ups in connection with their education, many will do it considerably later (Nabi et al., 2017). Students' start-up formation can also be repeated many times during their lives, which complicates the evaluation of university EE in relation to alumni start-ups (Vesper & Garner, 1997). The main part of empirical studies shows the effect on students' intentionality and propensity for entrepreneurship (Pittaway & Cope, 2007), which is usually evaluated by the students' own self-assessment in connection with their education. Asking about students' intention for the future is a quick method, but it says little about what will actually happen. To find out if their actual behaviour is affected, former students need to be traced years later and their entrepreneurial behaviour mapped. Pittaway and Cope (2007) as well as Rasmussen and Sörheim (2006) would like to see more longitudinal studies on graduates' careers, as the effect of EE is long-term (Galloway & Brown, 2002; Wright et al., 2020).

To determine the long-term impact on the national economy from university graduates requires time. Some studies have been conducted in the U.S., which has a longer history of EE. One such long-term study is the large survey of living alumni from MIT's long history. It shows that students start companies at an early age and that the impact of start-ups increases in society over time with company growth and when multiple companies are founded (Roberts & Eesley, 2009). Another study of alumni from Babson College showed evidence that two or more elective entrepreneurship courses increased both students' intention and actual start-up for a long time after graduation (Lange, Marram, Jawahar, Yong & Bygrave, 2011). Students will have plenty of time in life to benefit from EE, but also from experience through multiple start-ups. Even if earlier studies have shown contradictory results of benefits from previous start-up experience (Delmar & Shane, 2006; Politis, 2005; Politis, 2008; Rotefoss & Kolvereid, 2005; Westhead & Wright, 1998), it can always be argued that students need work experience, maturity and developed networks before creating a sustainable business. In a report about Entrepreneurship in Higher Education (2008) the European Commission concluded that students themselves pointed out their lack of relevant experience as well as their lack of self-confidence as the main barriers to immediate start-up. A narrow focus on entrepreneurship students' immediate start-up frequency without a long-term perspective makes the outcome difficult to determine.

When entrepreneurial behaviour is measured in terms of immediate start-up frequency, which is relatively easy, it can still be argued that individuals choosing EE have a pre-existing motivation, so a high start-up rate could be expected, irrespective of the education (Rasmussen & Sörheim, 2006). Selection bias is problematic and studies of start-up frequency often fail to include a relevant control group or both pre and post measures, not to mention the wide range of other variables that also influence a start-up (Honig, 2004, Nabi et al., 2017). Owing to these methodological problems, conclusive evidence that entrepreneurship in higher education creates more or better entrepreneurs can still be questioned. Nevertheless, students who have studied entrepreneurship at a university will probably view self-employment as a more viable career option (Iglesias-Sanches, Jambrino-Maldonado, Penafiel Velasco & Kokash, 2016). They will probably also be more aware of business opportunities in the future, and even if they have not obtained an entrepreneurial mind-set themselves, they will have an enhanced awareness of entrepreneurial attitudes and behaviours. In a broad sense, entrepreneurship empowers people to take their own destiny into their hands (Wilson, 2009). If the EE focuses on start-ups or just being enterprising in a general sense (see 2.1.1), it will be reflected in the diverse long-term outcomes. Therefore, this thesis will continue to consider different educational designs and practices.

2.3.2. Content of entrepreneurship education – a diverse matter

Despite the fast growth of EEs at universities, best practice for how to educate has still not been developed (Fiet, 2001; Kirby, 2007), which is partly dependent on different desirable outcomes. According to the European Commission (2008), EE can have various objectives such as: a) developing entrepreneurial drive among students (raising awareness and motivation); b) developing the entrepreneurial skill to identify and exploit opportunities; c) training students in the skills they need to set up a business and manage its growth. Wilson (2009) list important common elements of EE including: a) enhancing entrepreneurial behaviours and mindsets, b) building self-confidence, self-efficacy and leadership, c) creativity, innovation and ability to think “out of the box” to solve problems, d) managing complexity and unpredictability, e) basic business and financial skills (= “business literacy”), f) opportunity identification, g) how to build, finance and grow ventures, h) developing negotiation skills i) and finally building relationships, networks and social capital. All the above elements can be connected to how EE facilities student start-ups, but the very last one, (i) training students in networking and social skills such as communication and co-operation, is especially relevant for the purpose of this thesis.

Another way to describe the diverse content of EE is to make a distinction between learning *about, for* and *in* entrepreneurship. There seems to be some common agreement that if learning, not only *about* (= understanding the subject) but also *for* (= inspire to) entrepreneurship is intended, the education needs to differ from traditional academic education methods, such as lecturing (Fiet, 2001; Gibb, 2007; Kirby, 2007). The importance of innovative methods and a flexible design, as well as taking the education out of the classroom and the necessity of combining theory and practice have been emphasized in research. For universities, unconventional methods such as learning by doing, action learning, experimental learning, interactive as well as contextual learning and inter-, and multidisciplinary approaches have been suggested (Fiet, 2001; Gibb, 1997; Johannisson, Landström & Rosenberg, 1998; Leitch & Harrisson, 1999; Pittaway & Cope 2007; Rasmussen & Sörheim, 2006; Volkmann, 2009). Klofsten (2000) argues that the optimal EE is a combination of i) creating an entrepreneurial culture at the university, ii) giving theoretical courses about entrepreneurship or iii) actual training and more hands-on by trying to do it. In incubators the EE continues through interaction with others (Kickul & Fayolle,

2007) and is a form of hands-on training in the university environment representing learning *in (*=actually doing) entrepreneurship. Some educational programmes involve an actual start-up experience. Building the training on students' own initiatives, but also interaction with the context, are often pointed out as important for fostering future start-up.

EE can provide connections to a network of experienced entrepreneurs. The combination of social networking, along with education and research, is highlighted as contributing to the MIT success (Roberts & Eesley, 2009). In their education both theory and practice are blended, and both academics and successful experienced practitioners willing to share their time and experience with students teach classes (Roberts & Eesley, 2009). From the development of the ENP programme at Linköping University Klofsten (2000) reports success factors such as access to a good network in combination with students' own initiative for taking advantage of it. Previous students with experience participate in the training of new students (Klofsten, 2000). According to Volkmann (2009), involving alumni entrepreneurs is especially important, as they serve as role models to increase awareness of entrepreneurship as a viable career option. In Pittaway and Cope's review (2007) of EE, the impact of interactions between students and established entrepreneurs proved fruitful, mainly by influencing awareness and perception.

Consequently, an enlarged business network can be one essential outcome from EE. In line with this, Johannisson et al. (1998) encourage an increased exchange between the university and its regional stakeholders in order to improve training for students. By bringing the local business community into the educational environment, student entrepreneurs can benefit from interactions with experienced entrepreneurs in their environment. Rasmussen and Sörheim (2006) emphasize the importance of a regional context and regional networks for EE. Resources from outside the university increase the quality of the education in many ways. They contribute up-to-date real-life experience, provide networks and contacts, serve as role models as well as stimulating the entrepreneurial process to move forward.

EEs can be directly designed to support interaction between students and researchers. When Rasmussen and Sörheim (2006) investigated five Swedish entrepreneurship programmes, they found that all of them to some extent filled the objectives of educating entrepreneurs as well as establishing new ventures. But only Chalmers School of Entrepreneurship had a clear intention to commercialize university research, inspired by the well-known success story of Silicon Valley (Jacob et al., 2003). This aim could to a lesser extent also be traced to the EE at Gothenburg University and the ENP programme at Linköping University (Rasmussen & Sörheim, 2006). By combining entrepreneurship students with research-based ideas in cooperation with the inventors, several aims can be fulfilled. Ideas that would otherwise be neglected are developed and student entrepreneurs gain access to advanced ideas. Working with high-potent ideas gives the students a better training in developing high-growth businesses, and in addition, the establishment of successful firms is hopefully achieved. According to Rasmussen and Sörheim (2006), all these objectives are present at Chalmers School of Entrepreneurship. Features developed at Chalmers School of Entrepreneurship are, for example, the integration of innovative research, action-based training and pre-incubation support for entrepreneurship students (Jacob et al., 2003). Even if the importance of students' own initiatives is usually emphasized in entrepreneurial education, Chalmers deliberately couple students with ideas from research. When the high proportion of students involved in start-ups from Halmstad University was studied (Eriksson, 1996; Johannisson et al., 1998) the explanation was students' independence and involvement during their education. In addition, solving existing problems in interaction with industry in projects was pointed out as a success factor.

This means that EE can facilitate interaction between individuals with different experience and roles. Interaction between students has also proved to be fruitful. Management and engineering students interacting in projects is yet another explanation for the MIT success (Roberts & Eesley, 2009). Likewise, Volkmann (2009) points out the value of a multidisciplinary process in higher education in entrepreneurship. A beneficial cross-fertilization will take place when students take courses and engage in projects with students from other disciplines. This will facilitate expertise from different institutions to interact, such as business with engineering. Prodan (2007) suggests another way to combine business with engineering. He argues that all technical universities should include entrepreneurial courses, because technological entrepreneurs have different knowledge, skills and characteristics and often lack the necessary business skills. Another option is to let actors with technological competence interact with actors with business competence at university, for example in EE. Wright et al. (2020) conclude that EE is especially helpful for technological entrepreneurship. To sum up, diversity and interaction among actors in the university context facilitates the formation of start-ups as well as influencing the entrepreneurial capital in the future. In EE students willing to become entrepreneurs can be linked to researchers and experienced entrepreneurs in the university context. However, students are not always included as actors in the discussion of academic entrepreneurship, as will be addressed next.

2.4 Key actors in academic entrepreneurship

Based on the research field of academic entrepreneurship, this section will address the special features and conditions in the university context that influence key actors, in this thesis both researchers and students, with special focus on how these two groups interact for the benefit of student start-ups in the university context. Certainly, there are other individuals both within and outside universities that could be regarded as key actors, e.g. external (surrogate) entrepreneurs can play important roles. Rasmussen and Wright (2015) point out that

USOs are often started in teams with dynamic interaction of individuals with different competencies. They regard researchers as the key actor in the three competences discussed. However, they also mention students as a possible actor with an indirect role as a member of the founding team or early employees and that alumni can be useful for resource acquisition as they have a strong industry network (Rasmussen & Wright, 2015). Certainly, researchers hold a key role in the conventional view on academic entrepreneurship, as USOs are created to commercialize academic research. But with the focus of this thesis on student start-ups in the university context, the key role of researchers will be different and students will also become key actors as academic entrepreneurs.

2.4.1 Who are the key actors in academic entrepreneurship?

So, key actors in academic entrepreneurship are usually understood as researchers, even if it is not always explicit expressed. For example, in Klofsten and Jones-Evans' (2000) definition of academic entrepreneurship it is stated that: *all commercialization activities outside of the normal <u>university duties of basic research and teaching</u> could be named entrepreneurial*. To Fini, Lacetera and Shane (2010) based in the US context, the financial gain is in focus when they define academic entrepreneurship as the 'entire range of efforts by academics to profit commercially <u>from their scholarly activities'</u>. Both these broad definitions imply researchers as key actors, but it is possible to include not only the formation of USOs, but also patenting, licensing or commercialization in already existing companies. "All commercialization´" in Klofsten & Jones-Evans' definition, also open up for any start-up, not only USOs, including knowledge transfer from the university. Academic entrepreneurship is usually linked to researchers starting new ventures to commercialize their research findings, e.g. as: '*Development and commercial exploitation of technologies pursued by academic inventors <u>through a company they (partly) own'</u>* (Perkmann & Walsh, 2007, p. 262). This definition also expresses the common association of researchers within technologies, even if other areas of research can also be a source for commercialization.

The potential for commercialization naturally varies between different academic disciplines and so far, technology has gained most attention when academic entrepreneurship has been discussed. This is shown by statements such as; Preferable within the technology area, research has shown to be a main source of innovations (Blanco, 2007) or How to foster technological entrepreneurship is one of the most important factors for economic development (Venkataraman, 2004). Naturally, not all academic research is suitable for commercialization. A large amount of academic research is not possible to apply commercially. Unexploited knowledge and inventions have a limited effect on economic growth, as employment and economic growth will only be created when it is used, exploited and diffused (Robets & Eesley, 2009). New solutions and ideas emerging from academic research can be regarded as inventions, but is not always possible to develop them into practically useful innovations suitable for market launching. Even so, Volkmann (2009) asserts that by means of EE at university knowledge-intensive high-growth enterprises can develop from all academic disciplines, not just technical ones. With this background, actors from all academic disciplines can be included in academic entrepreneurship.

Regardless of discipline, commercially useful academic research results are often far from ready for market introduction and a long period of further development remains (e.g. Mansfield, 1998). Finding researchers ready to take on this long and insecure process of further development into innovations usable on the market, as well as carrying out the market launch, is rare. Whether start-up activities are still a relatively marginal phenomenon among academics (D'Este & Perkmann, 2011) or very high compared to the start-up rate of the total national adult population in Sweden (Wahlbin & Wigren, 2007) is a matter for discussion. Klofsten & Jones-Evan (2000) observed considerable entrepreneurial experience among academics in Sweden and Ireland, but this mainly relates to consultancy and contract research, not the creation of spin-offs. By studying Swedish biotech cases, Nilsson, Rickne and Bengtsson (2010) tried to uncover the "grey zone", concluding that the ways and reasons academic research is transformed to society are much more diverse and multifaceted than is usually measured. Within nanotechnology, Perez Vico and Jacobsson (2012) identified a range of ways academic R&D indirectly influenced commercialization. Another Swedish study by Wennberg et al. (2011) found that corporate spin-offs by far outnumbered USOs in number (14 to 1) and in performance. These corporate spin-offs are also a result of knowledge transfer from academia, but this indirect path is not counted, as it starts after the founder had gained experience from industry as well as from the university. Hence, even when researchers are engaged in the commercialisation of their research findings our knowledge remains sparse, as a large amount of commercialisation takes place in ways other than visible USOs.

Consequently, academic knowledge, technology and research results are spun-out in alternative ways, e.g. through collaboration with already established companies, or by external entrepreneurs, or by students usually not included in the discussion of academic entrepreneurship. By taking the prevailing but limited focus on researchers' start-up activities, only part of the phenomenon comes to light. Substantial commercialization takes place outside universities' formal support system, which make it more or less impossible to keep track of. This refers especially to Sweden with professor's privilege, but also elsewhere (Fini et al., 2010; Markman et al., 2008; Siegel et al., 2007). Therefore, a greater variety and other forms of academic entrepreneurship need attention, including the third mission nexus informed by research (Siegel & Wright, 2015) or by generating spillover entrepreneurship and entrepreneurial capital (Audretsch, 2017).

