GOTHENBURG STUDIES IN INNOVATION AND ENTREPRENEURSHIP 5

COMMERCIALIZATION DONE DIFFERENTLY:

How Swedish university incubators facilitate the formation of knowledge-intensive entrepreneurial firms

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To raise a PhD it takes a village – or is it the other way round? Either way, I would like to thank all of my present and former colleagues at the Unit (formerly Institue) for Innovation and Entrepreneurship (IE) for their support and comments throughout the PhD process. I would also like to thank the IE guest professors: Rögnvaldur Seamundsson, Guido Buenstorf, Astrid Heidemann Lassen, and Jun Jin. For the support, discussions, and friendship of former and present PhD students at our Unit, I would like to thank Ethan Gifford, Snöfrid Börjesson Herou, Erik Gustafsson, Karin Berg, Daniel Hemberg, Tanja Stefanía Runarsdottír, Viktor Ström, and Hani Elzoumor. I would also like to thank Professor Charlie Karlsson for taking an interest in my study and providing me with valuable comments. Moreover, thanks are due to Professor Håkan Ylinenpää for a good discussion on university knowledge transfer. For the discussions at my planning and midway seminars, I would also like to thank the attendees and my discussant professor Jun Jin and junior discussant Swati Ravi for the planning seminar, and the discussant Johan Brink and junior discussant Hanne Peters at my midway seminar. They have influenced my thinking and have been important for, not least, the methodological direction of this PhD thesis. I would also like to thank Professor Magnus Klofsten, who acted as my opponent at the final seminar for his valuable input and vast knowledge of university commercialization in Sweden. The importance of seminars and workshops that have been hosted by IE cannot be underestimated. Here I would like to thank the scholars and guest PhD students who attended for their valuable input on my research: Bart van Looy, Marcus Holgersson, Magnus Holmén, Anders Broström, Hanne Peters, Johannes König, Solmaz Sajadirad, and many more.

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Moreover, the study of competing projects discussed in Chapter 6 has been further developed together with Guido Buenstorf and Maureen McKelvey. It was developed into a conference paper (accepted to the AOM Annual Meeting 2020 as "best paper" and published in an abridged format in their proceedings (Brunnström et al., 2020). Our aim is to further develop and publish it as a full-format paper in a suitable peer-reviewed journal in the near future. This work has been done in parallel to my own and has greatly helped and improved my research process and influenced my way of tackling research.

In the end, curiosity for the world we live in is either acquired by childhood interactions or by genetics. Whatever the case, I would like to thank my parents, Lisa and Lasse Brunnström, both engaged scholars within their respective fields, architectural history and design history, for their support. Building on family ties, I would also like to acknowledge the patience of my wife, Jennifer, and our two children, August and Arvid, both of whom were born during the PhD process. Without them, and their support, this PhD thesis would not have been possible.

Some people have been mentioned, but there are many, too many to mention them all. So, from the bottom of my heart,

thank you all!

Abstract

This PhD thesis investigates how university incubators impact the formation of knowledge-intensive entrepreneurial (KIE) firms in Sweden, which is interesting due to its unusual institutional regime for commercializing research results. "Commercialization done differently" refers to university incubators in the context of the institutional regime of Sweden, which differs in that individual researchers own their own commercial research results and have complete agency over what to do with them instead of the university owning them. Under this institutional regime, previous research has suggested that university incubators may favor the creation of KIE firms, and I set out to find out how they do so. A mixed-methods approach is used, utilizing explorative case study, survival analysis, and OLS regression. The study thus triangulates and uses qualitative interviews, policy documents, and secondary data sources as well as a large longitudinal national database provided by the Swedish Innovation Agency (VINNOVA). My research leads to three findings of relevance for understanding how universities interact with society. The first finding relates to how interviewed incubator managers view researchers. Although researchers are perceived as being slow, less eager to start a business, and stuck on technical improvements, their ideas are also viewed as high-impact and as the most important ones. To deal with researchers as founders, incubator managers have developed a number of options, which all aim at either starting a firm anyway or at selling the idea. My quantitative findings substantiate the above mentioned managers' view of researchers as founders but further indicate that having more researchers facilitates a speedier and more successful process for other project founders. By differentiating by ownership of university incubators, I examine performance. University-owned incubators seem to have higher costs per supported firm, in part because they have more founders that are researchers. However, if the incubator is municipality-owned, having more researchers instead seems to reduce costs. Thus, even though university-owned incubators help facilitate the formation of KIE firms at a higher cost, a likely interpretation is that the potential in the type of firm they help create is greater. I synthesize my findings and conceptualization by also proposing a process model of how university incubators facilitate the formation of KIE firms under the institutional regime for commercializing research in Sweden.

Key Words: Commercialization, University Incubator, Knowledge-Intensive Entrepreneurial Firms, Incubator Performance, Inventor Ownership, Mixed Methods, Competing Risks

Sammanfattning på svenska

Den här avhandlingen, i monografiformat, undersöker universitetsinkubatorernas roll i skapandet av kunskapsintensiva (KIE) företag i Sverige. Det ovanliga institutionella regelverk för hur man kommersialiserar forskningsresultat i Sverige gör ämnet intressant. ”Commercialization done differently” syftar till hur universitetsinkubatorer agerar i den svenska institutionella kontexten. Den skiljer sig från andra institutionella kontexter genom att den enskilde forskaren äger det egna forskningsresultatet och har därför kontroll över vad som sker med det. Detta skiljer sig från vad som är vanligt i andra länder där istället universitetet står som ägare. Universitetsinkubatorer kan premiera utvecklingen av KIE-företag i denna institutionella kontext.

I min forskning använder jag mig av en “mixed-methods approach”, bestående av både en explorativ fallstudie, överlevnadsanalys och linjära regressioner. På så sätt triangulerar jag mina forskningsresultat och använder mig av kvalitativa intervjuer, policydokument och liknande dokumentation såväl som en stor nationell databas från den svenska innovationsmyndigheten VINNOVA, som innehåller 3400 projekt och 37 inkubatorer.

Min forskning leder fram till tre huvudsakliga resultat som är relevanta för att förstå hur universitet interagerar med samhället. Det första forskningsresultatet relaterar till hur chefer och mellanchefer på universitetsinkubatorer tolkar forskares roll som företagsgrundare. För även om cheferna anser att forskare är långsamma och inte så intresserade av att själva starta företag eller ofta är fast i sina tekniska lösningar så ser de också forskarnas idéer som viktiga och de med störst marknadspotential. Universitetsinkubatorerna har utvecklat ett antal sätt för att kunna möta de utmaningar forskare som företagsgrundare innebär. Alla dessa sätt syftar till att antingen starta ett företag ändå eller att sälja idén vidare.

Mina kvantitativa forskningsresultat stödjer chefernas syn på forskare som långsamma och mindre framgångsrika grundare. Dock indikerar mina resultat också att om inkubatorn har fler projekt med forskare som grundare så ökar det chanserna och hastigheten i inkubationsprocessen för andra typer av grundare att nå fram till ett färdigt KIE företag. Jag undersöker hur inkubatorerna presterar genom att särskilja universitetsinkubatorer utifrån dess ägarsammansättning. Om de är ägda av universiteten genom dess holdingbolag förefaller de ha högre kostnader per startat

KIE företag. Delvis beror detta på att de har fler projekt med forskare som grundare. Om inkubatorerna däremot drivs i kommunal regi blir kostnaderna per KIE företag lägre om de hjälper fler forskarföretag att starta. Även om universitetsägda inkubatorer tenderar att ha högre kostnader per KIE företag tyder mina kvalitativa forskningsresultat på att forskaridéer betraktas som de med högst ekonomisk potential. Avslutningsvis sammanställer jag mina resultat och slutsatser genom att föreslå en processmodell för hur universitetsinkubatorer kan skapa förutsättningar för nya KIE företag i den svenska institutionella kontexten.

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1. Introduction

Universities develop and diffuse new knowledge in society and are widely recognized to impact the knowledge society and knowledge economy (Etzkowitz et al., 2000; Broström, Buenstorf & McKelvey, 2020). While universities have traditionally been seen as having two missions, of research and education, in recent decades, the third mission of impacting society is now more widely recognized as a legitimate goal for universities. One formulation of this third mission, which I follow, is rather broad, and that is that universities should contribute to economic growth and social development explicitly (Smith, 2007). This broad conceptualization of the third mission must be turned into activities that the university does, and researchers have conceptualized this in many ways, such as entrepreneurial universities (Etzkowitz & Leydesdorff, 2000; Etzkowitz, 2004), entrepreneurial ecosystems (Stam, 2015), and technology transfer (Lee, 1996). Universities are also identified as key organizations within the sectoral, regional, and national systems of innovation (Lundvall, 1992; Cooke, 2002; Malerba, 2002). One influential stream in recent literature identifies the various activities that academics at universities do that can impact society, including research, education, commercialization and academic engagement. Academic engagement is examined more at the level of the individual academic and defined as academics' knowledge-based interactions with external organizations. In contrast, commercialization at universities usually involves individual academics but also organizational aspects such as technology transfer offices, and it includes processes related to starting up firms as well as patenting and licensing (Perkmann et al., 2013; Perkmann et al., 2021). In this PhD thesis, I examine commercialization processes related to universities, specifically related to university incubators. The purpose of this dissertation is to investigate how university incubators impact the formation of knowledge-intensive entrepreneurial (KIE) firms in Sweden.