2.4.2 The role of the third mission for researchers' start-up

Although universities' collaboration with industry and society is not a new phenomenon, the focus on academic entrepreneurship as an outcome is. Labelling this desired cooperation the '**third** mission' gave the impression that it was something new to add to the traditional tasks of education and research. This can have actually hindered the intended interaction with society (Wahlbin & Wigren, 2007). Calling upon academic researchers to take a direct part in commercializing, as the third mission is often understood, has been questioned within academia. The importance of keeping a balance between entrepreneurial performance and the quality of scientific output has been a subject of discussion (e.g. Van Looy, Ranga, Callaert, Debackere & Zimmermann, 2004).

A more nuanced picture of the beneficial two-fold cooperation is rarely discussed. Cooperation such as joint research projects, consulting and applied/contract research will transfer new usable academic research to industry, but also expose academics to the business world. In a report from Studieförbundet Näringsliv och Samhälle (SNS) (2014), the absence of the beneficial mutuality in the knowledge flow was pointed out as a disadvantage for Sweden compared to universities in the US. The study by Perkmann and Walsh (2009) concludes that collaboration is favourable for both industry and academia, but not necessarily concerning commercialization of university-developed technologies converted into commercial applications in new products. In most of the cases academics were instead contributing to ongoing projects within firms, providing industry with input to commercial problems without any personal commercial interest in the innovations. Interaction results in mutual learning opportunities and a fruitful cross-fertilization that can sometimes result in commercial outcome, even if that is usually not the academics' motives for working with industry (Perkmann & Walsh, 2009). Rasmussen & Wright (2015) argue that interaction with industry is actually needed for a faculty to establish a USO.

Previous research has shown that researchers do not interact with industry in order to commercialize their research findings, but for knowledge exchange. They engage to benefit their research and access new knowledge, ideas and insights (D'Este and Perkmann, 2011; Perkmann and Walsh, 2009). Lee (2000) reports significant support from scientists for industry collaboration, especially within engineering and the applied sciences. In addition to research-related benefits, other motives were found such as; a sense of duty, because they enjoyed it and a feeling of responsibility (Lee 1996; Wahlbin & Wigren, 2007; Wigren-Kristoferson, Gabrielsson and Kitagawa, 2011). In Lam's (2010) study researchers also reported the expected outcome from interaction such as; exploiting research results, creating an opportunity for knowledge transfer, enhancing the visibility etc. From researchers' point of view, disseminating knowledge to society appears to be strong a strong motive for collaboration with industry. Thus, their incitements for cooperation appear to be far from merely commercial or financial reasons. Researchers' non-interest in personal commercial activities has been pointed out in several studies (D'Este & Perkmann, 2011; Lam, 2010; Lee 1996; Wigren-Kristoferson et al., 2011). Consequently, the third mission seems rewarding in many ways, but evidence that it facilitates start-ups is lacking.

Hence, so far previous research shows little evidence that interaction with industry promotes start-ups. Nevertheless, apart from insights into the business world, interaction will connect academics to a network outside academia, both of which can be helpful in the case of a start-up. Also, when collaboration with industry has been studied, researchers are regarded as the key actor. Focusing on researchers as the sole actors from university can be questioned. Students can both contribute and gain from interaction in projects with industry during their education (Grimaldi et al., 2011; Eriksson, 1996; Roberts & Eesley, 2009; Wallmark, 1997).

2.4.3. The role of previous entrepreneurs at the entrepreneurial university

The term "entrepreneurial university" stems from Etzkowitz (1983), meaning universities acting entrepreneurially, mainly understood as showing commercial output. Sometimes the term includes new ways of organizing, funding or teaching. But it can also refer to universities' role in fostering entrepreneurial thinking, behaviour and entrepreneurial capital (Audretsch (2014). Schmitz et al. (2017) argue that: -----*the term entrepreneurial university best represents a university that embraces the missions of creating, disseminating and applying knowledge for economic and social development, in addition to pursuing a better sustainability for itself* (p. 385). The latter part (underlined by me) indicates that a university known as entrepreneurial will fulfil the expectations from policy on commercial output and therefore improve its own prestige. However, earlier success stories will not only influence institutional prestige, they will also inspire future actions in the university context (Rasmussen et al., 2006; Sine et al., 2003). Previous success stories will provide the presence of entrepreneurial role models, which positively influence future entrepreneurs (Shane, 2004) and will also enable access to entrepreneurial experience at the university.

This desirable but also debatable transformation from an administrative to an entrepreneurial institution has been examined in previous research. One common conclusion is that each university needs to be understood in the context of its own unique historical development and regional environment. Some characteristics across universities have been identified to explain why some generated more start-ups than others (e.g. Di Gregorio and Shane, 2003; Shane, 2004). Above all, many studies are pointing out the history and past success (e.g. Kenney and Goe, 2004). An existing tradition and past performance of start-ups positively influence future entrepreneurial activity as leading to a change in the university culture (Sine et al., 2003). University culture, with norms and attitudes, develops over time and the present culture is a result of the university's history

(Rothaermel et al., 2007). However, most studies are conducted in an American context and cannot be directly transferred to another country. Etzkowitz et al. (2000) describe American universities becoming entrepreneurial universities, as a market-driven "bottom-up-process", while the later transformation in Europe (with mainly stately owned and regulated universities with a longer history and a culture of more traditional academic values) as a "top-down" development, where commercialization of research has been forced by policy. Philpott, Dooley, O'Reilly & Lupton (2011) suggest that a top-down push can actually reduce entrepreneurial activity, because no one wants to be forced. Putting pressure on academics to increase the universities' entrepreneurial activity is one path, while inspiring potential entrepreneurs is another.

What is notable is that the availability of EE is usually not mentioned in research as a factor influencing entrepreneurial activity at a university. An explanation can be the prevailing focus on researchers as entrepreneurs, for whom EE is not usually available. However, Jacob et al. (2003) do mention students when arguing that the creation of an entrepreneurial university takes several years. Not only because cultural changes are necessary, but also infrastructural ones, including a new support system for fostering entrepreneurship among students and faculty members. Courses in entrepreneurship are part of this process. They assert that two changes in the perception of entrepreneurship have already taken place, the belief that entrepreneurship is a skill that can be taught and secondly from serendipitous and individual to social and organized (Jacob et al., 2003). Other researchers question if it is possible to plan entrepreneurial activity as many universities try to do in their attempts to be regarded as entrepreneurial. When comparing entrepreneurial activity between European universities, Guerrero, Urbano and Fayolle (2016) show that informal factors such as attitudes and role models have a higher influence than formal factors such as support and education.

Lately, EE has been regarded as a necessary and central base in the process to become an entrepreneurial university, for example by Iglesias-Sánchez, Jambrino-Maldonado, Penafiel Velasco & Kokash (2016). The Entrepreneurship 2020 Action Plan (European Commission, 2013) highlight EE as a way to develop an entrepreneurial culture leading to economic development. Iglesias-Sánchez et al. (2016) suggest that a university aiming to become entrepreneurial should concentrate on providing business creation tools not only to students but also to professors, who in turn will positively motivate students to engage in entrepreneurship. Among the studies that have analysed the role of universities in the promotion of entrepreneurship, a critical factor is the attitudes of teachers and students, which are unique to each university (Guerrero & Urbano, 2012). A basic condition for an entrepreneurial university is an integrated entrepreneurial culture, which will inspire potential future entrepreneurs.

Many universities are anxious to be regarded as entrepreneurial and therefore develop an entrepreneurial culture. Changing a culture is a long-time matter that might be easier at young universities than older ones. Young universities are probably more culturally open, flexible and innovative, which makes it easier to establish an entrepreneurial culture than at traditional universities where the preservation and maintenance of existing rigid structures and power relationship rule (Clark, 1998; Volkmann, 2009). In Eriksson's (1996) study of student entrepreneurs, it was argued that the context at the newly established Halmstad University, characterized by dynamic and continuous change, was supportive of student entrepreneurship in contrast to traditional universities where start-ups revolted against existing norms. If interaction with society is regarded as favourable for start-ups (see 2.4.2), young universities involve society more in educational cooperation. In general, employees at young universities had a more positive attitude to cooperation with society than at older universities with established norms and traditions (Wahlbin & Wigren, 2007). Cooperation and interaction between actors from university and society, labelled the third mission, has sometimes been regarded as a qualification for the so-called entrepreneurial university, i.e. showing commercial output. Indisputable interaction is a qualification for entrepreneurs' access to supplementary resources (2.2.3), network (2.2.3) and knowledge spillovers (2.2.4), as well as influencing entrepreneurial capital (2.2.5). One important mission of EE is to foster interaction (2.4) that facilitates start-ups. With this background, I will now put a closer lens on the main key actors in this thesis, students and researchers, and their different conditions as academic entrepreneurs.

2.4.4 Researchers' willingness and skills as academic entrepreneurs

Undoubtedly, the entrepreneur is the main actor in academic entrepreneurship, no matter how context dependent the phenomenon (Guerrero & Urbano, 2014), but the role of the individual and her/his diversity has been neglected in previous research of academic entrepreneurship (Clarysse, Tartari and Salter, 2011; Grimaldi et al., 2011; Lam, 2010; Rothaermel et al., 2007). Research about individuals' willingness and skills for start-up is sparse in academic entrepreneurship. Without doubt, enterprising individuals with entrepreneurial talent, desire and motivation are decisive for entrepreneurship to take place and for opportunities to be exploited. Individual-level attributes such as opportunity recognition capacity (2.2.1) and prior entrepreneurial experience are important for the emergence of start-ups. Clarysse et al. (2011) question why universities use a great deal of resources on support systems, which are of minor importance, but not much effort on to recruit entrepreneurially oriented individuals to an academic career.

When universities are busy responding to new expectations, an individual's motivation to engage in commercial activities must not be forgotten, as it is vital for start-up formation (Ambos, Mäkelä, Birkinshaw & D'Este, 2008). No matter how many businesses opportunities academic research may provide, or the number of massive support systems created, it is first and foremost individual motivation that plays a crucial part. People’s willingness to become entrepreneurs can therefore not be neglected (Locke, 2000). The situation in Sweden with individual researcher’s ownership of research makes commercialization even more dependent on individual desire. Certainly, motivation can be influenced; skills can be learned, but there will always be individual diversity in the decision to exploit entrepreneurial opportunities (Aldrich & Zimmer, 1986; Shane, Locke & Collins, 2003; Shane & Venkataraman, 2000). Klofsten and Jones-Evans (2000) question the academics desire to learn the new competences required to manage a spin-off instead of using their existing skills and experience in the context of existing industry. The reason for researcher’s non-realized commercialization probably includes individual reasons such as the priority they attribute to their research and established career (Braunerhjelm, 2007).

In a study of role identification among researchers involved in commercialization, Jain, George and Maltarich (2009) concluded that it is important for academics to continue to identify themselves first and foremost as academics, even after an entrepreneurial experience. Researchers will normally continue with their research, sometimes having a consultancy arrangement with the commercial company (Wright, Birley & Mosey, 2004). According to Braunerhjelm’s study (2007) of Linköping University in Sweden, a large proportion (68%) of the researchers who had commercialized their research results had done so in corporations where they had no ownership interest. Due to a lack of sufficient knowledge or interest in commercialization, the majority of researchers preferred to let others who possess this competence take care of the commercialization. This would not even be characterized as academic entrepreneurship in the definition of Perkmann and Walsh (2007) requiring owner interest. Researchers’ engagement in university-industry knowledge transfer is found to be far more commonly connected to traditional research values, than to commercialization, which is an indication of researchers´ ‘prime priority to research' (Perkmann et al. 2013). Thus, researchers' willingness to engage in a start-up is questionable.

In other words, expecting researchers to transform into entrepreneurs can be problematic. The predominant focus on researchers as academic entrepreneurs from both policy and in previous research has been questioned in some studies, underlining a loss of alternatives and diversity (e.g Jacobsson et al., 2013; Wennberg et al., 2011). Franklin et al. (2001) suggest a combination of academics and external entrepreneurs as the best approach. External entrepreneurs have a different mind-set with focus on commercializing, compared to academic inventors, who focused on developing technology (Politis, Winborg & Lindholm Dahlstrand, 2012). Wright et al. (2004) question to what extent researchers themselves are equipped to identify market opportunities, while Wennberg et al. (2011) point out the importance of commercial experience in addition to scientific knowledge. Focusing on the commercial customer's need is far from most researchers' mission. Moreover, many researchers are still of the opinion that it is ethnically dubious to make money on publicly funded research, which should be freely accessible to everyone (Krabel & Mueller, 2009). Ambos et al. (2008) express concerns that universities as organizations manage to balance the delicate matter of conflicting demands more effectively than the individuals do.

Hence, researchers have barriers to entrepreneurship, some of which have been identified in a study of various disciplines (Philpott et al., 2011). It was concluded that these barriers comprised: i) a lack of entrepreneurial role models, ii) absence of an entrepreneurial culture and iii) the unavoidable trade-off between academic versus entrepreneurial efforts. However, these barriers can be changed. Incidences of successful commercialization in the environment demonstrate feasibility and provide role models (Bercovitz & Feldman, 2008; Wright et al., 2004), which will inspire others and be of catalytic importance for new start-ups. Most important are the champions (often serial entrepreneurs) who leverage their social capital and serve as a catalyst for building the entrepreneurial ecosystem around the university (Wilson, 2009). The new norms of academic entrepreneurship are therefore highly localized and influenced by pioneering colleagues. Not only are commercial activities by others in physical or professional proximity important, but also engagement from the chair of the department (Bercovitz & Feldman, 2008). Academics remaining at university but also involved part time in a USO are role models, who provide advice to potential new academic entrepreneurs (Nicolaou & Birley, 2003). By maintaining their connection to the university, they will influence future academic entrepreneurship. Likewise, the presence of role models and an entrepreneurial culture will also facilitate students as well as researchers. However, the trade-off between research and business activities is not applicable for students. In the next section, students as academic entrepreneurs will be more closely compared with researchers.

2.4.5 An alternative view on academic entrepreneurs

Empirical studies of academic entrepreneurship, mainly from the U.S., are with a few exceptions conducted on the researcher/inventor as founder. Lately, some interest in post docs, students, alumni and surrogate/external entrepreneurs has also emerged. Their entrepreneurship will differ from the traditional one-sided view of faculty-as-entrepreneur approach with researchers as the primary actor starting ventures to commercialize their own research findings (Duruflé et al., 2018; Hayter et al., 2017). Whether PhD students are categorized as students or researchers varies. PhD students conduct a large part of university research but are also students. As a result of their position as both students and researchers, in some studies of academic entrepreneurship they are included in the faculty (e.g Wahlbin & Wigren, 2007). Courses in commercialization for PhDs are starting to emerge. However, in this thesis PhDs will not be specifically investigated.

The most obvious characteristic difference as regards students compared to researchers is their position, age and educational level. Many crucial resources for a business start-up can be related to these characteristics; researchers generally being advantaged in terms of, for example, work experience, personal financial assets and credibility. Researchers' professional and personal network will probably be superior to students regarding similar resources. But, even if researchers' access to a professional expert network within their research field is an advantage, their access to a business network is not necessarily better than that of students. First, with previous business experience academic entrepreneurs have broader social networks (Mosey and Wright, 2007). Established credibility in a research field and society is not directly correlated with business credibility. However, with age and position there is a likelihood of similar connections, which can be valuable for acquiring credibility. Relationships – new ones or those existing beforehand – are essential for a new venture to enter into markets and acquire the necessary legitimacy to act.

A means for new firms to overcome the liability of newness (2.2.2) and create legitimacy is to use other people's competence and connections to supplement their own limited experience and resources. Students lacking a track record of their own are sometimes able to gain legitimacy through their connections to a university. As many as 85 % of the alumni entrepreneurs reported that their connection to MIT had helped their credibility as new entrepreneurs (Roberts & Eesley, 2009). Local networks and connections in the region around the university can help the new firm to access capital, knowledge and employees and become an advantage when creating credibility. For second-order spin-outs the original parent or incubator organization can play a significant role in linking resources or providing credibility (Leitch & Harrisson, 2005). Students' disadvantages compared to researchers in terms of available resources and credibility will affect their emerging entrepreneurship, but access to useful resources can be provided by linking with and engaging others in the start-up formation. By virtue of their age and position researchers probably have easier access to some of the resources needed for start-up. However, their higher individual credibility can also be a disadvantage when the risk of loss of prestige in the case of failure is taken into account. Even if research on students as entrepreneurs is sparse and has received far less attention than deserved (Grimaldi et al., 2011), some other differences in the conditions for researchers respectively students as founders have been identified in previous research; namely, i) technology height, ii) EE and iii) career change.

Firstly, student spin-offs are likely to be built on less advanced technology than researcher-founded spin-offs (Eriksson, 1996; Pirney et al., 2003, Wallmark, 1997). In other studies, spin-offs started by young academics have shown a high growth rate and innovativeness (e.g. Klofsten & Jones-Evans, 2000). Pirnay et al. (2003) state "*that student spin-offs are usually launched to exploit a business opportunity that is rarely grounded on extensive research activities"* and in sectors with few barriers to entry. There seems, however, to be little empirical proof behind this, as hardly any of the studies referred to involve student spin-offs. It is argued that students are less strongly tied to traditional university activities, such as teaching and research, and for this reason their start-ups include fewer radical changes compared to those of researchers (Pirnay et al., 2003). The barriers to market entry are higher for radical innovations, which need to target completely new and unknown markets from their very inception. Students assumed to have business ideas based on less advanced technology are to a larger extent able to follow the traditional launching path, starting locally and expanding into further markets step by step. For start-ups with more advanced technology, international launching might be needed from the very beginning, which demands much higher entrepreneurial competence. For this reason, the entrepreneurs and their personal networks are even more in focus (Andersson & Wictor, 2003). For Born Globals (International New Ventures) with a global approach from the start, traditional gradual organizational learning and eventual internationalization are not the path.

Secondly, the relatively easy access to EE (see 2.3), which in turn can give access to a competent supporting network, is in favour of students, as compared to researchers. Also, the prevalence of fellow students with EE has proved to be an advantage for students to take start-up action in the context of universities (Bergmann et al., 2016). Entrepreneurship does not occur in isolation, but in a social context, and for researchers it has also proven beneficial to be surrounded by colleagues who possess practical experience of start-ups (Bercovitz & Feldman, 2008; Wennberg et al., 2011). A study among Swedish academics has shown that researchers' attitudes towards commercialization were mostly positive, but that they realized their shortcomings in entrepreneurial competence (Magnusson, McKelvey and Versiglioni, 2008). The researchers' lack of business skills appeared to be a barrier to start-ups. Even if their knowledge within research is high, doing business is a completely new field demanding other perspectives and competence. Despite researchers' closeness to business opportunities from academic research, they might be disadvantaged compared to students trained in opportunity recognition from EE. On one hand, researchers are not trained to be aware of customer needs, but on the other hand, their higher knowledge level can be an advantage in the opportunity discovery phase in terms of their skills to foresee new fields of application.

Thirdly, the stability of life-long university employment has been suggested as a barrier to entrepreneurial ambitions (Chiesa & Picculuga, 2000). If entrepreneurship is about taking risks (Knight, 1921), the risk for researchers leaving an established career path to start a new career that demands quite different competencies, is radical. A start-up is risky, USOs will take several years to develop, which is why individuals' attitude to risk-taking will play an important role. For researchers already in possession of a steady and respected position, the risk and prestige loss in the event of failure is higher than that of a student. In an old study of Chalmers University of Technology, professors were found to be more likely to patent than start spin-off companies. A start-up was regarded as adventurous and chance-taking, thus professors were held back by their safe and prestigious position (Wallmark, 1997). The attitudes towards failure in Sweden differ from those of the U.S., with higher tolerance towards entrepreneurial failure. There, failure can be looked upon as a useful experience for a second attempt and as part of the educational process of becoming an entrepreneur. The U.S. has one of the most entrepreneur-friendly cultures in the world (Volkmann, 2009). Elsewhere the culture is less supportive, which is why fear of failure can be a huge barrier, especially for successful researchers with a safe and prestigious position.

For students, on the contrary, it can be an ideal time in life to test an entrepreneurial career. They have research in proximity as a source for business opportunities and still do not have a fixed career. Entrepreneurship has been linked to a specific mind-set and ability to be flexible, creative and play about with the resources in one's possession (Sarasvathy, 2001). This can favour students yet not formed in a career with established, fixed working methods. Certainly, there are disadvantages as well, for example lack of credibility and life experience related to age, etc. But, for students the opportunity cost is low, an affordable loss (Boh et al., 2016). In the event of failure they at least gain learning opportunities for the future.

2.5 Point of departure for the empirical studies

Some of the presumed differences regarding students respectively researchers as entrepreneurs are compiled in the table below. This outline of the reference frame will help me to proceed to explore students´ special conditions compared to the quite different ones of researchers. However, due to the sparse of previous studies, some of the differences listed in the table are rather tentative and closer to proposals or suggestions, that will be further developed in my sub-studies. My intention is not to empirically test these differences deductively, but to shed more light by exploring student entrepreneurs. My focus is on student entrepreneurs, but due to the fact that earlier studies have mainly focused on researchers when studying academic entrepreneurship, this table can help me to clarify students' special conditions. I will therefore bring these differences indicated by previous studies with me when I approach my empirical studies, but with a critical mind. The understanding from previous research will be a starting point to help me to go continue. The table is structured in accordance with this chapter, where the three research fields constitute the sub-chapters, i.e. i) start-up formation (2.2) ii) entrepreneurship education (2.3) and iii) academic entrepreneurship (2.4).

Table 2:1 Some indications from previous studies that can influence start-ups by students and researchers respectively in the university context. (*Text in italics is not derived from previous studies but rather self-evident)*

2.2	**Start-up formation**	**Students as entrepreneurs**	**Researchers as entrepreneurs**
2.2.1	Business opportunities/ideas (BO)	Indirect access to research conducted in the university context Awareness of BO through EE, possibility to develop idea Less advanced -> easier exploitation? Open for an effectuation mind-set?	Direct access through inventions in own research Usually not trained to look for BO, focus on established career More advanced innovation=>more demanding exploitation Used to a causation mind-set?
2.2.2	Network	Less credibility due to lack of age and position Emerging business network through EE and fellow students? Local learning Close to incubators and ISS Many co-creators?	High position and age favourable for credibility, influential connections, established in society Professional network of colleagues also globally Global knowledge Distant to incubators and ISS Institutional barriers? Close colleagues' start-up experience important
2.2.3	Knowledge spillovers	The missing link=willing entrepreneurs? Cluster close to a university to gain access Absorptive capacity?	The knowledge source= innovators Access to research results Absorptive capacity
2.2.4	Entrepreneurial capital (EC)	Dependent on history, region, social circle, exposure etc. More impressionable to EC =>Willing to take the risk involved in a start-up Commitment among younger individuals (i.e. not giving up) is higher, while competence is lower Exposed to diversity, interacting with heterogeneous individuals Increased by EE, start-up becomes a visible opportunity, provides role-models and experienced entrepreneurs => a catalyst for later start-ups	Dependent on history, region, social circle, exposure etc. Social acceptance for risk-taking in terms of a start-up in their context? Commitment decreases with age, but increased competence in terms of identifying BO and resource allocation Exposed to colleagues within same subject?

2.3	Entrepreneurship education	Students as entrepreneurs	Researchers as entrepreneurs
2.3.1	Outcome from EE	Stimulate intention and propensity for start-up Awareness of BO A long-term effect, repeated start-ups Influences EC for the future	EE usually not available at university for researchers
2.3.2.	Content of EE	Access to a business network of experienced entrepreneurs Alumni as role models Provides a network with supplementary resources Hands-on practice, interaction with the context Stimulates interaction between students and researchers	

2.4	**Academic entrepreneurship**	**Students as entrepreneurs**	**Researchers as entrepreneurs**
2.4.1	Key actors	Usually not considered	Especially researchers within technology Professors´ privilege Commercial use of research in other ways without owner interest Sometimes part time entrepreneurs, devoted to research Ready to take on the long process of exploration and exploitation?
2.4.2	Third mission	Student projects, link to real problems	Balancing the three tasks Mutual learning opportunities for reasons other than start-up
2.4.3	Entrepreneurial university	Pulled by university culture Alumni as role models EE=>entrepreneurial culture EE to professors in order to influence students	Pushed by pressure from formal organization, but is it possible to plan or force? History of past success=>present culture Close colleagues with experience as role models – and support University´s success stories
2.4.4-2.4.5	Willingness and Skills	*Open for a new career* *Flexible mind-set* *Not used to a fixed salary* *Young, little work experience but long career ahead* *Lacking credibility* Low opportunity cost, a learning opportunity Business skills from EE Experience and market-orientation from EE Incremental innovation=> less demanding growth and launch	Barriers such as career change, safe position, fear of loss of prestige Academic mind-set established, lacking market orientation & commercial experience Problematic to balance science with business, research prioritised = fixed identity? Ethical dilemma? Aware of shortcomings in business Age, position, financial assets, work experience-> credibility Radical innovation=> demanding Born global?

The foregoing review and analysis of the literature will constitute the point of departure for the empirical studies included in this doctoral thesis. In previous research, focus has mainly been on a university-level, for example creating support systems to increase commercialization of research or finding characteristics of universities influencing the formation of university spin-offs. A great amount of interesting research and theoretical developments have taken place, but the individual key actors and how they interact in the university context are sparsely discussed. From this standpoint, the present dissertation will enhance the understanding of the formation of student start-ups in the university context. Entrepreneurial actions are ultimately up to individual zeal, which is why human agency cannot be neglected. However, entrepreneurship is also a social act formed in its context by the interaction of different individuals. Ultimately, academic entrepreneurship will therefore rely on the individual's willingness to take on different roles.

Academic knowledge or research can provide new business opportunities, but also actors motivated for entrepreneurship. Students choosing an EE show interest in taking on the entrepreneurial role and are present in the university context. They can therefore serve a function in the process of commercialization of university-based innovations if EE prepares them for start-up formation. EE at universities has attracted research interest and the review and analyses of the literature about EE suggest different teaching methods to encourage entrepreneurship. The long-term outcome of different forms of education and if the education actually influences students' start-up formation is, however, fairly unknown. Based on these arguments a first research question can be posed:

RQ1: How does entrepreneurship education at university facilitate start-up formation among students?

Moreover, the literature identifies a need to reconsider the predominant view on academic entrepreneurship that presumes a direct link to USOs founded by researchers. Irrespective of how important researchers are in the process of commercial use of academic research, most researchers are inexperienced as entrepreneurs and maybe unwilling to change to a completely new and risky career. By also focusing on other actors, the knowledge of the formation of start-ups in the university context will be enhanced. Consequently, there is a need to highlight and acknowledge the key actors and their different roles. In order to better understand the key actors in the university context a second research question is addressed:

RQ2: How and why do key actors in the university context facilitate student start-ups?

3 Methods

In this chapter the methodological choices in the thesis will be discussed and reflected upon. More details are presented in each of the five appended papers (Appendices A-E). First, I will describe and discuss the overall research process, followed by the empirical data collection and the data analysis. The chapter ends with reflections on strengths and weaknesses.

3.1 Overall research process and design

To fulfil the overall research purpose: *To enhance our understanding of student entrepreneurs by exploring how entrepreneurship education and key actors in the university context facilitate the formation of student start-ups,* three different sub-studies were conducted, resulting in five papers (Appendix A-E). This process started with my involvement in a research project about EE at three universities, which eventually resulted in Papers I and II. In the following project, commercialization from a specific research area at Halmstad University was investigated, presented in Paper III. After that, a project exploring commercialization at Chalmers took off, which gave rise to Papers IV and V. Together, these five papers contribute to the purpose of the thesis by answering the two overall research questions. How the five papers contribute is illustrated below. Arrows in bold show the planned research process, where sub-study 1 (resulting in Papers I and II), was intended to answer RQ 1 and sub-studies 2 and 3 (Papers III, IV and V) should answer RQ2. In retrospect, it turned out that important contributions to the two research questions also came from an unexpected direction, which is illustrated with finer arrows. Findings from Papers III and IV also helped to answer RQ1, while findings from Paper I added knowledge about RQ2.

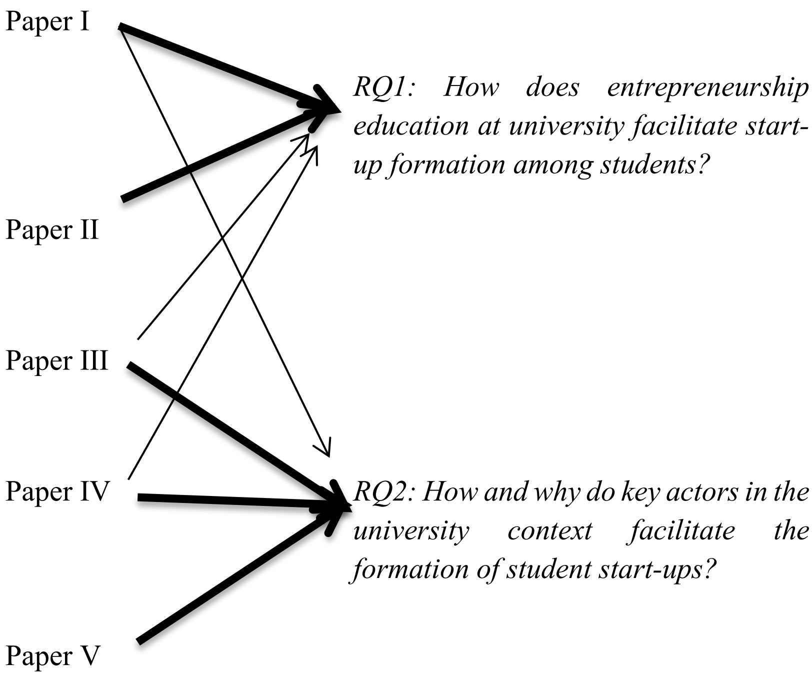

Figure 3:1 How the five included papers contribute to the two research questions.