Hence, in a broader sense, I have chosen to study university incubators because they are specifically designed to help commercialize knowledge available in the universities. As will be argued in later chapters, I conceptualize the process of incubation – as organized within university incubators – as one means to fulfill this third mission by turning scientific knowledge into new knowledge-intensive entrepreneurial firms. Entrepreneurial firms of this specific type are interesting to study because they are one way to provide society with scientific knowledge, and by that I mean that advanced knowledge and related products and applications are packaged in firms of this type. Moreover, entrepreneurial firms supported by university incubators are also argued to be more generally important than other types of firms, in that they add substantial value to the economy (O'Shea et al., 2005; Barbero et al., 2012).

Sweden provides an interesting empirical context due to the institutional regime of ownership of scientific knowledge. What makes this interesting is that, in this context, it is the researchers who have full ownership of commercial outcomes of their own research instead of the university or the state. One reason why it is particularly interesting to study university incubators in Sweden is that they help many different types of founders to create new KIE firms. Thus, university incubators are one way universities try to impact society, and they do so by supporting founders that create these firms, which are sometimes based on research conducted at the university. The institutional context in Sweden is also relevant for understanding commercialization done differently. The notion of a "third mission" for universities was incorporated into law already in 1977.[1] Moreover, according to Swedish law and the institutional regime, the first and second missions of universities remain to do research and educate students respectively.

I contribute to the literature about the role of universities in society by adding to literature specifically about academic commercialization, university incubators, and knowledge-intensive entrepreneurship. My contributions are within the following three topics:

(1) By providing insights into how researchers are seen, helped, and coached by university incubators within the institutional regime of inventor ownership and reflecting upon the roles and outcomes of university incubators more generally, I add to the literature on academic entrepreneurship.

(2) By analyzing how five types of knowledge-intensive entrepreneurial founders with diverse backgrounds may impact project development, set during an early phase characterized by accessing resources and knowledge in the protective environment of a university incubator, I add to the incubator literature by exploring multiple founder types within the same type of incubator.

[1] The 1977 law, however, had a slightly different definition of what the third mission would entail, focusing on a "bildung" perspective, where the public would get access to university knowledge, and less on other types of interaction with society, for example, academic engagement and activities such as industry collaboration (Kasperowski & Bragesjo 2011). Kasperowski and Bragesjö (2011) add that collaboration with industry had been part of what universities did historically before the law and therefore this law diverged from this tradition. However, Swedish universities already had mature institutions for knowledge transfer, and the law changed (in 1997) to encompass a wider variety of activities.

(3) By connecting the goal of incubation with the cost that is associated with incubators supporting the development of projects into knowledge-intensive entrepreneurial firms and how the ownership model of the incubator affects this, I add to the literature about knowledge-intensive entrepreneurship and incubator performance.

1.1 Purpose, setting, and key definitions

The purpose of my PhD thesis is to investigate how university incubators impact the formation of knowledge-intensive entrepreneurial (KIE) firms in Sweden. Such KIE firms are defined in Malerba and McKelvey's (2020:6) research as: "new learning organizations that use and transform existing knowledge and generate new knowledge in order to innovate within innovation systems."

As a starting point I use McKelvey and Lassen's (2013) definition of university incubators, which they define as university owned and operated incubators that allow projects to have access to university resources and infrastructure. Incubators as such are related to the early stages of firm formation and startup activity and can therefore conceptually be separated from science and technology parks, which deal with more mature firms (Bergek & Norrman, 2008). Starting from the definition above, I will further conceptualize and empirically investigate university incubators in later chapters. Note that science and technology parks will not be addressed in this PhD thesis.

In studying university incubators, I am interested in the processes leading to KIE firms. Therefore, I define an incubation process as a process initiated by a selection procedure within the incubator, and with the aim of supporting founders with selected projects into becoming KIE firms. I am also interested in evaluating outputs, and therefore start from Bergek and Norrman's (2008) definition of incubator performance as "…the extent to which incubator outcomes correspond to incubator goals." Hence, I consider the creation of knowledge-intensive entrepreneurial firms as one means of commercializing research results, and in that sense, of reaching the incubator goals. This type of firm is of particular interest as it would be more likely to introduce innovations, and thus to contribute to the ongoing evolutionary process of societal change, than other types of firms (Malerba & McKelvey, 2018; 2019).

My study is limited to Sweden, which maintains a national institutional regime known as inventor ownership for researchers/teachers. This institutional regime has also been referred to as teachers' exception, teachers' exemption, or professors' privilege in previous literature. Inventor ownership means that research outcomes belong to the researchers themselves. That Sweden has retained this right for its researchers is quite unique in the Western world (Wennberg, Wiklund & Wright, 2011). Most previous research on university commercialization is based on studies conducted in countries with institutional regimes that instead allot ownership of research results to the university.

Within all that has been outlined above, I am interested in university incubators and KIE firms. I investigate how university incubators impact the formation of knowledge-intensive entrepreneurial firms in Sweden, which has an institutional regime where university employees own their intellectual property rights (Swedish Law, LOU 1 § 2 paragraph 1949:345). This regime is called inventor ownership. Most previous research addresses a different empirical context, where the countries have an institutional regime in which the university owns the intellectual property rights. That regime is called university ownership. In the inventor ownership context, what matters is what the individual researcher-teacher, rather than the university, does in relation to commercialization of their research results. Thus in relation to contribution 1, I explore the dynamics of having researchers commercializing their own ideas from the point of view of incubator managers.

Research conducted in countries with university ownership has to a large extent investigated the effects of the Bayh-Dole Act of 1980 in the United States. This Act shifted ownership control from the government to the universities themselves. Mowery et al. (2001) and Mowery (2001) argue that the positive effects that have historically been associated with the reform might have been due to other factors, such as a new focus on the biomedical area, and that US universities had a pre-existing tradition of patenting. Since the US reform was implemented, many European countries later reformed their institutional regimes into university ownership. The effects of these changes in Europe regarding ownership control have been analyzed as well. Indeed, ample research found that the changes have had small to negative effects on academic patenting and entrepreneurial activity (Mowery & Sampat 2004; Baldini, Grimaldi & Sobrero, 2006; Kenney & Patton 2011; Von Proff, Buenstorf & Hummel, 2012; Czarnitzki et al. 2016; Hvide & Jones, 2018). For example, Hvide and Jones (2018), looking into the effects of a change in institutional regime in Norway, analyzed how a change from inventor ownership to university ownership had affected patenting and starting new companies. Their analysis suggested a 50% decline in patenting and entrepreneurship activity at Norwegian universities since the implementation of university ownership. Further, they assessed that the quality of patents and new firms declined as well.

From this point onwards, in order to be consistent, I will only use the term “inventor ownership” when referring to the institutional regime of Sweden. I consider the creation of KIE firms as one form of commercializing research results. In studying university incubators, I investigate not only university researchers but also other types of firm founders.

1.2 Positioning this PhD thesis relative to gaps in the literature

Research into incubators has tended to compare and contrast an aggregated category of university incubators. It has done so by identifying the type of firm by the type of incubator. In so doing previous research has analyzed incubator firms and projects in the following ways:

1) Research has compared incubator firms in one type of incubator with incubator firms from another type, assuming incubator firms to be more or less homogeneous inside the same type of incubator. The results have shown that firms supported by university incubators tend to be slower than their peers to complete incubation (Rosenwein, 2000; Grimaldi & Grandi, 2005; Ratinho, Harms & Groen, 2010; Barbero et al., 2012). Rosenwein's (2000) research, for example, suggests a doubling of the time needed to complete incubation processes in public incubators (such as university incubators) as compared to private ones.

2) Research has also compared incubator firms to matched non-incubated firms. Incubator firms incubated in university incubators were found to have superior performance during as well as after incubation, using growth metrics such as turnover and number of employees (Lasrado et al., 2016). However, an earlier study by Schwartz (2013) was unable to find evidence supporting differences in survival between university-incubated firms and matched non-university-incubated firms. The former indicates that being incubated in a university incubator has positive effects on the firm's growth as compared to non-incubated firms but does little to explain differences between incubator types. The latter research suggests that being incubated in a university incubator does not provide protection against firm failure and bankruptcy.

3) Research has investigated university connection, defined as how strong a connection the project has to the university, where the researchers as founders would have the strongest connection to the university. This connection has then been analyzed in terms of how it affects firm growth and survival. Rothaermel and Thursby (2005) used this approach to analyze the intra-incubator effects of university connection for the founders. University connection was found to be important to firm growth, both during the incubation process and after the firm had completed incubation and left the incubator (Lasrado et al., 2016; Rothaermel & Thursby, 2005). However, Rothaermel and Thursby (2005) also found that a stronger connection led to the projects staying longer in the incubator.

4) From the perspective of what incubators offer to incubator projects, research has investigated what the founders of incubator firms and projects deem to be important to their success. The (external) network of incubators

> was identified as important by firm founders for their firms' growth and survival (McAdam & Marlow, 2008; Scillitoe & Chakrabarti, 2010). However, other research suggests a mismatch between what the incubator managers think is important and what their project founders consider important to their own success (Van Weele, Rijnsoever & Nauta 2017). Here, incubator management highlights business knowledge, coaching, and networks internal to the incubator as important, while founders judge tangible assets such as funding as more important.

The definition of a university incubator in much of the previous literature has been specifically linked to commercialization of research by university researchers (Barbero et al., 2012; Lasrado et al., 2016) and more recently extended to students. Students were found both to bring their own ideas to university incubators and also to be involved in incubation projects based on researcher intellectual property (IP) (Culkin, 2013). The same study called for policy action in the UK for additional support for students exploring their ideas within university incubators, and crucially, within the incubator's business network.

Previous research, done in other contexts, suggests that when researchers are firm founders, relative to other founders, they are slower on average and that only the outliers succeed (Jensen & Thursby, 2001; Rothaermel & Thursby, 2005). Little research within KIE exists on how university incubators work with different types of founders, and in ways that impact the formation of KIE firms. In my empirical context of Sweden, university incubators receive a mix of funding from universities, municipalities, regions, and governmental agencies. These diverse sources of funding result in diverse types of projects being admitted into the incubators. Given the specifics of the institutional regime and available database, a unique Swedish Innovation Agency (VINNOVA) database that covers most of the Swedish university incubators and their projects enables me to address a gap in the research on founder types within the same type of incubator. Therefore, it is possible to do a more fine-grained analysis of not only researchers and students but also other types of founders active in university incubators. These other founder types are non-researcher university employees, independent inventors, and corporate spin-offs. Although the former founder type would have ties to the university, the latter ones do not have any previous ties to the university.

Thus in relation to contribution 2, the national incubator database also enables me to study how this diversity of founder types and (in relation to contribution 3) incubator characteristics can affect firm formation. The database I use originates from the national incubator program (established in 2005), currently operated by VINNOVA. The program has been providing governmental funding to university incubators, and in the process an impressive amount of data has been collected.

University incubators are part of how universities interact with society. By studying them we can learn more about the role of researchers in society and how universities have developed responses to the call for more direct involvement in the prosperity of society.

To summarize this section, three knowledge gaps were identified. The first relates to how commercialization would function more specifically in an inventor ownership context, as previous research has indicated that firm formation is the likely commercialization alternative in such an institutional regime. The role of university incubators in facilitating this remains largely unexplained. The second and third knowledge gap identified in the above discussion relates to diversity in terms of founder and incubator types. Here, diversity in founder types within the aggregated category of university incubator means projects founded by researchers, students, or founders unrelated to the university. Previous research has instead mainly been focused on differential performance of firms, assigned properties by the type of incubator they are supported by and not the type of founder they have. Therefore a more fine-grained analysis could contribute to the incubator literature. Additionally by using the KIE firm concept to study university commercialization at university incubators it open up for the diversity of founders in Swedish university incubators. In identifying these gaps, this thesis contributes to the KIE literature and related literature on new technology-based firms and young innovative firms.

1.3 Research objectives

University incubators in Sweden are tasked with providing business support to researchers, students, and even those founders who are not affiliated with the university (hereafter, independent inventors and corporate spin-offs). With this support the incubators aim to help these diverse founder types to start KIE firms. In order to add theoretical understanding of this process, my research objectives are to:

1. Synthesize relevant literature in order to propose and revise a process model of how university incubators, under an institutional regime of inventor ownership, affect the formation of knowledge-intensive entrepreneurial firms.

2. Explore how managers at university incubators interpret national policy goals and work with researchers in relation to the formation of knowledge-intensive entrepreneurial firms.

3. Investigate the early formation of knowledge-intensive entrepreneurial firms by analyzing the differential outcomes of projects and incubators within the national incubator program.

In Table 1.1 below, the individual chapters are connected to my research objectives.

Table 1.1 Relationship of chapters to research objectives

Chapter No.	**Chapter name**	**Research objective**
Chapter 2	Theoretical considerations and model	1
Chapter 4	Empirical context: Institutional regime for why commercialization is done differently in Sweden	2
Chapter 5	Incubating KIE firms in Swedish universities	2
Chapter 6	Analyzing KIE project types' probability of becoming firms in university incubators	3
Chapter 7	Efficiency analysis of incubator KIE firm formation	3
Chapter 8	Discussion and conclusion	1, 2 and 3

As seen in Table 1.1, the first research objective is addressed in Chapter 2 but also in Chapter 8; the second in Chapters 4 and 5 (and 8); the third in Chapters 6 and 7 (and 8). Below, I summarize each of the subsequent chapters.

1.4 Structure of this thesis

In the previous sections I introduced my research, and in the following sections I outline the subsequent chapters in my PhD thesis.

In Chapter 2, I review the literature to develop the key concepts used in this dissertation, namely technology knowledge transfer, academic entrepreneurship, university incubators, incubation process, knowledge-intensive entrepreneurial firms, and incubator performance. Based on this literature review, I have chosen specific definitions of each concept. Moreover, by synthesizing the literature, I also formulate research questions for subsequent chapters. These research questions are designed to provide more in-depth analysis by which to address the research objectives defined above. Finally, based upon this work, I propose an initial process model of how university incubators may impact the formation of KIE firms.

In Chapter 3, I describe the research design I use, which consists of a mixed-methods approach. This approach allowed me to access and use different types of data sources (interviews, policy documents, and VINNOVA data from the national incubator program of Sweden between 2005 and the end of 2014) and methodologies (explorative case study, competing risks regressions, and OLS regressions) to explore how university incubators impact the formation of knowledge-intensive entrepreneurial firms.

In Chapter 4, I develop an analysis of how commercialization in Sweden is done differently by describing the empirical context of this PhD dissertation. I use a literature review of research into institutional regimes to contrast and contextualize the Swedish regime as compared to those found elsewhere. Further, I use collected source material (governmental reports, etc.), interview material from my qualitative study, and descriptive statistics from VINNOVA to describe the empirical context and the ultimate goal for commercialization of policymakers and incubation managers. I provide an overview of commercialization of research in Sweden, which I call a subsystem of the Swedish innovation system. In this chapter the reader gains insight into how the institutional regime of inventor ownership, which governs how research results are owned and administered, matters as well as an overview of how the national policy of Sweden can impact firm formation at university incubators.

In Chapter 5, I explore the incubation process and especially how incubator managers deal with different types of founders, including researchers. A particular focus is on how these incubator managers describe researchers as founders of KIE firms, and I discuss this in relation to how the literature describes researchers and a similar process in other regulatory contexts. This chapter builds on interviews conducted with managers at university incubators and innovation offices in Sweden. Here the reader gets the managerial perspective about the advantages and disadvantages of researchers being founders, and my analysis enables me to detail how the managers have developed five strategies in handling researchers as founders. This chapter also raises questions about the diversity of founder types.

In Chapter 6, I quantitatively analyze the competing risks of projects either failing or successfully completing incubation at Swedish university incubators. Here I use a special type of survival analysis, called competing risk analysis. This method allows me to explore how the diverse backgrounds of different types of founders (researchers, students, other university employees, independent inventors, and corporate spin-offs) may affect their likelihood of completing incubation and becoming a KIE firm. I use databases provided by VINNOVA that originate from Sweden's national incubator program. In this chapter the reader learns more about how university incubators help create KIE firms, and also learns that projects initiated by researchers seem to create a beneficial effect.

In Chapter 7, I use descriptive statistics and linear regression (OLS) models to explain incubator efficiency, seen as the number of firms they supported or produced each year and the average amount the incubator spent on supporting them. I apply this analysis to the VINNOVA databases. By using Bergek and Norrman's (2008) definition of incubator performance, I connect the goal of incubators (which is to help facilitate the formation of new KIE firms) to their performance in terms of cost-efficiency. In so doing, I find differences between the two types of university incubators (university-owned and municipality-owned), including differences in cost-efficiency, and I also suggest possible explanations for this difference.