This thesis is intended to fill the gap in current research about the role of individuals, with focus on student entrepreneurs and their start-up formation in the university context. In order to study how student start-ups are facilitated in the university context, two different points of departure seem appropriate. Firstly, the role of EE at university is a natural starting point when addressing the phenomenon of student entrepreneurs. What kind of education is important and how do different educational designs influence immediate and later start-up? To capture the answer to these kinds of questions, a large group of students was required. A quantitative study was conducted based on previous research about EE. This sub-study indicated a need to go further for deeper information. How had the start-ups been facilitated by academic research? How had researchers contributed to facilitate students' start-ups and spin-offs? The next step was therefore to capture this deeper information by interviewing individuals involved in start-ups connected to a specific research area at Halmstad University. This was facilitated by the small and new university. Aware of the pros and cons in studying one small university, the comparison with a larger one with a different context and interaction became next objective. For this reason, Chalmers was chosen for the third and last sub-study. Entrepreneurship is formed in interaction with others, which is why the organisational context and personal networks are of vital importance for start-up formation (Johannisson, 2000). Consequently, another pattern could be expected here, which would nuance the picture. Approaching student entrepreneurs from these different directions will shed a broader light on the phenomenon in order to enhance our understanding.

Table 3:1 Overview of the five empirical studies

Paper	I	II	III	IV	V
Research purpose	Explore whether and how academic entrepreneurship education influences entrepreneurial behaviour	Explore whether and how academic entrepreneurship education and/or previous start-up experience influences communication skills and handling of liability of newness	Trace and explore the influence of university research and the direct and indirect regional effects created	Capture the parallel development of an entrepreneurial university in relation to how academic research is commercialized	Explore and visualize a broader range of commercial effects generated from academic research.
Research questions	What effect has academic entrepreneurship education on students' view of start-up formation and how do different forms of entrepreneurship training influence the start-up process?	What differences are there in communication skills and the handling of liability of newness between entrepreneurs with an academic entrepreneurship education and/or previous start-up experience?	Has university-based research been commercialized? If so, how and by whom? Which direct and indirect regional effects have this created?	How is the development of an entrepreneurial university contributing to if, how and by whom university-based research is commercialized?	If, how and by whom academic/university-based research can be commercialized outside the university' s formal innovation Support system.
Research design	Quantitative: survey	Quantitative: survey	Qualitative: interviews	Qualitative: interviews	Qualitative: interviews
Study unit	Former academic entrepreneurship students	Student entrepreneurs compared to control group	Start-ups with connection to a certain research area	Key persons involved in ISS at Chalmers	Researchers at two chosen departments and key persons
Sample	294 entrepreneurship students former	183 student entrepreneurs, control group of 209	15 USOs, 3 founded by researcher, 12 SSOs	8 key persons within organizations involved in commercialization at Chalmers	18 researchers, heads of department and key persons involved in commercialization
Data collection	Postal questionnaire (Autumn 2006)	Postal questionnaire (2006)	Semi-structured interviews with founders (Autumn 2007)	Mix of semi- and non-structured interviews (Autumn 2009)	Mix of semi- and non-structured interviews (2009-2010)

Thus, the empirical data are based both on postal questionnaires (Papers I and II) and personal interviews (Papers III, IV and V). In the research field of EE, knowledge has increased during the last few decades (Gabrielsson et al., 2018), which enabled the more deductive approach in the first sub-study. It became possible to formulate theory-derived questions and hypothesis, which facilitated statistical testing. The collected numerical data from the initial surveys provided a general brief picture of the role of EE at university. Figures and frequencies were obtained, e.g. for perceived skills, the extent of student start-ups and the origin of business ideas. However, to answer the more unexplored RQ2 a more inductive approach was necessary. Qualitative studies became a natural next step in order to generate new knowledge about key actors and their roles in the university context. For understanding the connection between the context and the individual a qualitative method is preferable (cf. Miles & Huberman, 1994). Underlying reasons for occurrence and intentions behind the actions, as well as the specific situation in the surrounding context had to be carefully interpreted. With the intention of capturing profound and holistic data, e.g. concerning informal interaction in the context, personal interviews became the choice. When data are collected in close proximity to the natural situation, in the present case at the workplaces of the respondents, some element of observation will also be present that additionally contributes to an understanding of the context. Consequently, the rich explorative knowledge required for understanding the interacting roles (RQ2) of so far unknown patterns is conceivable only in qualitative studies, but nonetheless, challenging to reveal.

The design of this comprehensive thesis, involving different methods such as surveys and interviews, can be referred to as a form of triangulation (Miles & Huberman, 1994; Yin, 1994). The reason for triangulation in this thesis is to let later studies contribute more in-depth and explorative knowledge. My use of multi-methods is to understand issues that emerged during the process (Miles & Huberman, 1994). The later interviews made it possible to obtain a deeper understanding of the formation of student entrepreneurs by identifying the underlying pattern of interaction between key actors.

It was only after the interviews had been analysed and interpreted that a more comprehensive view and contextual understanding of the formation of student start-ups was captured. This substantially richer picture could only be obtained through the combination of methods used. While the opposite order of combining the methods might be more common, i.e. first collecting qualitative new information and then continuing to collect frequencies and figures to make empirical generalization possible, it is difficult to imagine it for the purpose of my thesis. My combination of quantitative and qualitative data collection methods in the different sub-studies has been favourable for the purpose of this thesis. The methodological variety produced a more distinct picture that contributed to an increased understanding of student entrepreneurs. Findings from each sub-study contributed to fulfilling the purpose and answering the two research questions. What is more, is that the whole adds more information than the parts. This might be an example of what Yin (2003) calls a looser form of triangulation, when different sources are analysed separately, but the conclusions are compared. Each of the five papers had a different purpose, research questions, research design, study units and data sources as illustrated above in Table 3:1. When results are compared, a richer overall pattern appears.

3.2 Empirical data collection

Three universities were chosen for the empirical studies, all with well-known EEs, namely Halmstad University, Chalmers University of Technology (in Gothenburg) and Gothenburg University. This choice of universities enabled examples of one new, one technology focused and one more traditional (i.e. older, multi-disciplines) university. All three universities are situated on the west coast of Sweden, but the cities of Halmstad and Gothenburg vary in size and industry structure etc. Access to data from the three chosen universities was simplified by researchers' already established connections and by the proximity of the location. By using previous knowledge of the three universities, education programmes, incubators, spin-offs and regions, the start of the studies became easier as the time required to find basic information was reduced. The three universities formed the base for the three empirical sub-studies, EEs at all three universities were included in sub-studies 1. For sub-study 2 the context of Halmstad University was studied and for sub-study 3, the empirical data were collected at Chalmers.

For ***RQ1*** a sample of sufficient size was needed and also a more structured approach in order to find what is representative of the population. Earlier research on EE enabled the operationalization of variables measuring the benefits of EE for start-up formation. Surveys made it possible to clarify the influence of EE at universities and simultaneously make comparisons between different groups; such as educational programmes or previous start-up experience. By means of postal questionnaires it became empirically possible to address several cohorts of former entrepreneurship students (graduated 1998-2006) at three selected academic EE programmes. With an alternative method, such as interviewing, only a limited number of respondents could have been reached. A postal questionnaire facilitated reaching several cohorts of entrepreneurship students and therefore more general long-term conclusions could be drawn.

By addressing all former students up to nine years after graduation made it possible to study what had occurred in terms of start-ups during this period. Previous empirical studies have been criticized for only showing the effect on students' intentionality and propensity for entrepreneurship, usually evaluated by the students' own self-assessment in connection with their education (Pittaway & Cope, 2007, Wright et al., 2020). Asking about students' intention for the future is a quick method, but it says little about whether their actual behaviour is affected in the future. Another alternative could have been to study the very same students before and after their EE in trying to map the changed entrepreneurial behaviour. This would have reduced the influence of other external factors when time passes after their graduation. However, even during the few years at university external events occur outside the education, which could be the reason for changed behaviour. Consequently, the pure educational effects are difficult to isolate. A control group of statistically chosen entrepreneurs (as in Paper II) is another option for tracing educational effects. A control group of university students without EE could also have been an option for Paper I. Even if this comparison is relevant, finding a suitable control group is delicate. Considering that students choose an education based on an existing predisposition, a comparison after completion can be questioned for revealing already existing imprints instead of educational effects. Students who choose an entrepreneurial education have a pre-existing motivation for entrepreneurship that reveals their future professional intension. The effect of a certain education can therefore be hard to separate from pre-existing differences (cf. Rasmussen & Sörheim, 2006). In sub-study 1, conclusions about the influence of EE were drawn with caution and possible pre-existing differences between the groups was discussed.

To answer ***RQ2*** deeper information was required to understand the meaning academics attached to the course of events during a rather long period. Both Halmstad University and Chalmers University of Technology had a relatively long history of EEs in contrast to Gothenburg University. Therefore, the first two universities were chosen to understand the deeper pattern behind the figures and frequencies over a long period. Both of the two chosen universities have a reputation for well-known prosperous EEs and well-established collaboration with industry. By purposively choosing two universities well-known for successful entrepreneurial activities peculiarities of the context become more evident than in more ordinary settings. To illustrate extreme cases is appropriate in an open-ended exploratory study when looking for typical characteristics of the context (cf. Seawright & Gerring, 2008). The underlying pattern is more likely to be visible and manifested in the use of good examples, i.e. in terms of universities acknowledged for academic entrepreneurship. Nevertheless, the two chosen universities and environments are very different to each other and will therefore also provide variation.

For the first explorative study (sub-study 2) a new and small university was chosen. Without knowing what patterns to expect, tracing commercial use of research was anticipated to be easier in a less complex university context. Halmstad University was chosen as a suitable empirical case for many reasons. One is its limited academic history, which made it possible to follow the development of academic start-ups in the region from the very beginning. Another reason is that Halmstad University has been regarded as a pioneer in Sweden for stimulating students' start-ups with the Innovation Engineering Programme, one of the first of its kind (SOU 1996:89). Many researchers (Galloway & Brown, 2002; Pittaway & Cope, 2007; Rasmussen & Sörheim, 2006; Roberts & Eesley, 2009) agree on the fact that a long time period is necessary in order to see the effects of EE and encourage more studies of alumni. The choice of Halmstad University made it possible to trace and study academic entrepreneurs over the last 25 years. My own pre-existing knowledge of the university's development and of front-line persons also facilitated the study. USOs from one prominent research area (CERES) became the point of departure; a clearer picture of the links and connections was expected when restricted to one research area. A choice of USOs origin from different areas would have made it difficult to find common characteristics. But on the other hand, the decision to study objects with similarities excluded effects connected to differences in other research areas or in other regions. In this sub-study the essential roles of key actors for commercial use of knowledge and research became evident.

A natural next step was therefore to compare the findings from the specific context at Halmstad University with another university. The findings needed to be verified in a different context to strengthen the rigor of the new knowledge of different key actors' involvement. It appeared essential to examine a university with a longer history as a contrast to Halmstad University. Chalmers University of Technology has a long history of distinguished research and could also provide long-term data of academic entrepreneurship. In addition, technological universities are known to be a rich source of business opportunities, and it was already included in previous quantitative studies. Chalmers was consequently chosen to provide variation that could enable confirmation or disconfirmation of the initial findings in order to determine whether important common patterns could be identified, which would increase confidence in the conclusions (cf. Miles & Huberman, 1994). With the intention of increasing the number of new insights, in-depth interviews were also chosen here as the data collection method. As a first step, persons with long experience of commercialization in the specific context of Chalmers were selected. To capture the interplay of actors today, persons involved in the innovation support system more recently were added. This choice of persons instead of entrepreneurs as in sub-study 3, aimed to broaden the perspective. Entrepreneurs only provide information from their own personal unique process, but persons involved in the formal ISS around the university were able to complement the previous sub-studies with more general as well as up to date information.

The findings from Paper IV revealed a planned and structured system for commercialization of research, a standard practice that had developed within the ISS at Chalmers. In order to capture less visible academic entrepreneurship an approach from another direction was required. Maybe there were actors creating start-ups outside the formal ISS? Maybe start-ups from departments not usually scanned when the EE was out hunting for research ideas to commercialize? Therefore, researchers and heads at two departments were selected next. The departments were picked by asking the respondents in Paper IV about which departments were most active in commercializing within the ISS. The two chosen departments were never mentioned by anyone. Turning to these two departments not known for commercial activities was an attempt to capture commercial actions that had taken place behind the formal ISS and therefore appropriate as cases different from the well-known. Selecting departments known for frequent commercialization would probably have supported the already known features instead of developing the understanding. This choice has close similarities to extreme (or deviant or negative) case sampling. On one hand, a university of technology provides homogeneity in contrast to universities with a larger variation among disciplines. On the other hand, the prerequisites are quite different at the 17 departments of Chalmers, not only in the share of research compared to education, but also in how to cooperate with the surrounding society. Some departments can be regarded as more likely to commercialize their research findings than others with a different alignment. Further, it must be added that at the two departments studied, commercialization was commonly regarded as equal to creating USOs within the formal ISS. Hence, many follow-up questions became necessary to explore researchers' roles in alternative commercial use of academic knowledge and research.

For sub-studies 2 and 3 an open approach was required to capture the interacting roles in the university context. The respondents' stories should not be directed by predetermined questions, which is the reason that non-structured and semi-structured interviews open for as much new information as possible were chosen. For example, at Chalmers the interviews often began with the open question; How is research commercialized here? In order to understand connections between individuals in the university context and the events involved as well as to preserve the chronological flow required closeness to the respondents. The possibility to be open for the unknown, unexpected and new is an advantage of a qualitative method. This method enables the researcher to learn more and discover previously unknown links and relationships. Personal interviews make it possible to interpret details and nuances, read body-language, adapt questions and enable a personal connection that makes people open up, even for sensitive questions. Only by profound listening did it become possible to collect the view on key actors and identify roles. Trying to follow the interaction between individuals connected to the university needed cautious handling and an awareness of the interviewer's impact on the output (cp. Kvale, 1997). Both a passive and an active role was demanded, as digging with follow-up questions was also necessary to find underlying causes. It is difficult to imagine an alternative to interviews, as asking busy respondents to write down their stories in detail seems unrealistic and, besides, less information would probably be revealed in writing than orally.

3.3 Data analysis

The data analyses included two levels, within as well as across sub-studies to answer the two research questions that form this compilation thesis. The analysis of each of the five sub-studies is described in the respective paper (appendix A-E). Each paper had its own unit of analysis, as shown below:

Table 3:2 Unit of analysis in each of the five studies

Paper I	Entrepreneurship education programmes
Paper II	Student entrepreneurs + control group
Paper III	USOs from one academic research area
Paper IV	Key actors for commercialization at university
Paper IV	Researchers at two university departments

For the aggregated analysis leading to the overall conclusions in this comprehensive thesis, I regard the unit of analysis as the individuals (=student entrepreneurs) in the university system. In the university system students interact with other key actors (such as researchers and alumni) as well as with the present conditions (EE, business opportunities, etc.) that facilitate start-ups. The outcome, i.e. a start-up, is directly connected to the entrepreneur when defined as a business founder, as I do in this thesis.