In the concluding chapter, Chapter 8, I present a detailed and modified process model of how university incubators impact the formation of knowledge-intensive entrepreneurial firms. I modify and update this model, based on my findings in previous chapters. Specifically, the model proposed is a further articulation of the three stages that I defined in Chapter 2, that is, inflow of ideas, incubation process, and incubation outcomes. In doing so, I discuss how the model has been enriched in relation to my findings on diversity in founder types; researchers seen as a special type of founder; the effect of having more researchers as founders in the incubator; and how cost-efficiency differs between subsets of university incubators. In structuring this chapter, I explain how the results from each of the chapters contribute to a synthesis that answers my research objectives and relevant literature. Finally, based on the findings in my PhD thesis, I explore future research avenues and present three policy recommendations.

2. Theoretical considerations and model

The purpose of my PhD thesis is to investigate how university incubators impact the formation of knowledge-intensive entrepreneurial (KIE) firms. This chapter provides an overview of the state of research on this topic. In doing so, I will review relevant literature, leading to definitions of the key concepts I use and, crucially, to relevant research questions that guide the individual chapters going forward. The key definitions were briefly introduced in Chapter 1 and were used to initiate my research. Here I explain how I arrived at them.

The research objective guiding this chapter (Research objective 1) is thus, to:

> Synthesize relevant literature in order to propose and revise a process model of how university incubators, under an institutional regime of inventor ownership, affect the formation of knowledge-intensive entrepreneurial firms.

This chapter is divided into six sections. In Table 2.1 below, the individual sections are outlined and the content briefly described.

Table 2.1 Individual sections and content

Section	Title	Content
2.1	University knowledge transfer	General topics and definitions
2.2	University incubators	
2.3	Knowledge-intensive entrepreneurial firms (KIE)	
2.4	Previous, relevant literature on the empirical context of Sweden	
2.5	Proposed theoretical model and research questions	Specific topics, definitions and research questions
2.5.1	Inflow of projects to university incubators	
2.5.2	Incubation processes	
2.5.3	Incubation outcomes	
2.6	Summary	

As can be seen in Table 2.1, the content is divided into two broader parts. The first part provides the reader with insights into broader topics related to university commercialization, a review of previous research in this area in the empirical context of Sweden, and key definitions for university incubator, incubation process, and knowledge-intensive entrepreneurial firms. The second part is centered around specific topics related to university incubators and their processes and arrives at detailed research questions guiding the coming empirical chapters and a process model. Further relevant definitions are also made in that section.

2.1 University knowledge transfer

Universities are expected to remain the most important institutions in the knowledge sector if they maintain their educational mission, according to Etzkowitz et al. (2000). Educating students is one of the foremost ways in which universities diffuse knowledge acquired through research to society. Graduates are the product of years of university education, and they form part of tomorrow's management and workforce. With them they bring knowledge acquired from their education to positions at existing firms or at businesses they start themselves (Etzkowitz & Leydesdorff, 2000).

University knowledge can be transferred or diffused to society or industry in a number of ways besides the knowledge-related activity of educating students. Two such ways are by academic engagement and commercialization. Academic engagement refers to how researchers interact with external organizations, and commercialization refers to academic knowledge being transferred by patenting, licensing, and academic entrepreneurship (Perkmann et al., 2013; Perkmann et al., 2021).

Much research has been done on how to transfer the knowledge generated by research at universities to society. For the purpose of my PhD thesis, I have organized the research on university knowledge transfer into five areas: reasons, channels, barriers, measurements, and spillover. In Table 2.2 below, each area is linked with selected papers in that area, the number of Web of Science citations, and the number of citations for that paper in comparison to the mean number of citations in the field of university knowledge transfer (≈ 12 according to Web of Science, as of 2020-06-05). The last measurement exhibits their relative impact on the field.

Table 2.2 Five selected research streams of university knowledge transfer (Web of Science, as of 2020-06-05)

Selected research streams	What are the foci?	Selected authors: year	No. of citations	% of average citations: university knowledge transfer
Reasons	Looking at the reasons as to why firms would want to receive knowledge from universities and reasons as to why researchers would want to engage in knowledge transfer processes.	Lam, 2011	176	1,467%
Channels	There are numerous channels to transfer knowledge from universities to society. This is also the focus of another research stream that looks at why and how different channels are preferred by those producing the knowledge, (i.e. professors etc.) and those who receive it (i.e. usually firms).	D'Este & Patel, 2005; Bekkers & Bodas Freitas, 2008	616; 310	51,333%; 25,833%
Barriers	Another research stream looks into different types of barriers to commercialization.	Bruneel, D'Este & Salter, 2010	440	36,667%
Measurements	Patents have been important in other studies, however, they only account for 10% of the MIT knowledge transfer according to Agrawal and Henderson (2002). Co-publications and spin-offs are other ways of measuring.	Agrawal & Henderson, 2002	499	41,583%
Spillover	By looking at the spatial relationship of universities and firms with performance measurements, much research tries to measure knowledge transfer success.	Jaffe, 1989; Uyarra, 2010	1,361; 109	113,417%; 908%

In Table 2.2, the first research area focuses on reasons as to why firms would want to receive knowledge from universities. There are many reasons. Rossi (2010), for instance, argues that research into areas of high knowledge complexity and high uncertainty of outcome, both where there is high and low appropriability, is where most university-industry knowledge transfer takes place. Lam (2011) outlines reasons behind university researchers engaging in these types of activities, ranging from financial reward to career rewards and finally to intrinsic motivations. Financial reward is found to account for only a small part; rather, intrinsic motivation and motives related to furthering one's career are seen as more important for researchers. Yet those researchers identified as entrepreneurial differ from others in that they recognize the importance of financial rewards.

The second research area is channels, as in channels to transfer knowledge to society. Bekkers and Bodas Freitas' (2008) study, based on survey data from both the industry and university researchers and looking at 23 distinct transfer channels, found that there was a good match between how knowledge was transferred from researchers and how the industry preferred to find the knowledge. Given the abundance of transfer channels, it seems likely that using measurements such as number of patents, license agreements, and the like would capture only some of the ways universities engage with industry. But most importantly, the abundance also implies that much transfer of knowledge from universities to the industry is ongoing, and that we know less about this transfer. Another issue with using, for example, patents to measure technology transfer is the fact that the number of patents registered does not imply the quality of said patents.

The third stream is barriers to achieving knowledge transfer. Here, research has focused on how to lower barriers such as orientation in the subject matter. Prior experience of having participated in collaborative research has been found important to lowering this particular barrier (Bruneel, D'Este & Salter, 2010). Other types of barriers can be related to negotiations and ownership claims of resulting IP. Some research suggests that tensions between the university administration and the collaborating firms has increased as a consequence of university ownership (Siegel et al. 2003).

The fourth research area relates to measurements of knowledge transfer; here the prevalent way has been to use patents, but as indicated in Bekkers and Bodas Freitas' (2008) study, this channel is only one of the 23 identified by them. Further, Agrawal and Henderson's (2002) research highlights the disadvantage of focusing only on patents when measuring knowledge transfer. They used data on patents in MIT to measure knowledge transfer. The authors' findings suggest that patents accounted for a mere 10% of the total amount of knowledge transferred from their labs to society. Spin-offs, entrepreneurial activity, and co-publications with industry are other examples of measurements that are property-based and often rely on studying volumes (Bozeman, Fay & Slade, 2013). Other types of measurements can be knowledge-based, such as number of citations, which would measure the use of the knowledge that is being co-created with industry or transferred from the university. McKelvey and Ljungberg (2017) use similar reasoning and formulate a conceptual framework with two routes to transfer knowledge as in:

1. The direct route – related to commercialization, which often ends up as property-based or codified knowledge that is more easily measured than knowledge transferred through the indirect route.
2. The indirect route – related to academic engagement, what Bozeman et al. (2013) would label knowledge related. It refers to more tacit knowledge transfers that happen in the interaction between researchers and industry or society. This type of knowledge transfer is harder to measure, and Perkmann et al. (2013) suggest that academic engagement should get more scholarly attention.

The fifth, and final, research area relates to spillover effects, which can be effects resulting from the spatial relationship of universities and firms (Uyarra, 2010). The physical distance seems to matter a lot for the diffusion of knowledge, with less distance from a university facilitating spillover. While these effects seem to mostly be associated with technological fields, Jaffe's (1989) research also suggests that university research causes local industry to increase research and development (R&D) activity. In this research area, the objective is often to measure the success of knowledge transfer.

From this brief overview of five topics on knowledge transfer as a research field, I have decided to narrow in on what McKelvey and Ljungberg (2017) describe as the direct route of commercialization. I will first explore it in the context of Sweden more generally and then look at the outcomes of these processes in order to measure aspects of them that previous research has neglected. Within commercialization of research, I am looking only at KIE firms, incubators, and founder types.

2.2 University incubators

Historically, the first observation of what we now conceive to be an incubator is said to have been in 1959 in Batavia, New York (Aerts, Matthyssens & Vandenbempt, 2007; Dee et al., 2011). Since then, this type of organization born to foster startups has evolved, and today researchers and practitioners usually make a distinction between business incubators and public incubators, between technology incubators and non-technology incubators, and lastly, between university incubators and private incubators (Ratinho et al., 2010). McKelvey and Lassen (2013), after reviewing much incubator literature, derived four main types of incubators: business innovation centers (BICs); university business incubators (UBIs); independent private incubators (IPIs); and corporate private incubators (CPIs).

The first type are business innovation centers or BICs, which are incubators that are publicly owned and operated. They aim at promoting local, regional, or national growth by creating firms that positively affect employment rates and technological development (McKelvey and Lassen, 2013). In the data material these incubators are often owned by a mixture of public owners (such as the local municipality, the regional council, or similar).

The second type listed by McKelvey and Lassen (2013) are the university business incubators or UBIs, which are university owned and operated incubators, as the name indicates. This allows projects to have access to university resources and infrastructure. They facilitate the flow of knowledge to society in the form of new KIE firms.

In Figure 2.1 below, I illustrate these four types of incubators and have divided them according to their ownership structure, where BICs and UBIs belong to the public domain, and IPIs and CPIs to the private one.

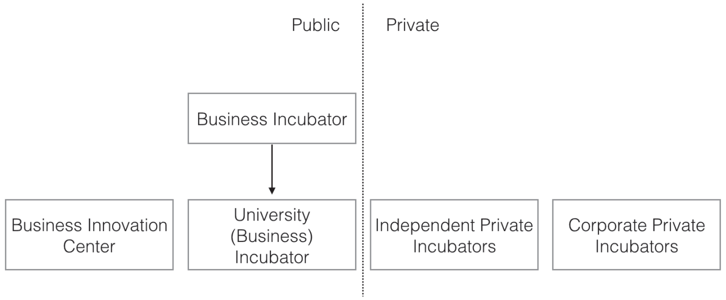

Figure 2.1 Type of incubators divided by ownership and university business incubator as a type of business incubator

Further, in Figure 2.1, the university (business) incubator is seen as a type of business incubator (Mian, 1996). Mian (1996) describes business incubators as providing a nurturing milieu for new business startup firms. The term "business startup" refers to market-oriented firms.

In this PhD thesis I initially started from McKelvey and Lassen's (2013) definition of university incubators; specifically:

> University incubators are university owned and operated incubators that allow projects to have access to university resources and infrastructure.

The last two categories: independent private incubators (IPIs) and corporate private incubators (CPIs) are privately owned. The difference lies in their purpose and focus, as CPIs focus on spinning out internal knowledge in the form of spin-offs. This is often done for strategic reasons as some internal knowledge does not mix with the mission and vision of the (mother-) corporation. The IPIs developed as a function of market demand as there is profit in creating new firms (McKelvey & Lassen, 2013).

Comparing different types of incubators, or the benefits for firms of being either incubated or not, has been the subject of much previous incubator research. In a study from 2002, for example, Colombo and Delmastro looked at 45 new technology-based firms (NTBFs) in Italy that had been incubated at a technology incubator and compared them with firms that had not undergone incubation. They found that the firms that had been incubated had higher growth rates and generally better human capital, that is, higher educational attainment in founders and staff. Another perk identified in the study was that the incubated firms had easier access to public funding, something that was highly valued in Italy at the time of the study, as the state did not have an extensive national innovation system to support NTBFs (Colombo and Delmastro, 2002).

Moreover, according to Peters, Rice and Sundararajan (2004), non-profit incubators graduate at a higher pace than for-profit or university incubators. This, they argue, is due to a higher prevalence of subsidized rents. Similar findings were reported by Rosenwein (2000), who concluded that projects and firms in private incubators graduated within one year as compared to two years for public incubators. The discrepancy was explained as having to do with market pressures instead of subsidized rents.

In a longitudinal study on university linkages for the outcome of graduation, failure, or staying in the incubator, Rothaermel and Thursby (2005) found linkages to the incubator-sponsoring university to be a factor that both increased the time spent in the incubator and reduced the probability of failure for the firm.

2.3 Knowledge-intensive entrepreneurial (KIE) firms

Malerba and McKelvey (2019:574) define the knowledge-intensive entrepreneur as one who “takes risks and reaps eventual profits, turns technology and ideas into innovations in the market and enables new combinations, faces uncertainty about current choices in relation to future outcomes and creates opportunities by both driving and adapting to change in the external environment.”

The KIE entrepreneur is thus similar to that described by Schumpeter, who defined an entrepreneur as an innovator that recombines existing knowledge and brings an invention to the marketplace. Malerba (2010) elaborates the recombination aspects to encompass resources and organizational skills as well as external links and the knowledge component. Knowledge can be of a market, technological, business, and creative nature (McKelvey & Lassen, 2013). These knowledge aspects can of course be held by the same person. The knowledge aspects can be overlapping between researchers at universities and, for example, graduates employed in firms or those who are already entrepreneurs.

Malerba and McKelvey (2019) argue that KIE entrepreneurs turn ideas and indeed technology into viable innovations in the marketplace. This, they argue, enables new combinations that thereby create new opportunities upon which other entrepreneurs can act. Thereby this can lead to changes to the economy at large and in some cases lead to economic growth. KIE firms are therefore of particular interest theoretically, but also in a (regional, national, or even international) policy perspective.

On successfully leaving a university incubator, a knowledge-intensive entrepreneurial firm is born. Malerba and McKelvey (2020) have operationalized the KIE concept to KIE firms, where they empirically differentiate them from other types of firms by four criteria: being newly created, being independent and innovative, having knowledge intensity, and exploiting innovative opportunities. This empirical definition does not differentiate by industry belonging; instead, KIE firms exist throughout all sectors. Knowledge-intensive implies that they are able to learn as organizations and are thereby able to innovate and adapt to external changes in their environment better than other types of firms. The knowledge is seen as a product of founder and employee education in many cases (Malerba & McKelvey, 2019). Malerba and McKelvey (2020:6) define them theoretically as follows:

> Knowledge-intensive innovative entrepreneurial firms are new learning organizations that use and transform existing knowledge and generate new knowledge in order to innovate within innovation systems.

In addition to university incubators being part of the Swedish innovation system, the firms they select and produce, KIE firms, innovate within an innovation system. By "innovation system" they are referring to both the theoretical concept and how it would work in practice. The concept of innovation systems has been extensively explored by research, however, the gap between the theoretical concept and how it actually tends to be as studied empirically is substantial (Fagerberg & Scrolec, 2009). As my PhD thesis deals exclusively with how university incubators facilitate the formation of KIE firms under the institutional regime of inventor ownership, this concept and its theoretical foundations are not used as an analytical tool. However, it does inform me about the complexity of actors, resources, and culture endemic to a nation, region, or technological field that tends to affect what could be expected of the output of the system, be it new inventions, innovations, or firms.

In the conceptualization of KIE firms proposed by Malerba and McKelvey (2018), the firms operate in an external environment and thus external factors affect their survival and performance. Among the external factors, market conditions and competition are factors that do not directly affect the projects incubated in an incubator, and thus they fall outside the scope of this PhD thesis. Rather, my study covers one of the potential origins of KIE firms, namely, those KIE firms developed within the protective shell of the university incubator. They are thus pre-market entry projects.

In order to use the KIE firm concept, I will compare it with other conceptualizations or theoretical groupings of firms with certain characteristics. In Figure 2.2 below, KIE firms are placed in relation to other firm-grouping concepts.

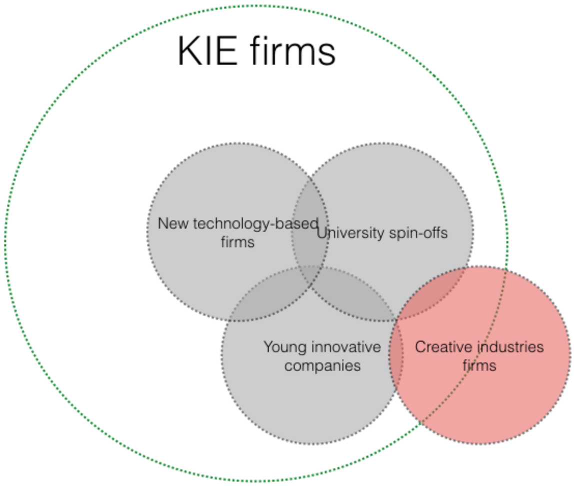

Figure 2.2 KIE firms in relation to delimitations of other types of conceptualizations and operationalizations of firm

In Figure 2.2, university spin-offs, the label used in many other incubator/incubator-firm studies, are seen as a key driver of change and growth on the economy-wide level (Bercovitz & Feldman, 2008). There is no clear-cut definition for university spin-offs they are so varied in terms of how are created, the industries they operate in, etc. (Bathelt, Kogler & Munro, 2010). As I will show in this PhD thesis, the firms created in university incubators are diverse in terms of founders as well, working not only with researchers, students, and firms taking on university IP but also with others who are not affiliated with the university. Therefore university spin-offs are one type of KIE firm (illustrated by the gray circle to the right inside the KIE circle).