The overall purpose of this thesis was thus fulfilled by approaching student entrepreneurs from different angles in each of the five separate papers. Together, the five papers contribute to developing the overall picture of student start-ups in the university context. The aim of the first paper was to compare different forms of EE at university and their influence on the formation of start-ups. In the second paper the effect of academic EE and/or previous start-up experience on the ability to communicate and handle liability of newness is analysed. These two essential skills, which are important for success with the start-up process, are compared among student entrepreneurs to a control group of statistically chosen business founders. Hereby, the influence of academic EE as well as previous experience of a start-up became visible. The third paper focuses on how a certain research area becomes the source of spin-offs in the region around a university. The developed absorptive capacity around the university and the connections between key actors, that influenced the start-up were in focus. In the fourth paper key actors at an entrepreneurial university as well as the developed standard practice for commercializing of research is illustrated. The fifth paper focuses on how researchers contribute to commercial use apart from participating in the founding of USOs themselves. By using different empirical perspectives, the overall findings are verified and explained (Bryman, 2002).

In the two quantitative papers (I and II) statistical tests were conducted. The analytical process becomes more objective in character when using a statistic computer program and interpreting figures instead of words. Even when the data collected are quantifiable and statistically analysed subjective choices are still made, such as what results to present and the interpretation of them. In the three qualitative oriented papers (III, IV and V) the analysis took place over a relatively long period of time, when the collected data were put together and patterns started to slowly develop. The transcripts were read several times as a way to become familiar with the material and as a way to structure and organize the material into themes that were extracted as a result of the iterative analysis process (Miles & Huberman, 1994). For each study the large volume of empirical material was manually reduced and compared with respect to different themes and directions that were identified throughout the process. The material was structured in matrices on huge flipcharts or in sorted heaps of paper slips with quotations from the interviews. Using matrices is one way to systematize statements from interviews (Grönmo, 2006). When the information was put together, patterns slowly developed and conclusions emerged.

The final interacting roles gradually emerged and took form when more data were collected. The studies were conducted in the above order and the unique patterns of each had emerged and were analysed before the next took place. By a combination of inductive and deductive logic more complex relationships could be identified in a stepwise manner, such as the interaction of roles in the university context. This process enabled questions raised in one study to be explored in following studies. Based in the literature and confirmed by the data, student entrepreneurs and the supporting roles of alumni and researchers were identified and confirmed. The literature distinguishes between student and researcher entrepreneurs and the role of alumni as role models is discussed. Similarities and differences could therefore be compared with the theoretical framework and in line with Eisenhardt's (1989) method for building theory from case studies. Similarities and differences in the different settings were compared during this identification process in line with the recommendations of Miles and Huberman (1994). The table below shows how each paper has contributed to defining the three roles of key actors:

Table 3:3 Contribution of each respective paper to the final roles

Paper:	I	II	III	IV	V
Students as entrepreneurs	X	X	X	X	
Alumni as resource-providers and role models			X	X	X
Researchers as enablers	X		X	X	X

The increased value of combining qualitative and quantitative methods became obvious when analysing the combined results. Through analysing the quantitative data, the influence of academic EE on student start-ups was found. But only through the interviews did it become possible to gain a deeper understanding of how key actors and their interacting roles in the university context had facilitated the formation of student start-ups. Results from the two quantitative studies are by nature limited by the existing theoretical knowledge of the phenomenon, but new insights were gained from the in-depth interviews, which explained what had happened. Interaction and connections that were not possible ascertain from a survey were revealed in the later interviews. The experience from the interviews can also be used evaluate the precision in of surveys as additional information pertaining to the set questions in the questionnaires was obtained. After the interviews, the vital importance of the interaction between individuals in the university context became clear. Together, the five papers illuminate the different roles of key actors, but also the developing entrepreneurial capital in the university context and how EE facilitates knowledge spillovers from research.

Without the complementary methods the conclusions would have been less exhaustive. The benefits of different data sources contributed to understanding the importance of combining EE, experienced alumni entrepreneurs and academic knowledge and research in the university context. Yin (2003) calls it a looser form of triangulation when different sources are analysed separately, but the conclusions are compared. In this thesis the findings from each study are used for the overall conclusions. The interest in students as one important actor in academic entrepreneurship was present from the very beginning, but the importance of alumni and researchers emerged inductively later in the process. Accordingly, even if this dissertation answers a call for analyses of academic entrepreneurship on an individual level, the individuals need to be analysed in their system, i.e. in the university context. The importance of the interplay between the key actors and their different roles has emerged gradually during the research process as a joint contribution from the combination of sub-studies.

3.4 Strength and Weaknesses

There are reasons to discuss the trustworthiness of research findings in terms of reliability and validity. Validity is internal (credibility) and external (sometimes referred to as generalizability or transferability). These concepts originate from a quantitative research tradition and when applied to qualitative research methods, a somewhat different interpretation must be made. Reliability usually refers to whether the same result would be derived if the study had been conducted on another occasion or by another researcher, that is, if it is possible to replicate. Hence, reliability can be questioned in a qualitative study, based on personal interviews, as the current situation always influences the result. On another occasion the outcome would vary. Repeating the study with exactly the same result is impossible, as the situation is affected by the temporary mood of both the respondents and the interviewer. When it comes to qualitative studies, reliability is more a question of transparency in terms of the description of the course of action, the situation and process leading to the conclusions.

3.4.1 Reliability

If sub-study 1 were to be repeated in the same population the result would most likely be similar. Accidental individual variations will automatically be compensated for by the number of respondents in a quantitative study. The reliability is higher in a written questionnaire as it is possible to repeat the exact study as well as analyse the raw data in a similar way. The respondents are anonymous in contrast to personal interviews, where the respondent might be eager to give a certain impression. Therefore, the risk of discrepancies between what people say and the actual course of events is higher when personal interviews are conducted. Even if the respondents intend to convey 'the truth', the story will be coloured and interpreted by the individual. The view of their subjective reality and the meaning they attach to events will be expressed. Consequently, the respondents' constructions had to be interpreted in order to understand the underlying causes. Having said this, I regarded the respondents' narratives as plain-spoken and detailed and believe that the main points would have been unchanged had the interviews been repeated within a short period of time.

Hence, trying to understand the more hidden messages is important in a qualitative study (Yin, 1994). A few alumni entrepreneurs in Paper III seemed anxious to emphasize their independence from the university, anxious to point out their own ability and the fact that they managed by themselves now. On closer examination ongoing connections and cooperation with the university emerged. This tendency to exaggerate their own competence and underestimate the influence of others can be connected to the discussion in the literature about entrepreneurs' characteristics in terms of self-efficacy, locus of control or optimistic causal attributions (Landström & Löwegren, 2009). However, this was only perceived a couple of times and most student entrepreneurs seemed, on the contrary, eager to pinpoint the importance of interaction in the university context. Most of the entrepreneurs pointed out their mistakes and ignorance, rarely showing any wish to make a competent impression. Regarding the researcher entrepreneurs, two spontaneously admitted their lack of business competence as a reason to withdraw. The third, by then still active in the recently listed company, appeared anxious not to reveal any sensitive inside information or shortcomings. It is notable that this was a respondent with whom I was previously acquainted on a private level.

Well aware of the risk of being receiving an embellished version of events, I took every opportunity to verify the information provided. Using different empirical perspectives was one way to verify and explain the findings (cf. Bryman, 2002). As I was surrounded by colleagues with good knowledge of present as well as past start-ups around Halmstad University, it became natural to validate the picture that emerged from the interviews with them. In many cases they contributed valuable information, for example of alterations over time and fellowships. When the pattern from the entrepreneurs' unique individual stories had emerged, it was checked with persons involved in research, incubator and start-up activities at the university. The understanding that finally emerged was thus verified by several individuals with different empirical perspectives and the accuracy of the analysis was agreed upon by well-informed sources. This applies to both the context of Halmstad University as well as Chalmers. Moreover, similar results were derived from different respondents, indicating consistency of the phenomenon or in other words a high probability of being reliable.

To prevent my position as a teacher/researcher influencing the situation, I consciously was very careful to assume a low profile, especially at Halmstad University where I am employed. It turned out that by curiously asking a few basic questions the respondents started to tell their stories. This course of action reduced reflexivity, i.e. the respondent answering what the interviewer wants to hear, which is another weakness of interviews (Yin, 1994). When probing questions were needed, I focused on their practical actions and kept away from theoretical concepts that might be unfamiliar to them, as well as related to my status as a faculty member. Influencing the respondent is a weakness of personal interviews, where a personal connection between respondent and interviewer is established. My pre-existing understanding of the context of Halmstad University might to some minor extent have affected the interviews, even though aware of the risk as I was, I tried to keep a neutral position and have an open mind.

There are many benefits but also disadvantages when studying and analysing a familiar university setting. I regard the fact that I, as interviewer, have been employed at Halmstad University since 1989 as mostly positive. It enabled me to gain easy access as well as my ability to understand the respondents' situation due to sharing the same university context. It made the interviews run smoothly, as I was familiar with most of the names mentioned by the respondents, as well as the educational programmes. Furthermore, I was able to follow-up with "inside" questions that made the interviews relaxed and familiar. Reminding them of people and situations a long time ago helped them to recall. Being a representative of their former university with acquaintances in common probably facilitated the respondents' confidence in the interviewer. I therefore consider my role as a teacher as mainly an advantageous in the empirical collection of data resulting in Paper 3. However, despite the many benefits there are also difficulties involved in studying and analysing a familiar university environment. Being part of the studied environment meant that I was already coloured by my own experience of the same setting. Therefore, the discussion with my co-researcher/supervisor who has experience of other university contexts was valuable. A critical distance is important to facilitate a broader and objective perspective on the object of study.

I certainly gained new insights during the process. One example was the combination of closeness and distance to the research object in the interchange between the perspectives of interviewer and critical researcher (Grönmo, 2006). The hermeneutic circle turned into immediate practice during the process of interviewing and an increased understanding of the context was gained with new data (Hallberg, 1999). My preconceptions of the context around Halmstad University, which at the beginning of the research process I thought I was well acquainted with, changed. The uniqueness of Halmstad University gradually appeared to me, partly in the light of the attention attracted from outside. This phenomenon is described by Silverman (2016) as ability to see the exceptional in the usual. Being two researchers in sub-study 2, one with a background and experience from another university, also helped to open my eyes to what was unique in my own familiar environment.

Compared to sub-study 2, interviewing at Chalmers was a quite different experience due to having an outside perspective on this empirical context with an unfamiliar university culture. For example, some terms frequently thrown around there were rather unfamiliar to me, which highlighted the culture difference. On one hand, not being part of the Chalmers culture made me notice occurrences that an 'insider' would probably take for granted. On the other hand, there could have been more under the surface that I failed to capture because of the distance to what was being observed. However, I got a feeling that my curiosity about and ignorance of their culture and system actually triggered their talkativeness during the open-ended interviews. The respondents seemed to appreciate the opportunity to present their opinions in detail to someone who listened intently and was genuinely interested. Obviously, ´utilization´ was a subject in which they were deeply engaged. They appeared eager to pass on their well-thought-out views, usually at great length. According to Yin (1994), listening also includes observing and grasping messages between the lines. Sometimes I sensed an anxiety to only deliver information about world class performance and that more humble start-ups did not count for the respondents, who were products of a culture of elitism. As a result, less successful examples of start-ups may have been left untold or forgotten.

The respondents gave about the same picture of commercializing at Chalmers. They were also noticeably united in the recipe for successful commercialization, which was: Let the researcher stick to the research and allow someone else to commercialize. There can be many explanations for their remarkable unanimity, such as acceptance of and loyalty to the system of which they are a part. One interviewee actually commented with a smile: ‘Since I’m retired, I am free to tell you what I really think!’ Another interpretation of their agreement can be that these questions had been thoroughly discussed on previous occasions and consensus had been reached. A pronounced common opinion that researchers should stick to their research leads to the risk of this becoming a self-fulfilling prophecy that will not inspire researchers’ own start-ups. Surely Chalmers’ strong university culture also plays a part in the apparent prevailing agreement and in the respondents’ obvious interest in the question of utilization and commercialization. Most of those interviewed also had a background as former students at Chalmers and were therefore well socialized into the prevailing culture of utilization.

My participation in events at Chalmers, such as the Chalmers Energy Day, workshops, kick-offs etc., was an opportunity to capture some additional information, but above all a way to verify and confirm my findings. I could put questions to representatives from industry about their collaboration with Chalmers and benefits from Chalmers’ research. They were also asked about the reason for their participation at the present event. Another way to confirm whether the pattern formed from the interviews was representative of the respondents’ departments was by being present at coffee table discussions and informal conversations at the two departments. It was possible to raise the question of commercialization and capture and compare additional people’s views on the phenomenon. Being present in everyday situations at the departments was also a way of understanding the university culture at Chalmers. Secondary information found on the Chalmers homepage also helped to form the final pattern. Consequently, to validate the picture that slowly developed from the interviews, many other individuals were briefly consulted as illustrated above. This information fitted surprisingly well with the data collected through the more formal interviews. Comparing findings from the data collected to other relevant and available information is a way to check external consistency (Grönmo, 2006). In view of how well the different parts of the material together created the overall pattern, despite the fact that they were derived from sub-studies conducted with different methods, unit-of-analysis and in different university contexts also demonstrates that internal consistency is present.

3.4.2 Validity

The concept of validity is applied differently in quantitative and qualitative studies. It usually refers to whether a study measures what it is supposed to measure. Concerning quantitative studies, validity is to a great extent determined by the researcher through the choice of constructs used to match selected measures (cf. Hair et al., 1998). Some of the variables in the quantitative sub-studies are measured by the self-perceived influence of EE. The awareness of what they are expected to have learned during their EE can consequently have affected their answers to some extent. Measuring actual behaviour, such as start-up frequency can also be questioned in relation to the time frame. The studied 1-9 years after the EE are not sufficient to measure the full long-term effect, as new graduates lack the resources, skills and experience necessary for a start-up (cf. Galloway & Brown, 2002). However, a much longer time span was not possible due to the fact that EE is a relatively new phenomenon in Sweden.

In the qualitative sub-studies 2 and 3, factors depending on different conditions in different research areas were reduced by the decision to exclude research areas with other characteristics. By reducing variation, the pattern of student start-ups became clearer. However, individuals are influenced by separate disciplinary norms reflecting divergent opportunities for research commercialization in various fields (cf. Lam, 2010). Variations within universities in perceived support for academic entrepreneurship dependent on the norms and cultures at department level have also been suggested (Bercovitz & Feldman, 2008; Bienkowska et al., 2016). The chosen examples are not intended to be representative of the entire university in which they take place. On the contrary, the choice was motivated by the possibility to distinguish a pattern for the formation of student start-ups. The robustness of the first picture formed in sub-study 2 is exposed to quite different research settings in the follow-up studies at Chalmers (Papers IV and V). Finding the same key actors and similar roles in different contexts enhances internal validity. However, it must be added that both these sub-studies have a base in a technological context and other conditions would probably have resulted in a moderately different pattern, as would the choice of other universities.