New technology-based firms are also a subset of KIE firms (illustrated by the upper-left gray circle inside the KIE circle), as they too are based on knowledge (see NTBF definition in Storey & Tether, 1998). Young innovative companies are seen as different from NTBFs due to their growth ability and are defined as being less than six years old, having fewer than 250 employees, and having an R&D intensity of above 15% (Veugelers, 2009; Czarnitzki & Delanote, 2013). Due to their R&D intensity, which is a way of exploiting innovative opportunities, these firms are also a subset of KIE firms (illustrated by the bottom-left circle inside the KIE circle in the figure).

Lassen, McKelvey and Ljungberg (2018) did a comparison study of firms, identified as KIE firms through the KEINS survey, in the creative industries and manufacturing. They found a higher degree of knowledge intensity (in higher attainment of higher education for founders and employees) in the creative industry firms. Further, they propose that firms in the creative industries engage less in radical innovation due to a higher reliance on internal knowledge and resources, while firms in manufacturing engage more in radical innovations due to being less dependent on internal knowledge and resources. Lassen et al. (2018) identified KIE firms in the creative industries in a number of steps by looking at UNESCO 2007 classifications and freeform, which reduced the initial 1406 creative industries firms to 601 KIE creative industries firms. Hence not all (young) creative industry firms are KIE firms, illustrated in Figure 2.2 by the red circle that overlaps the green KIE firm circle.

The definition of KIE firms allows for the inclusion of a broader scope of firms than other concepts, including the concept of new technology-based firms (NTBFs). NTBFs are operationalized as being relatively young and operating in (high-) technological fields such as biotechnology or specialized engineering (Little, 1977; Klofsten, 1994; Rickne, 2000; Ferguson & Olofsson, 2004). Even though this narrow definition has been questioned and more recent research into NTBFs has tried to include more firms based on firms' ability to make use of knowledge, it is hard to move away from its focus on technology (Storey & Tether, 1998).

Crucially, for the empirical aspects of this PhD thesis, the NTBF concept in its original definition also excludes all types of spin-offs in the definition (Little, 1977) and primarily focuses upon firms in high-tech sectors. In contrast, the literature on KIE firms specifically is not limited to high-tech industries nor does it exclude spin-offs. This definition is therefore more inclusive, and the type of KIE firm that I investigate in this PhD thesis operates in diverse industries but is primarily differentiated from non-KIE firms by the knowledge component (Malerba & McKelvey, 2020).

Lately, the concept of KIE firms, which encompasses a wide array of different types of firms, has been nuanced to emphasize the knowledge aspect. This has been done in order to learn more about a particular type of KIE firm, the super-KIE firm, that has been suggested to be even more prone to affect the larger economy (Malerba & McKelvey, 2020). In this KIE firm differentiation, the knowledge component has been indexed. The knowledge indexation has, for example, allowed Gifford et al. (2020) to do an interesting quantile regression model on super-KIE firms from the KEINS population of KIE firms and measure their performance and survival. Results from the same study indicate that academic experience (a measurement of knowledge intensity) has a positive impact on KIE firms in the top quantile of growth. This, they argue, could be due to making it easier for the KIE firm to maintain ties with the university and academic experience could also be of use in building firm capabilities. They conclude that only a few of the KIE firms surveyed grew, but the firms that did grow had high growth rates in employees and turnover. This research suggests that the assumption of KIE firms coming from universities as instrumental to economic growth could be correct. Further, it would also justify some of the societal costs of operating university incubators.

The above review of the knowledge-intensive entrepreneurial (KIE) firm concept and how it relates to the narrower concept of NTBFs has been used in many previous incubator studies, but is too narrow and excludes spin-offs in its original interpretation. Therefore this concept is of limited use in this PhD thesis, and I will instead use the original definition of KIE firms.

The definition I use is Malerba and McKelvey's (2020:6) description of KIE firms:

> Knowledge-intensive entrepreneurial firms are "new learning organizations that use and transform existing knowledge and generate new knowledge in order to innovate within innovation systems."

2.4 Swedish literature on commercialization, university spin-offs, and incubators

In the following section I will review literature produced in the empirical context of Sweden on the topics of commercialization, academic entrepreneurship, entrepreneurship education, university spin-offs, and incubators. Note that this is a selection of literature on these topics in the empirical context of Sweden, and topics related to science parks, for example, are not included.

2.4.1 Swedish institutional selection

Research focusing on differences between institutional regimes in Sweden, other European countries, and the US suggests that the national institutional regime seems to affect what type of commercialization is more likely to happen in terms of either patenting and licensing or starting new companies (e.g. Bengtsson, 2017; Åstebro et al., 2019). Bengtsson (2017) analyzed differences in the types of commercialization carried out by Norwegian, Danish, and Swedish universities and found that Swedish universities were more likely to support the creation of new firms, whereas universities in the other Nordic countries were more likely to commercialize by license agreements. However, apart from having different institutional regimes, the author highlighted other factors as important to achieving commercialization in the first place, such as a well-developed support structure. Åstebro et al. (2019) partly substantiated this finding by comparing participation rates in entrepreneurship between large sets of academics in the US and Sweden. They found that Sweden had a higher rate of academics starting entrepreneurial firms than had the US. However, they also noted that the overall rate of engaging in entrepreneurship was lower for university employees as compared to non-university employees in both countries.

Hence, this empirical context of Sweden provides interesting insights into how commercialization with the help of university incubators may work differently than commercialization in other empirical contexts, due to the specifics of the institutional regime of inventor ownership.

Underlying much of the literature on the empirical context of Sweden is what has been coined "the Swedish paradox." When Edquist and McKelvey (1991) first used the paradox metaphor, they stressed its importance, and found a relationship between poor aggregate growth and the weak development of knowledge-intensive industries despite a high R&D intensity (Edquist & McKelvey 1994;1998). This later evolved into an academic paradox, this time indicating poor output of academic patents in Sweden, and it was later addressed by the Swedish government in a series of initiatives (Jacobsson, Dahlstrand & Elg, 2013). The notion of the Swedish paradox became a question of commercialization and a perceived "insignificant" contribution of universities to strengthen the knowledge-intensive industries (Jacobsson, Dahlstrand & Elg, 2013).

Using longitudinal data (1985-2001) on the entire Swedish economy, Ejermo, Kander and Henning (2011) analyzed the Swedish paradox, i.e. the increasing levels of R&D connected to a comparatively low level of GDP growth. They found the paradox only to occur in fast growing manufacturing and service sectors. Their interpretation is that their results does not indicate a malfunction in the national innovation system of Sweden, but rather that slow-growing sectors are slow growing due to their relative low investment in R&D.

The Swedish paradox brought up a policy discussion in Sweden. Although this discussion culminated with the SOU deliberations (SOU, 2005) that investigated the pros and cons of keeping inventor ownership and landed on keeping the status quo, it still remains a discussion point (e.g. KTH Magazine 2016). Evidence from research has emerged that challenges the narrower interpretation of the paradox as being one of poor output in the form of academic patents compared to the total amount of patents. Instead, research indicates that this interpretation of the paradox was due to a measuring issue (Ljungberg, Bourelos & McKelvey (2013). While looking at inventor-level data instead of assignee-level data, Ljungberg et al. (2013) found that Swedish faculty were as active in patenting activity as their American counterparts. This research was building on the insights from Lissoni et al. (2008), who studied inventor-level data in other European countries at the individual level and found evidence suggesting that Europe has similar levels of academic patenting (a measurement of commercialization activity among others) to those in the USA.

Other research, instead of focusing on academic patenting, has focused on how universities, in different ways, have become more entrepreneurial. An illustrative example of this research is Jacobs, Lundqvist, and Hellsmark's (2003) case study of Chalmers University as an emerging entrepreneurial university. They argued that it takes a long time to build up the infrastructure and change the culture, which is deemed necessary for successfully becoming an entrepreneurial university. Further, they argued that Chalmers' managerial top-down approach, shifting from a research to an innovation focus, might not be what mattered most in making the university more entrepreneurial. Instead, they pointed towards an internally driven process, much explained by Chalmers being an engineering school.

Research on participation of researchers in commercialization activities in Sweden indicates that rather than creating new ventures, faculty prefer to participate in other university-industry activities such as collaborative research and contract research (Klofsten & Jones-Evans, 2000). However, results from a more recent survey study suggest that Swedish researchers in science and engineering are positive towards commercialization in general as well as patenting and venture creation (Bourelos, Magnusson & McKelvey, 2012). Not only that, the same study also found that researchers that published also tended to commercialize, and that support structures, such as incubators and technology transfer offices, had an important role. Moreover, with a sample of over 7000 university employees and their propensity to start firms in Sweden, Karlsson and Wigren (2012) found activities within universities to be inconsequential regarding university employees' propensity to start firms, while activities such as contact with external product development teams had positive effects.

2.4.2 Students as sources of knowledge

This section highlights a few studies indicating that students can be a source for impacting firm creation.

Lundqvist and Middleton (2013) analyzed venture creation in a US university and two Swedish universities. They found that venture creation and being a researcher could be combined without infringing too much on the role of the researcher. They argue that this could be done by involving the researcher in the project but not in a leading capacity. Instead they argue, involving students as the entrepreneurial agent could be an option not previously proposed.

Research has also been carried out on how entrepreneurship education at universities can be combined with incubation. Ollia and Middleton (2011) studied this facet of commercialization in Chalmers University, which has entrepreneurship education where the students also go through incubation processes. This, the authors argue, gives its students a truer picture of what it is like to be an entrepreneur and provides hands-on learning of entrepreneurial skills. The approach with more hands-on entrepreneurship education forms one of two strategies identified by Zaring, Gifford, and McKelvey (2019), who created an index of entrepreneurship education in Sweden. The other was the more traditional theoretical approach.

Lackéus and Middleton (2015) analyzed 10 entrepreneurship programs at Swedish universities that applied a venture creation approach and found beneficial aspects of a collaboration between the universities' technology transfer activities and the entrepreneurship programs. The positive aspects they found were twofold, combining education and technology transfer gave an increase in technology transfer activities but also students equipped with knowledge of how to transfer technology via means of venture creation.

Moreover, Lundqvist, Middleton and Nowell (2015) investigated how entreprenurial identity evolved over time, using longitudinal data from a venture creation program, on entrepreneurship students that developed ideas originated from research. Their findings suggests that interaction with venture creation and expectations regarding team roles are the explanations to becoming entreprenurial rather than, the more traditional, intention-based role-creation process.

By studying resource logic in relation to student venture creation, Politis, Winborg and Dahlstrand (2010) found students to have a higher preference and more commonly apply both booth-strapping and effectuation methods as compared to non-student entrepreneurs. Where effectuation refers to using the resources the founder have access to and contacts the know in order to build their venture. Their analysis is based on a survey to 325 Swedish entrepreneurs, of which 46.5% were student entrepreneurs.

2.4.3 Swedish university incubators, firm creation and incubator performance

In the Swedish empirical context, much previous incubator research has focused on the role of university incubators and innovation offices in producing new firms. Previous literature have often studied university incubators from the point of view of firms, usually from a very particular type of firm: new technology-based firms or NTBFs (Aaboen, Lidelöf & Löfsten, 2008; Löfsten, 2010; Aaboen & Löfsten, 2015). Aaboen, Lidelöf, and Löfsten (2008) suggest that being located in incubators facilitates technology transfer for NTBFs. Moreover, they continue, this effect will persist due to efforts on incubator and systemic levels. Löfsten (2010) found no evidence of a relationship between firm performance and incubators' internal and external networks when performing correlation tests on a batch of 131 incubated NTBFs in 16 Swedish university incubators. However, Löfsten (2010) also pointed toward an internal incubator network as a potentially important factor for later firm development. In Aaboen and Löfsten (2015), they focus on the internationalization strategies of the same sample of firms as in the former studies

University incubators has also been analyzed for studying financial attainment strategies of NTBFs (Winborg, 2015). In the study, the financial attainment strategy of boot-strapping was identified as a possible way to negate some of the consequences of liability of newness for incubator firms. Liability of newness refers to how the incubator firm lack a track-record which would indicate reliability to potential customers and suppliers.

The Swedish context has been studied extensively from the viewpoint of NTBFs. Hence, the focus of most of the research discussed in the subsection above is on the firms and less so on the incubators themselves.

Autio and Klofsten (1998) compared two cases of what they called local small and medium-size enterprises' (SME) support arrangements, one in Sweden and one in Finland. They found that both arrangements had adapted to their local environments and actively exploited their different local settings, working with their respective local industrial bases and institutional settings, such as universities. Moreover, they interpreted management practices as a good way to take full advantage of the local context.

While surveying and analyzing a sample of 52 SMEs in the Gothenburg area of Sweden Dahlstrand (1997b) found technology-intensive SMEs to mainly stem from two local sources: Chalmers university (a university focused on technology and engineering) and medium and large local industrial firms with well-established operations. A conclusion drawn from the survey was the importance, in the early stages of firm-development, of local links and relationships were identified as the founder's previous employer and Chalmers university. This importance became less pronounced with time.

Moreover, Johansson, Jacob, and Hellström (2005), doing work on spin-offs that had not been incubated, found that firms with stronger ties (small in number but strong in interpersonal connections) to universities gave the firms an advantage in growth as measured by the increase in the number of employees as compared to those firms that have weaker connections. They argued that few but strong connections would give access to basic research support, which would be important for the firm in development and later on as well.

While studying entrepreneurial spin-offs selected from a population of Swedish technology-based firms Dahlstrand (1997a) found that only one-sixth of the spin-offs had been spun-off from a university. Rather the majority of spin-offs in her sample had been spun-off from private firms. Going further, she compared the growth rates between the sample of spin-offs and a sample of firms that had not been spun-off, concluding that the spin-off firms had significantly higher growth rates as compared to non-spin-off firms over the ten first years of operating.

In a connected study to the one above, Dahlstrand (1997b) compared technology-based (Chalmers) university spin-offs, corporate spin-offs and non-spin-offs, where she found the spin-offs from Chalmers to be small and to have a slow rate of employee-growth than the other types of firm. The corporate spin-offs were found to have faster growth than both of the other kinds of firm. A key contribution from this study, however, is that she identified university spin-offs to have more patent-activity than both of the other types of firms, for which she offers an explanation based on these type of firms acting as technology supplier to other firms and thus being very important for regional growth.

By studying university incubators specifically, I am interested in the broader issues of how universities may impact society and the appropriate organizational forms for commercializing research. This is an interesting question because researchers may act differently from other types of founders, and university incubators may act differently from other types of incubators.

Bergek and Norrman (2008) have studied incubators from the perspective of best practices related to different incubator models. In doing so, they formulated three model components: selection, business support, and mediation. Each component then has different set-ups. They then applied the framework on 16 Swedish incubators and found each type represented. They also argued for a new approach to measuring incubator performance, as in evaluating incubators on the outcomes of their own goals. This paper has been quite influential in the incubator literature and is frequently cited by much of the incubator literature reviewed in this PhD thesis, and I use different aspects of their research as a basis in Chapter 7, for example.

Dahlstrand and Politis (2013) specifically analyzed differences between male- and female-led ventures in Swedish incubators and concluded that incubators were unable to attract academic female entrepreneurs. However, they acknowledged that Sweden has a high percentage of female-led ventures as compared to international numbers.

Lundqvist (2014) investigated the effect of surrogate entrepreneurship in Swedish university incubators. Surrogate entrepreneurship refers to someone other than the founder taking over the development of the project into a startup. His study covered 170 technology ventures incubated in 16 Swedish university incubators during the period 1995-2005, and he found 9 out of 16 incubators and 34% of the technology startups to have surrogate entrepreneurs. Further, due to skewness in the data on performance, the study could only get indicative results of slight over-performance (in revenue and growth) of the surrogate firms as compared to those firms without surrogates. Interestingly enough, Lundqvist (2014) differentiated between academic technology startups and non-academic ones, and found academic technology startups to have slightly higher effects of the use of surrogates on firm performance.

By analyzing factors affecting incubator size, Klofsten et al. (2020) showed incubator size to be positively associated with two incubator specializations: those with a strategic focus on universities and research institutes and those with a sustainability focus. However, they did not find a positive relationship for incubators with technological or regional specializations.

2.4.4 Reflections on the Swedish literature

Much research has been done on the topic of university commercialization in the empirical context of Sweden. It has touched on larger society-changing subjects, such as how universities are becoming entrepreneurial in new ways, and also on how entrepreneurship education may matter for university incubators and the commercialization of university knowledge. The Swedish literature has also had a focus on technology-based firms. This has perhaps led to missed perspectives that other types of firms could bring. Arguably, technology firms are important in many respects. However, selecting only these as the study object to measure how university incubators facilitate the formation of firms would exclude other important types of firms (see Section 2.3 for the more inclusive concept of KIE firms in relation to NTBFs, among others).