Considering external validity, the possibility to generalize varies between qualitative and quantitative studies. In a quantitative study, statistical generalization from a representative sample can be made if significance is found between groups as in Papers I (different EE programmes) and II (experience from EE or previous start-up). This means that the findings from a sample can be transferred to the whole population and research setting (Grönmo, 2006). Nevertheless, caution is required when applying the findings to other populations. Although a relatively large number of entrepreneurship students/student entrepreneurs were studied, they were picked from only three unique universities and three unique educational programmes, all with a high start-up frequency. The results are coloured by the context and cannot be directly generalized to other populations with a different EE design. That different training results in different start-up processes is one of the conclusions in this thesis, which is why other programmes will show other results. However, the chosen entrepreneurship schools represent well-known and successful EE programmes, known to have figured as models for more recently established entrepreneurship programmes, which means that similar findings can be expected elsewhere. The fact that only three EEs were included in the quantitative studies and illustrative examples from only two unique universities in the qualitative studies does not provide a complete picture at by any means. The universities chosen are unique in many respects and not representative of all universities. When it comes to student entrepreneurship, they might even be characterized as good or extreme examples, compared to typical cases, which instead highlight what is average or normal. As unique examples, the chosen universities provide knowledge that enhances our understanding of the formation of student start-ups.

With qualitative methods the possibilities for generalization are more of a conceptual and analytic nature. According to Yin (1994), analytical generalization is possible from case studies, i.e. trying to generalize the results to a broader theory instead of to other cases. Despite the fact that it is not possible to directly transfer the findings to other populations, contexts, situations or circumstances, the typical patterns can be valuable. By explaining what is going on in a few particular research settings, a more detailed picture of the formation of start-ups is obtained. Even if the chosen examples are not representative of all universities, there are implications to be learned. The dimension of typicality serves to understand the nature of the phenomenon, even if the unique only represents itself (Eisenhardt, 1989). The typical features of the interacting roles and emerging entrepreneurial capital identified in this thesis will be useful for understanding the phenomenon of student entrepreneurs and future commercial use of academic knowledge and research.

4 Summary of appended papers

The five appended papers, all of which have been published, will be summarized in this chapter. Each summary will include the purpose and research questions, followed by methods and findings structured in this order. The summary will end with the papers' contribution and connection to the overall purpose and the two research questions of this doctoral thesis. Finally, my contribution to the three co-authored papers will end each summary.

4.1 Paper I – Linking innovation and entrepreneurship in higher education: A study of Swedish schools of entrepreneurship

Authors:
Lindholm Dahlstrand, Å. and Berggren, E.

Presentation status:
Published as: Lindholm Dahlstrand, Å. and Berggren, E. (2010) in R. Oakey, A. Groen, G. Cook and P. van der Sijde (Eds.), *New Technology-Based Firms in the New Millennium, vol VIII,* (35-50), Bingley, UK: Emerald.
Received: ***Outstanding Author Contribution Award by Emerald Literati Network 2011***

Purpose:
The purpose of this paper is to explain how EE at universities influences and contributes to start-up formation. Questions dealt with include; if different forms of entrepreneurship education result in different start-up formation, if the educated entrepreneurs are able to use what they have learned with a view to establishing firms, the frequency of start-up formation among students and the source of their business ideas.

Method:

The paper is based on an empirical sample of almost 300 former entrepreneurship students, who graduated between 1998 and 2006 from three Swedish universities. A postal questionnaire was sent out in the autumn of 2006 and the answers were used to statistically analyse the differences between the entrepreneurs and the education programmes. The study includes a comparison between entrepreneurship students who graduated from formal schools of entrepreneurship and graduates from an innovation engineering programme.

Findings:

The result indicates that an EE influences the entrepreneurial behaviour of students. Students who choose to participate in a formal school of entrepreneurship (Master programme) seem to especially benefit from what they have learnt with a view to exploiting opportunities and creating new firms. The two formal schools of entrepreneurship match early stage ideas from researchers and innovators with their students. Students from the innovation engineering programme, a three-year candidate programme focusing on innovation and product development, are to a higher extent employed by others. From the formal school of entrepreneurship 64 % of the students had start-up experience in contrast to only 13 % from the other group. Students from formal entrepreneurship schools also tend to be habitual entrepreneurs with experience of more than one start-up, with 42 % currently running their own firm compared to 12 % of the innovation engineers. The results show that the group from formal EE seems to be more focused on business opportunities by reflecting on, actively searching for and realizing them. The group of innovation engineers experience more problems concerned with realizing business opportunities, for example finding resources and how to transfer their ideas to others. They also tried to avoid insecure situations to a higher extent.

The innovation engineering programme has a stronger focus on the innovation/exploration phase than on the exploitation of the business idea. Students in the two programmes studied already had an interest in entrepreneurship/innovation shown by their choice of education. Students at a formal school of entrepreneurship stated to a significantly higher degree that their motive for choosing the education was a wish to start their own company. The results indicate, however, that the education itself contributes more to start-up frequency than this existing motivation. The study shows that students trained at a formal school of entrepreneurship are able to use what they have learnt with a view to establishing new firms. Consequently, the education affects actual entrepreneurial behaviour.

Contribution to the overall research questions:
This study contributes to the overall RQ1 by showing that EE at university will influence students' awareness of business opportunities and foster start-up formation. Various types of education will contribute differently to students' changed entrepreneurial behaviour. It also demonstrates a habitual start-up frequency among one of the two groups of entrepreneurship students. The study indicates that ideas stemming from academic knowledge, technology or research results can be commercialized by student entrepreneurs and thereby also contributes to answering RQ2 in finding students as a key actor using academic research as a source for start-ups. Consequently, students are found to be valuable actors for the commercialization of academic knowledge, technology or research results.

My contribution to this co-authored paper:
At the time I became involved in the project the study was already broadly planned, but I had the possibility to influence some parts of the design and to express my opinions on the questionnaire. I was responsible for the administration of the postal questionnaire, sent it out, coded the answers, transcribed it into SPSS and ran all the statistical analyses. As this was at the very beginning of my doctoral process, the interaction with my co-author and supervisor Lindholm Dahlstrand was close and most of my actions and the findings were discussed with her. She had the main responsibility for which results

to finally present and she also organized the content of the paper in a logical manner. I wrote the beginning of the paper, i.e. introduction, method and description of the schools and afterwards she improved the coherence and structure. She wrote the last part of the paper but considered my opinions on how best to present the findings and conclusions.

4.2 Paper II – The role of entrepreneurship education and previous start-up experience for handling communication and liability of newness

Authors: Ulvenblad, P., Berggren, E. and Winborg, J.

Presentation status:
Published as Ulvenblad, P., Berggren, E. and Winborg, J. (2013). *International Journal of Entrepreneurial Behaviour and Research. 19*(2), 187-209.

Purpose:
This study compares whether there are differences between entrepreneurs with or without an EE at universities as well as with or without earlier start-up experience in the way they communicate and perceive liabilities of newness. More specifically, the impact of experience on handling communication and liabilities of newness was compared between founders with EE and/or earlier start-up experience. Learning to communicate with potential stakeholders in order to acquire the resources necessary when starting a new venture can be of special importance for young entrepreneurs lacking a track record. This study compared whether the entrepreneurs' communication skills and perceived problems with liabilities of newness are affected by EE at universities and/or previous start-up experience.

Method:

The empirical data are based on two groups. One group consists of entrepreneurs learning entrepreneurship at a university, i.e. former entrepreneurship students with start-up experience including students placed in a university incubator. The other group is a control group of entrepreneurs statistically chosen without EE from a university. The final sample consists of 392 entrepreneurs, of whom 183 are university-educated entrepreneurs and 209 non-university-educated entrepreneurs. 45 % in the first group had experience of more than one start-up, compared to 54 % in the control group. The answers to the questionnaire were statistically tested against the hypothesis developed.

Findings:

The results indicate that the three operationalized dimensions of communication, i.e. openness, adaptation and other-orientation, were learned differently. The result shows a relation between EE and a higher degree of adaptation. Openness in communication was affected by both EE and previous start-up experience. To communicate with the other party's interest in mind, other-orientation, on the other hand, was shown to be related to previous start-up experience. Regarding liability of newness, entrepreneurs with EE reported minor problems in handling laws, regulations and the lack of informal structures but experienced greater problems with marketing and influencing customers. Estimating the market potential and handling roles and functions appeared to be an experience gained from earlier start-ups. Entrepreneurs with both an EE and previous start-up experience show the greatest overall skills and are consequently best prepared to handle communication and liability of newness.

Contribution to the overall research questions:

This study contributes to answering RQ1, how EE facilitates start-up formation. Some essential start-up skills are learned in EE, while other skills are learned in previous start-ups. Consequently, EE facilitates start-up formation among students by providing some of the essential communication skills and how to handle the liability of newness. However, entrepreneurs with EE in addition to previous start-up experience are best prepared for start-up, i.e. alumni entrepreneurs. This finding relates to RQ2 by indicating alumni as possible key actors in the university context. Their possession of additional skills achieved through previous start-up experience can potentially be useful for the formation of new student start-ups.

My contribution to this co-authored paper:
All three authors took active part in planning the design of the study as well as in the development of the paper. In several meetings we jointly influenced the process. The writing of the theoretical framework was divided; Winborg was responsible for the liability of newness, Ulvenblad for communication, while EE became my part. The merging of two existing data bases was conducted by Ulvenblad and I. I ran and wrote the descriptive data, while Ulvenblad ran the analysis. All three authors were involved in the discussion of the findings, after which I wrote the first draft, with later improvements by Winborg. All three of us responded to the comments from the reviewers.

4.3 Paper III – Creating an entrepreneurial region: Two waves of academic spin-offs from Halmstad University

Authors:
Berggren, E. and Lindholm Dahlstrand, Å.

Presentation status:
Published as Berggren E. & Lindholm Dahlstrand, Å. (2009) *European Planning Studies,* 17(8)1171-1189. Also, in Johannisson, B. and Lindholm Dahlstrand, Å. (2012) (Eds), Enacting *Regional Dynamics and Entrepreneurship: Bridging the territorial and functional rationales,* London and New York: Routledge, pp. 66-84.

Purpose:
The purpose of this study is to analyse if, how and by whom university-based research has been commercialized as well as to trace direct and indirect regional effects of university research.

Method:
The empirical data were collected from the region around Halmstad University and are based on interviews with founders of 15 academic spin-off companies, all with connection to the research conducted at CERES, Centre for Research on Embedded Systems at the School of Information Science, Computer and Electrical Engineering (IDE) at Halmstad University. The academic spin-offs around Halmstad University are characterized by the large number started by students. Out of the fifteen spin-offs in the study only three were started by researchers. The case study of the Halmstad region has specific characteristics and is an example of how academic knowledge, technology or research results can be spread and commercialized. The choice of the relatively newly established Halmstad University made it possible to trace and follow how one research area had given birth to the emergence of university spin-offs in the region.

Findings:
The result shows the importance of the spirit of the new organisation and some front-line persons involved 25 years ago, when Halmstad University was established. The early students at the Innovation Engineering programme created a 'first wave' of spin-offs around the university. This EE combined broad general engineering knowledge with business thinking. Of the studied spin-offs established between 1988 and 2004, 9 out of 12 had students from this programme directly involved in the start-up, despite the fact that the programme was *not* linked to the research area that formed the starting point of the study. In many cases these students started together with students from the School of Information Science, Computer and Electrical Engineering (IDE) or at least used the competence provided by CERES. The innovative capacity is thereby linked to entrepreneurial capacity. The pace of new established student start-ups slowed down for a period,

but a ‘second wave’ emerged after 2000. In mapping the effects, it appeared that this second generation is strikingly inspired and reinforced by the first wave or generation of student entrepreneurs. The findings show how the university contributes both directly and indirectly to regional development by the creation of university spin-offs and by the strengthening of the absorptive capacity in the region. Collective learning based on social interaction and networking has triggered continued regional renewal.

Contribution to the overall research questions:

This study contributes to the identification of key actors in the university context that influence the commercialization of academic knowledge, technology or research results as well as the roles these actors play in the process (i.e. RQ2). In this study, students’ start-ups are more frequent and persistent than the those founded by researchers. Student entrepreneurs are supported by alumni entrepreneurs and researchers. Indirect and accelerating effects at a far later stage are shown to stem from a pioneering entrepreneurship/innovation education. Therefore, this paper also contributes to answering RQ1 in showing indirect and long-term effects from EE at university.

My contribution to this co-authored paper:

I collected all the empirical data by conducting the face-to-face interviews. After several attempts to analyse and make sense of the large amount of data myself, Lindholm Dahlstrand stepped in and together we structured the findings. I was responsible for writing the empirical results, with support and critical input from Lindholm Dahlstrand. The writing of the reference frame and conclusions was mostly the work of Lindholm Dahlstrand.

4.4 Paper IV – The entrepreneurial university's influence on commercialization of academic research – the illustrative case of Chalmers University of Technology

Author:
Berggren, E.

Presentation status:
Published as Berggren, E. (2011) *International Journal of Entrepreneurship and Small Business, 12*(4), 429-444.

Purpose:
The purpose of this study is to explore and analyse how the development of an entrepreneurial university contributes to if, how and by whom university-based research is commercialized within a university's formal innovation support system.

Method:
This is illustrated by the case of Chalmers University of Technology in Sweden, known for its successful entrepreneurial activities as well as its distinguished technological research. Leading persons in organizations involved in the present Innovation Support System (ISS), but also individuals involved in earlier organizational structures or functions for commercialization were chosen for eight deep face-to-face interviews. Each respondent suggested other appropriate respondents. The respondents were given the opportunity to freely describe their understanding of actors and actions in the present innovation support system, as well as influential actors and actions in the past.

Findings:
The findings show the strong impact of early pioneers who from the very beginning of the university's existence (founded 1829) created a favourable culture for cooperation and utilization. That research should lead to practical use still imbues Chalmers. The fact that it is a private university has created more action space, compared to

traditional public-owned universities in Sweden. The findings also show the influence of a few front-line individuals for the development of best practice in the innovation support system of today, which can be characterized by the visible support for university spin-offs with high growth potential. Standard practice is to build teams and match-make researchers to complementing competences such as entrepreneurship students as well as using alumni as potential resources. The respondents were unanimous in their view that research should be utilized, but not by trying to transform experienced researchers into entrepreneurs. The front-line individuals within the ISS also function as gatekeepers and have a strong impact on which ideas gain access to the massive support provided. In the same way as a few early pioneers strongly influenced the development of the Entrepreneurial University of today, a few front-line individuals have a strong impact on if, how and by whom research is commercialized today.

Contribution to the overall research questions:
This study is in line with RQ2, in terms of understanding how and why key actors in the university context facilitate the formation of student start-ups. At Chalmers researchers are matched to entrepreneurship students in a master programme, consequently this paper also contributes to answering RQ1. More than one actor is often required for the formation of USOs, where the roles of entrepreneurs and innovators need to be matched. Later in the commercialization process, alumni with business experience are commonly added to the USO as complementary resources. Accordingly, similar key actors and roles reappear in this study (as in Paper 3) but in another and different university context with a more formalized commercialization process. The standard practice in the present innovation support system has developed and is influenced by previous and present actors, resulting in students´ role as entrepreneurs.

My contribution in this paper:
I conducted all the work but received advice from my supervisor Lindholm Dahlstrand on research design and presentation. In this single-authored paper I had sole responsibility for data collection, analysis and writing.

4.5 Paper V – Researchers as enablers of commercialization at an entrepreneurial university

Author: Berggren, E.

Presentation status:
Published as Berggren, E. (2017) *Journal of Management Development,* 36 (2), 217-232.

Purpose: The purpose of this study is to explore alternative ways – how and by whom – that academic research can enter into commercial use. The purpose is to visualize a broader range of commercial effects generated from university-based research than the usual focus on USOs connected to the university's formal innovation support system.

Method:
Chalmers University of Technology was chosen as a case for this study. With prominent and voluminous research within technology the university provides good opportunities for commercialization. A long history of close cooperation with industry and society contributed to the choice of Chalmers. Two departments; Energy and Environment respectively Civil Environmental Engineering were chosen for further examination. None of them are known within the university's formal innovation support system for being active within commercialization or giving birth to USOs. The choice was motivated by trying to find other ways of commercialization than the

standard practice at Chalmers of matching researchers to entrepreneurship students. In order to go beyond this obvious path, heads of departments as well as researchers were interviewed about their views on commercialization and on how research had entered into commercial use at their department. In total, 18 interviews were conducted.

Findings:

The findings show an overall view that research should be utilized in society and that it was mutually beneficial to cooperate with industry and society. Through knowledge interchange the academics gained input into their research and in return they diffused knowledge to industry and other organizations in society. The predominant view on commercialization was that it was desirable as one way to utilize research findings. Lacking interest in personal commercial activities (except for some consultancy), the researchers in this study fulfilled 'their need for utilization' by enabling others to make commercial use of their research. Researchers generously shared their advice and research findings primarily to alumni. Alumni were present in the university network and common cooperation partners. Five propositions were advocated in this paper related to researchers' role as enablers of others' commercialization. The concept of "need for utilization" was introduced as the critical explanation for researchers' readiness and individual motivation to transfer knowledge to established companies. Given what was found in the study research is spun out from university to a much larger extent and diversity than to researchers' USOs, which are usually in the limelight as the essential output from entrepreneurial universities. This prevailing focus on countable USOs for fulfilling 'the third mission' in research as well as from policymakers and universities, maintains the belief in an academic paradox and reduces the real variety of other options, which are more difficult to measure.

Contribution to the overall research questions:
This study contributes by identifying why researchers facilitate the formation of student start-ups (RQ2). In particular, the role of researchers as enablers, supporting and facilitating others' commercial use of academic research is explored. The role of alumni and how they linger in the university context also becomes evident. In keeping the ties to their university, they are an essential link in knowledge transfer between research and industry. This beneficial link is most likely applicable for alumni entrepreneurs as well, despite the fact that only one obvious case could be demonstrated at the two departments studied.

My contribution in this paper:
I conducted all the work but received advice from my supervisor Lindholm Dahlstrand on the research design. In this single-authored paper, I had sole responsibility for the data collection, analysis and writing.

5 Contributions, conclusions and implications

In this chapter there will be a discussion about the combined contributions from the sub-studies that answer the two overall research questions. It will begin with a short summary of the main contributions and conclusions (5.1). Then a more detailed discussion will follow about the different roles in interaction taken on by key actors facilitated by entrepreneurship education (5.2). Section 5.3 outlines implications for policy, universities and entrepreneurship education, followed by limitations and suggestions for further research.

5.1 Summary of main contributions

This thesis contributes to theory by enhancing knowledge about student entrepreneurs in the academic entrepreneurship field. Firstly, it brings insights from EE that identify long-term effects as well as the outcome of different behaviour related to the design of the EE programme. Secondly, this thesis identifies roles of interconnecting key actors in the university context that facilitate students' start-ups. The role of alumni as an important key actor for student start-ups became obvious. Overall, EE was found to facilitate knowledge spillovers from research, which is deliberately designed in the programme at one university or more a case of serendipity at another. This thesis also contributes to theory by showing how EE develops the entrepreneurial capital in the university context over time, e.g. by providing role models and access to over time developed business experience. Accordingly, the main theoretical contribution of this thesis is to the areas of entrepreneurship education, entrepreneurial capital and knowledge spillover theory for entrepreneurship.

Thus, EE facilitates student start-ups not only directly by providing useful skills and awareness of business opportunities on a long-term basis, but also by improving the entrepreneurial capital when alumni linger in the university context, providing role models and complementary resources, not least in terms of business experience. Consequently, EE link students to other key actors with experience and knowledge. In addition to alumni, EE also links researchers with student entrepreneurs, thereby facilitating knowledge spillovers useful for start-ups. These conclusions are illustrated in figure 5:1 below.

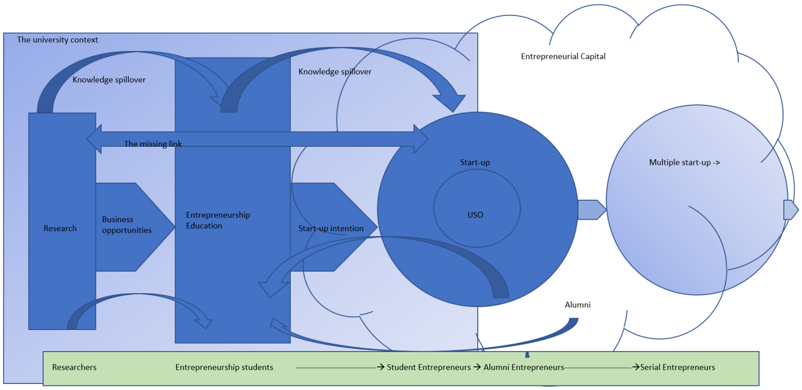

Figure 5:1 Entrepreneurship education and key actors facilitating start-ups in the university context

In summary, the combined conclusions from the five empirical papers in this thesis show that:

-EE facilitates start-ups by enabling knowledge spillovers from research to willing entrepreneurs – the missing link.

-EE contributes to development of the long–term entrepreneurial capital, which facilitates future start-ups.

-EE facilitates student start-ups by connecting key actors with different roles:

Students as present, prepared and persistent entrepreneurs

Alumni as resource-providers and role models

Researchers as enablers with a need for utilization

-The reasons the key actors take on the above roles are, in short:

> Students looking for a career gain start-ups skill in EE and in the university context they have access to role-models, business opportunities and fruitful interaction.
>
> Alumni are keen to pass on their business experience and anxious to maintain the mutually beneficial ties to the university.
>
> Researchers are reluctant to change their established career but have a need for their research to become useful in society. Sharing knowledge with students is a familiar role for them.

5.2 Entrepreneurship education as the missing link

This thesis enhances our understanding of student entrepreneurs by exploring how entrepreneurship education and key actors in the university context facilitate the formation of student start-ups. Previous research has regarded the entrepreneur as the conduit for transferring knowledge into commercialization (e.g. Audretsch, 2009; Audretch & Keilbach, 2008). Consequently, if individuals prepared to take on the entrepreneurial role are lacking, business opportunities stemming from academic knowledge and research will remain uncommercialized. Identifying latent opportunities does not seem to be the problem in Sweden but perceiving the skills and ability necessary to realise them in a start-up (Braunerheim et al., 2019). Findings in this thesis show that EE provides entrepreneurs with willingness and skills that deserve to be acknowledged, as opposed to the previous scanty consideration of students as potential entrepreneurs (Hayter et al., 2017; Klofsten & Jones-Evans, 2000; Pirnay, Surlemont & Nlemvo, 2003; Åstebro et al., 2012). The step from intended to realized action or from latent to emergent entrepreneurship (Caiazza et al., 2020) is therefore facilitated by EE. As shown in this thesis, students are one way to reduce the shortage of entrepreneurs in the university context, the missing link

(Braunerhjelm et al., 2010). The findings in this thesis also show the importance of EE in facilitating knowledge spillovers as well as improving the entrepreneurial capital in the context. Consequently, it contributes with contextual and long-term outcomes from EE previously called for (e.g. Nabi et al., 2017).

Besides students as possible entrepreneurs, this thesis points to other key actors such as alumni and researchers for facilitating student start-ups. In the context of universities, proximity between actors in repeated interaction creates mutual trust and a shared identity that promotes the use of knowledge spillovers (cf. Audretsch and Feldman, 1996; Saxenian, 1994). Therefore, the findings of this thesis contribute to understanding of the importance of close interaction for commercial use of academic knowledge and research, facilitated by EE. The interacting roles that facilitate student start-up will now be further discussed.

5.2.1 Students as present, prepared and persistent entrepreneurs

By their choice of education, entrepreneurship students have already shown an interest that they are **prepared** to become entrepreneurs. The findings confirm that to a large extent their intention becomes a reality; entrepreneurship students have a high start-up frequency. This actual outcome of EE has been questioned in previous research (e.g Pittaway and Cope, 2007), as due to the lack of empirical long-term studies of actual behaviour only increased intentionality and propensity have proven. The results from three Swedish EEs (Paper I) show a high start-up frequency and also **persistence** in continuing as entrepreneurs years later, which are consistent with two large American studies of alumni from MIT and Babson College respectively (Lange et al., 2011; Roberts & Easley, 2009).

Despite students' disadvantages concerning youth and inexperience, many are already **prepared** to start a new venture in connection with their graduation. It could be argued that students' situation can be an advantage for taking on a risky project. Still without an established career, they can allow themselves to experiment with potential business ideas. Not being accustomed to a fixed salary can be an advantage that actually increases the necessary endurance for the long phase before receiving revenues. Another argument to take into consideration is that the pressure of loss of prestige in the event of failure is lower than for researchers with an already established career and professional prestige. Age and position constitute some barriers, which make a career change less likely. In interviews at Chalmers (Paper IV), the view was expressed that the border line for changing to an entrepreneurial career was the doctoral degree. The reason for this statement was that after the dissertation the student' mind-set had changed to that of a researcher, lacking the endurance, flexibility and ability to make decisions without well-grounded arguments. Consequently, in terms of the conditions for entrepreneurship, adaptable students facing their future career choice can be more suitable than actors already established in working life.

In addition to **prepared**, understood as willingness to take on the entrepreneurial role, the word can also be understood as the entrepreneurial skills acquired in EE at university. The included sub-studies add to our understanding that skills are achieved, but also connected to a network with complementary skills. Best **prepared** in terms of communication skills and how to handle the liability of newness are students with EE in combination with previous start-up experience (Paper II). Many entrepreneurship students have a tendency to become habitual entrepreneurs only a few years after their education (Paper I), which indicates magnified further start-ups over a lifetime. Despite contradictory results in research when it comes to the advantage of previous start-up experience for performance (Rotefoss and Kolvereid, 2005; Westhead et al., 2005), it can be argued that with additional practical experience a higher outcome can be expected. In particular, skills concerning market communication seem to be achieved through practical experience (Paper II).

An additional perspective on students as **prepared** to take on the entrepreneurial role can be added. One important empirical finding (Paper I) is that after EE students claim to be more aware of business opportunities. To find (or create) a business opportunity is an early prerequisite for a new start-up, even if awareness is far from actually acting upon the opportunity. If the recognition of business ideas is related to prior knowledge (Shane, 2000; Sarasvathy, 2001) students are disadvantaged due to their limited life/business and/or industry experience. Two ways to overcome this disadvantage have been observed in connection with the studied EEs. At Chalmers, more experienced actors provide entrepreneurship students with research ideas evaluated as having commercial potential. This way shows a clear intent to commercialize university research (Rasmussen and Sörheim, 2006) using students as entrepreneurs. This approach with the starting point in research is differs from the prevalent approach at Halmstad University. Here, the source of business ideas is often initiated from industry, making students turn to research to solve the existing problem. The approach at CSE will guarantee a high technological excellence, while the Halmstad approach favours market demand. Some scholars (e.g. Eriksson, 1996; Pirney et al., 2003; Wallmark, 1997) have acknowledged students' start-ups as being built on less advanced technology than those of researchers. Although comparing the level of innovation has not been in focus in this thesis, it can be noted that among the studied USOs around Halmstad University (Paper III) student start-ups appear to originate from a relatively clear customer demand, as in contrast to the few started by researchers in the same study. The researchers' business ideas were more tentative, yet possible to adapt in different applications and markets, all of which demanded an international launch from inception. Adapting new techniques to an existing customer need, instead of trying to find application areas for new research results, will have quite different paths to success and barriers to entry.

The empirical findings presented in this thesis show that different entrepreneurship programmes shape different entrepreneurial behaviour, e.g. in terms of **persistence**. Students from CSE are trained to fill a function in a team for a while, resulting in so called professional entrepreneurs, who are habitually establishing new firms and experimenting with start-up activities (Paper I). Many of them have already been involved in several start-ups within a few years of graduation. ‘The innovator entrepreneurs’ from the Innovator Engineering Programme at Halmstad University are to a larger extent developing start-ups based on an idea claimed to be their ‘own’. They show a tendency to remain with the start-up they founded when it develops and grows. Both educations foster **persistence** as entrepreneurs, but CSE fosters students to fill one function in the entrepreneurial process for a while and then enter the next venture, while the student entrepreneurs around Halmstad University seem to develop more of a life-time commitment to their first start-up. One explanation for this tendency towards a longer engagement can be a stronger personal identification with the start-up founded, as it was initiated more independently. Different alignments of EE consequently influence the outcome, shown here as fostering a tendency of hopping from one start-up to the next, or staying with the first. These different patterns are likely to linger in the university context for years to come due to different available role models (see alumni 5.2.2).

The heterogeneity of USOs demand different approaches (Siegel et al., 2007) but different approaches of EE also foster different kinds of start-up and alignment of entrepreneurs. Chalmers offers an exclusive EE and back-up for relatively few selected students, which are provided with potentially high-growth research ideas. The support and involvement of the university is massive during the development of the new USO, with equity stakes taken and a final exit planned. Whether a high degree of university involvement contra independence is beneficial for the performance of newly created USOs has been debated before (e.g. Di Gregorio & Shane, 2003;

Johansson et al., 2005; Leitch & Harrison, 2005). Halmstad University has a broader approach to student entrepreneurship, with courses in entrepreneurship included in many programmes or given as eligible classes and a system that also supports less advanced student start-ups, such as consultancy and within the service sector. With EE accessible to a broad mass of students there is diversity among the new start-ups. The standard procedure at Chalmers follow Nicolaou and Birley's (2003) categorization of a hybrid spin-out, while at Halmstad University research spills over to student start-ups, often without any formal involvement of the researcher. At CSE the researcher is always involved in the professional board appointed for the new USO. Here entrepreneurship students fill a function in the early phases, but usually other actors who are more experienced in business are added and/or take over in the systemized process, deliberately created to commercialize research results. In other words, Chalmers follow the traditional `first wave` in academic entrepreneurship (Duruflé et al., 2018), with start-ups emerging from research but with entrepreneurship students involved. Halmstad University, with start-ups mainly driven by students, can be argued to have adopted `the second wave` from the very beginning.

5.2.2 Alumni as resource-providers and role models for student entrepreneurs

The findings in this thesis show how ongoing cooperation in spatial proximity between alumni and the university are beneficial, not least for novice student entrepreneurs. Alumni entrepreneurs have not only cleared the way in serving as close role models demonstrating entrepreneurship as a feasible career for present students, but they also constitute an essential part of the important learning network that facilitates start-up (cf. Johannisson 2000; Witt, 2004). Consequently, the power of student entrepreneurs pays off on a long-term basis, generating decisive effects on successive generations of student entrepreneurs. One of the main findings from the empirical sub-studies of this thesis is the contagious effect of alumni entrepreneurs on new batches of entrepreneurship students and student entrepreneurs. The role of alumni as important resource-providers with business experience crucial for new student start-ups has not received much attention in research so far. Involving alumni as a resource for EE has, however, been acknowledged before (e.g. Klofsten, 2000) and so has their catalytic importance as role models (e.g. Volkmann, 2009) providing success-stories (Nicolaou & Birley, 2003; Wright et al., 2004; Shane, 2004).

The findings of this thesis indicate that various types of entrepreneurs are shaped by different EEs, which will constitute the available resource base of alumni entrepreneurs. Consequently, different role models and resource-providers will be available in different university contexts. At Chalmers, for example, students' alignments are to a larger extent formed for a more temporary engagement, compared to the more permanent one around Halmstad University. Not only will different kinds of start-up be developed but different role models and resource-providers will be provided to future generations of students (Guerrero et al., 2016). Earlier success-stories that are circulating in the context set examples for the future and continue to inspire, form and foster later student start-ups. Taken together, the choice of EE alignment at university appears to have a long-term impact on how start-ups are created. As the results demonstrate, different EEs contribute differently to the entrepreneurial capital, which provides various conditions for entrepreneurship (cp. Saxenian,1994).

One main finding in this thesis is the long-lasting effect from EE due to earlier student entrepreneurs' influence on later student entrepreneurship. Once start-ups have started to emerge around a university, experienced entrepreneurs will soon be present to stimulate and improve future academic entrepreneurship. Growing entrepreneurial experience in the network around the university will accelerate over time. This is consistent supported by research pointing out the importance of history for creating new USOs (cf. Guerrero et al., 2014; O'Shea et al., 2005, Shane, 2004), but shows that it applies to students as well as faculty members as founders. The results of this thesis also reveal the long-lasting indirect effect of EE by providing a resource bank of dedicated alumni acting as a source of guidance and support to the next generation of student entrepreneurs. The alumni entrepreneurs (Paper III) were very anxious to transfer their own hard-earned lessons to novice student entrepreneurs, e.g. in communicating the offer from the perspective of customers' needs. Taken together, investment in EEs at universities pay-off a long time into the future and the sooner started, the sooner accumulated experience will influence future conditions for start-up (cf. O'Shea et al., 2005, Lange et al., 2011). In all five included papers, the future multiplicative and long-term effect is evident. In agreement with O'Shea et al. (2005), who stated that each university has different available resource stocks depending on its history and past success, the observed start-ups in this thesis are clearly influenced by the past.

There appear to be several reasons for the engagement of alumni as resource-providers. Using their experience to support the next generations of student entrepreneurs might be fulfilling in itself, but it also appears to be a way to repay the university for the support they once obtained themselves. Certainly, alumni entrepreneurs' contribution is not solely one-sided, but rather mutually beneficial. By their lingering and participation in the university context knowledge spillovers can be absorbed, which are useful in their own firms (cf. Audretsch & Feldman, 2004). Furthermore, alumni will be updated about new start-ups and potential future business partners. New student entrepreneurs extend their own business network and can provide an inflow of new ideas and questions. Through cultivating university connections alumni entrepreneurs will also receive priority with regard to recent graduates when recruiting potential candidates for new positions in their company. The access to educated new staff has been found to be an important factor in the decision to locate close to the university, especially for knowledge intensive firms. Thus, alumni entrepreneurs' own network will benefit from keeping in touch with the university and the next generations of students. The included sub-studies show the importance of access to a mutually rewarding network in the university context.

5.2.3 Researchers' need for utilization facilitates student start-ups

While alumni mainly provide resources originating from their business experience, researchers contribute resources in terms of new technology and front-edge research. The involvement of researchers is therefore vital if university-based innovations should enter into commercial use. The findings of this thesis show researchers spinning-out new knowledge for commercial use of others. For researchers lacking a personal passion for entrepreneurship, this is one way to see a concrete result of their scientific efforts in society. A strong need for utilization in addition to reluctance to make a career change (Klofsten & Jones-Evans, 2000) motivates researchers to enable others to use their scientific efforts commercially. Diffusing knowledge is a role familiar to a researcher, in contrast to engaging in business. Previous research has described scientists as keen on preserving their academic role identity (Jain et al., 2009) motivated by developing science and driven by values such as prestige and established position (Perkman et al., 2013). It has also been suggested that commercialization is still not quite accepted in academia as a researcher's mission and that the academic role is in conflict with the entrepreneurial one (Lockett & Wright, 2005), which opens up an entrance for commercialization of academic research by students (or alumni).

It is worth considering that researchers cooperate with industry first and foremost to advance their research (cf. D'Este & Perkmann, 2011; Lam, 2010) not primarily as a way to bring their research into practice. This is not a one-sided beneficial arrangement but a two-way knowledge flow of mutual advantage (Balconi & Laboranti, 2006), as industry gains access to academic research that is possible to use commercially. The dialogue with society outside the university was very important for the researchers studied at Chalmers, not surprisingly as utilizing and serving industry and society is part of the university culture (Paper IV). Researchers making use of research through their existing consultancy firms were rather invisible at Chalmers (Paper V). Different explanations for the lack of attention can exist. One can be that serving industry is part of the culture and the line is blurred when it comes to what falls beyond a department's normal service of providing free advice or direct guidance. As the consultancy firms might therefore compete with researchers' ordinary employment they are run in silence. Another explanation might be that the firms are rather modest and therefore regarded as employees' 'private businesses', not useful as success-stories to put in the limelight for the university. Nevertheless, they were an example of the impact of pioneering colleagues as well as how the close local environment inspires (cf. Bercovitz & Feldman, 2008).

Some findings concerning researchers' willingness and skills to become entrepreneurs are also worth considering. The studied researchers in this thesis clearly expressed the priority of their research and established career, but also concerns regarding their competence within business. Researchers' lack of business skills as well as lack of time has been brought forward as an explanation for a low frequency of USO-companies (cf. Ambos et al., 2008; Braunerhjelm, 2007; Magnusson, McKelvey & Versiglioni, 2008). With a long demanding commercialization process that requires experience and resources far from their own, but with a strong need for utilization means that they are open to other solutions. One is to let their research enter into use in existing firms, whether in cooperative projects with industry or through consultancy. Another option is to engage in a start-up based on their research, but let students take on the entrepreneurial role, which is standard procedure at CSE. Another possibility fulfilling researchers' need for utilization is to assist students in their projects, which can enter into commercial use. Enabling others to take commercial advantage of their research will acknowledge their 'need for utilizing', while at the same time allowing them to retain their position in academia.

5.3 Implications for policy, university and entrepreneurship education

5.3.1 Implications for policy

Important implications for policy makers concern the need to broaden the view of academic entrepreneurs from the prevailing limited focus on turning researchers into entrepreneurs to acknowledging entrepreneurship students as present, prepared and persistent entrepreneurs in the university context. EEs deserve attention when aiming to enhance utilization of research. This thesis proposes increased attention to students as entrepreneurs and highlights the importance of EE in fostering USOs. Having educated and available entrepreneurs in the university context enables knowledge spillovers as well as enhancing the entrepreneurial capital for the future. Students' tendency to linger in the university context constitutes catalytic role models and resource-providers for later generations. Alumni entrepreneurs visualize the long-term return on investments in EEs. Once EEs are started, multiplicative and long-lasting effects can be expected. With continual new batches of entrepreneurship students an accelerating effect is achieved. In Sweden, the long-term effects have just started to become evident and the full effect will need more time to develop. The large group of students possesses a huge creative capital possible to harness for commercializing research. As an input to both theory and practice, EE at university can be used to link otherwise un-commercialized opportunities from research to student entrepreneurs for further development.

Many researchers have no interest in changing career, but have a strong ‘need for utilizing’, which is why they open up opportunities for others to make use of their research. One option is through student entrepreneurs present in the university context. The researcher’s individual attitude towards start-up formation is rarely discussed, despite the fact that individual motivation is vital for commercial outcome (cf. Ambos, Mäkelä, Birkinshaw & D’Este, 2008; Locke, 2000). Research findings have even suggested that forcing researchers to engage in commercialization by means of policy can actually reduce entrepreneurial activity (Etzkowitz et al., 2000; Philpott et al., 2011). It is therefore worth considering that many researchers want to continue to contribute within research, instead of becoming entrepreneurs. My findings suggest that students willing to take on the entrepreneurial role deserve more attention as actors for commercializing academic knowledge and research.

5.3.2 Implications for universities and entrepreneurship education

When building organizations and structures to meet new demands for commercialization, universities should not underestimate the role of individuals and their interactions as suggested in this thesis. The role of alumni as experienced resource-providers for start-ups in the university context is an important finding of this thesis. One implication for universities is therefore the importance of maintaining the ties to alumni for mutually beneficial interchange. Alumni willing to remain in the university context are an essential asset for a university’s future commercial output. Speaking the same language due to having been socialized into the same university culture is important for knowledge-transfer, which is why alumni are especially suitable as resource-providers for later student entrepreneurs. The universities’ resource-bank of experienced alumni entrepreneurs will continuously expand and a virtuous circle can be created with accelerating effects in years to come.

Hence, the findings suggest that EEs are not only of importance to prepare individuals for an entrepreneurial career, but also useful for a university in fulfilling the mission of commercialization. To allow student entrepreneurs to exploit business opportunities stemming from research is an alternative to placing all expectations and efforts on trying to transform researchers into entrepreneurs. Linking research to potential student entrepreneurs can be a possible way to increase commercialization of academic research results at universities. In the pedagogical discussion of *about, in and for* entrepreneurship, a suggestion is to add the dimension of *to*. EE can be used to link motivated and willing entrepreneurship students to otherwise unexploited research and therefore at students' disposal in the very same university context. However, a fruitful outcome also presupposes the involvement of other actors with more experience.

Furthermore, the long-term effects depending on the design of EE are of critical concern for universities and have important implications. Not only will different kinds of entrepreneurs be formed, but also a different resource bank of alumni and role models shaped for the future. The choice of which role models to highlight is a delicate matter, which requires awareness. Will the most successful inspire to high achievements or the more modest demonstrate a surmountable path? Placing only excellent success-stories in the limelight might alienate and hamper. Universities focusing on one successful approach can reduce the variation of opportunities. The power of penetration of 'best practice' leads to replication. When only part of the options is visualized as possibilities, the full range of universities' contribution to commercialization falls erroneously short of expectations and may reinforce the view that investments in academic research does not pay off in society.

A more specific implication for EE is to improve students' communication skills, enabling them to keep in mind the other's perspective. The ability to understand the other's point of view and present an offer with the customer's need in focus is a problem for novice student entrepreneurs shown in this thesis. How to achieve an increased understanding of the mutual outcome from a business deal is therefore an issue that needs to be considered in EEs. Student entrepreneurs with previous start-up experience perceived minor problems with market communication. The aspect of other-orientation thus evolves with experience, but could certainly be improved in EE.

5. 4 Limitations and suggestions for future research

Further research is needed in several directions and numerous issues related to the formation of student entrepreneurs and commercial use of academic research still remain to be examined. Firstly, the findings of this thesis are mainly based on a few unique universities and will require testing in the contexts of other universities, both nationally and internationally. There are reasons to believe that the establishments of Chalmers as well as that of Halmstad University were unique examples in offering space for action compared to many other universities in Sweden. New empirical contexts might bring introduce somewhat new characteristics for the different roles identified and will allow the possibility for comparisons. Some differences emerged at the studied universities in how the identified roles function as well as how they interact. Therefore, the findings require testing at other universities to shed more light on the different characteristics of the key actors and their interaction. Researchers have received much attention in previous research, but mainly as potential entrepreneurs not as enablers of others' commercialization, a role which has cbecome visible with this thesis and deserves further research. In particular, the crucial role of alumni merits to be verified and refined in other empirical settings. The intrinsic power of alumni for academic entrepreneurship is therefore one suggestion for future research.

Secondly, this thesis raises questions about two other roles that can be of importance for start-ups in the university context, namely those of pioneers and boundary-spanners. Pioneering individuals involved at the very start of the university appear important for setting the standard of an entrepreneurial culture that promotes individuals' initiative and sets the scene for enterprising activities for a long time ahead. One remaining question is therefore whether the culture-creating role of pioneers can be found at other universities and be analysed in relation to the universities' entrepreneurial output. In more traditional academic cultures other norms prevail, thus clarity about how to transform an existing culture to become entrepreneurial remains for future studies. This thesis has also pointed out the crucial role of boundary-spanners, linking research that is possible to commercialize to willing entrepreneurs. They also connect student entrepreneurs to a corresponding and constantly growing network of alumni. It has previously been suggested (Tushman & Scanlan, 1981) that a formal status in the organization is required for this task, but according to my findings this linking role seems to rely to a large extent on individual initiative, which is why acknowledgment is required.

Finally, the first EEs introduced in Sweden have just started to show their long-term effects and more follow-up studies are needed in order to prove further indirect and multiplicative effects in a longer perspective. The studied student entrepreneurs started in direct connection to their education, but many first gain experience and a business network through employment before start-up. After graduation many students disappear from the university context and how they use academic knowledge and research in their employment or in eventual start-ups is still largely unknown. More longitudinal studies are consequently required to prove the full effect of EE, also large-scale studies that enable empirical generalizations. Regarding EE as a channel for commercializing academic research, i.e. using student entrepreneurs as the missing link, more research is required concerning outcome and performance, but also in how research is linked to student entrepreneurs. Examples of a structured process based on research findings, but also a more serendipity governed one have been observed. Whether formalization of the process hampers the variety and/or creativity is also a question for future studies to clarify.

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