For this PhD thesis, a probable interpretation of the reviewed literature would suggest that a more fine-grained analysis of how university incubators facilitate the formation of the firms using the more inclusive concept of knowledge-intensive entrepreneurial firms could add to a rich literature.

2.5 Proposed theoretical model and research questions

In this section I connect the definitions that I made above, in relation to literature, with an initial conceptualization of a model to explain how university incubators impact the formation of KIE firms.

In Figure 2.3 below, I make an initial conceptualization of how university incubators impact the formation of KIE firms.

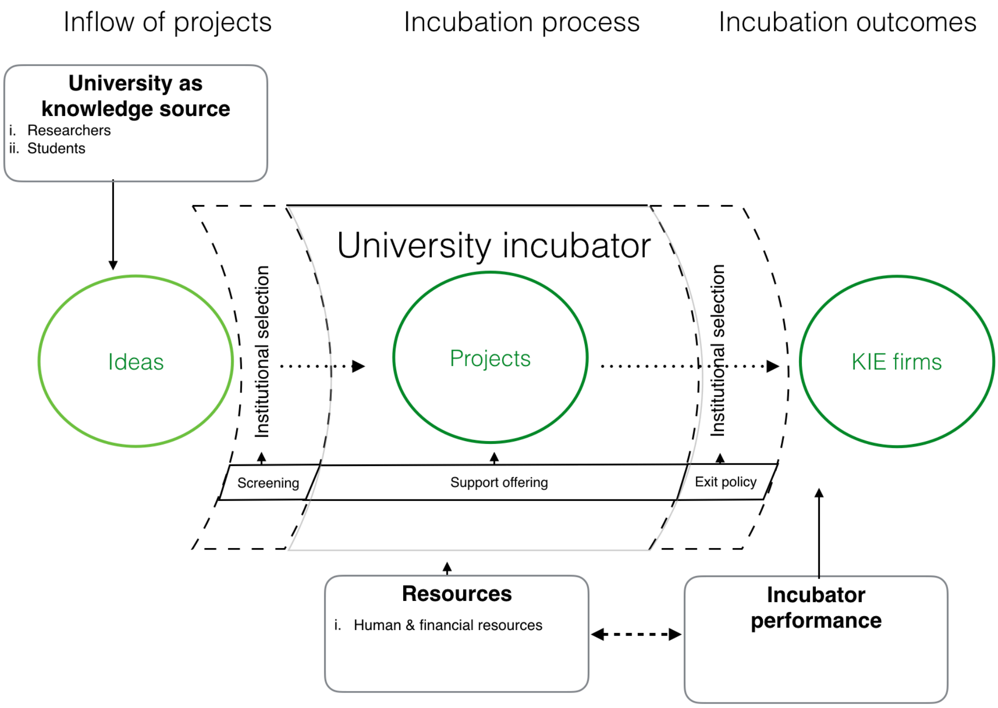

Figure 2.3 Initial conceptualization on how university incubators support the creation of KIE firms

Figure 2.3 has three phases (inflow of projects, incubation process, and incubation outcomes), which correspond to the subsequent subsections and lead to deriving my research questions.

These three subsections are:

2.5.1 Inflow of projects to university incubators
2.5.2 Incubation processes
2.5.3 Incubation outcomes

Hence, the explanation for the figure is distributed throughout these coming subsections.

2.5.1 Inflow of projects to university incubators

This subsection addresses the phase of inflow of projects. In Figure 2.3, on the far left, the box represent the knowledge source identified as important in the literature, knowledge coming from the university. The internal knowledge source is divided into (i) researchers, and (ii) students competing to enter incubation at a university incubator.

Potential founders try to access the incubator by proposing their ideas, represented by the left-most green circle. Ideas are then selected by the incubator, represented by an institutional selection dotted box, drawing on the reasoning of Bergek and Norrman (2008), who highlighted the importance of selection in relation to different incubator strategies.

The following paragraphs deal with the institutional regime and what makes Sweden different and lead to a first broad research question related to researchers in particular. The reason I use the notion of institutional selection here is to differentiate this type of selection from the type that firms are subject to in a marketplace. Here, I follow Nelson and Winter (1982; 1977), who made a distinction between market selection and non-market selection. Market selection, they argue, involves customers, retailers, and producers. If no customers want to buy the products or services the KIE firm produces, then the firm does not earn money and will eventually die from lack of liquidity. Likewise, if retailers are needed to sell to end customers, these can make or break a business. The same can be said about producers. Non-market selection, they argue, refers to selection done by universities, commercialization infrastructure, norms, and customs.

One aspect in particular makes the Swedish setting especially interesting to study in relation to university incubators and their role in transferring university knowledge to society, and that is the institutional regime of inventor ownership.

In Sweden, the institutional regime of inventor ownership identifies individual teachers/researchers as the owners of their own ideas. However, between 2004 and 2006, the incumbent Swedish government had serious considerations about changing the law (SOU 2005:95, Government Bill 2008/2009:50). Although these considerations generated a governmental report on the pros and cons of Sweden changing legislation to university ownership, no such change has been made to date.

In fact, Sweden is the only Nordic country that has kept this right for its researchers to commercialize themselves (Audretsch & Göktepe-Hultén, 2015). In Norway, they changed from inventor ownership to university ownership, where the university instead of the researcher owns and has the responsibility, and potential reward, for commercializing it. Hvide and Jones (2018) analyzed how this change in institutional regime to university ownership had affected patenting and starting new companies, and their analysis suggested a 50% decline in patenting and entrepreneurship activity at Norwegian universities. They also assessed that the quality of said patents and new firms declined as well. Moreover, European Union member states Austria, Germany, Italy, and Finland have, in later years, introduced university ownership (Ejermo & Toivanen, 2018; Audretsch & Göktepe-Hultén, 2015).

Meanwhile, patent data research analyzing what proportion of all patents are academic patents, has even suggested that Sweden is performing on a similar or higher level than other Western countries, the US included (Ljungberg et al., 2013; Lissoni et al., 2008).

Much existing research suggests that changing from inventor ownership to university ownership can be detrimental to academic patenting and the formation of new companies (Mowery & Sampat, 2004; Baldini et al., 2006; Kenney & Patton, 2011; Czarnitzki et al., 2016; Ejermo & Toivanen, 2018; Hvide & Jones, 2018). The current policymaker viewpoint in the European Union and the United States is that the university itself should commercialize (European Commission, 2008).

Some research suggests that the Bayh-Dole reform in the US, which is a reform that made the university the owner of researcher results, indeed had an impact on the huge increase in academic patenting by American universities. It is suggested, though, that this impact was small compared to what other factors contributed, such as changes in the research set-up and the boom in biotechnology (Kenney & Patton, 2009; Mowery et al., 2001). Moreover, unlike later changes in this type of legislation, such as the European changes described above, in the US, ownership of researcher IP was taken from the government and given to the university employing the researcher. Von Proff et al. (2012) argue that the diminishing distance between inventor and owner of the invention is another reason why the changes made in the US, as compared to those changes made in Europe, where the distance instead increased, gave such disparate results. Another consequence of the Bayh-Dole Act has been what Kenney and Patton (2009) describe as gray-market strategies, meaning that the inventor has several ways to circumvent the process, cheating the university of its potential profits emanating from owning the research results.

Sweden has not changed its institutional regime since it was made into law in 1949, which allows me to study how university incubators affect the formation of firms in a stable institutional regime that is not under constant threat (e.g. KTH Magazine, 2016). Swedish universities do not own their researchers' inventions, which is likely to affect what commercialization activities they perform.

Here, I do not have a specific research question, but instead provide detailed insights into the empirical context in Chapter 4.

2.5.2 Incubation processes

This subsection addresses the incubation process phase. As visualized in Figure 2.3, the ideas that get admitted to the incubator are shown in the middle green circle; I differentiate these from the ideas the incubator selects from, and label them as projects.

This process occurs within the university incubators. Moreover, when projects are in the incubation process, they have access to the incubator's support offering. The support offering is affected by the resources of the incubator. Drawing from the resource-based view (RBV), resources are seen as heterogeneous, in that organizations have access to different types and amounts of resources (Barney, 1991). When projects are in the incubation process, they have access to the incubator's support offering, which in turn is affected by the available resources.

Research has been done on what resources are important for the projects (Bergek & Norrman, 2008; Peters et al., 2004), and there appears to be a mismatch between the needs of the projects and the support offered by the incubators (Van Weele et al., 2017). Hence, I leave this box nearly empty with the general text, human and financial resources, addressing it in later chapters. The following paragraphs deal with the incubation process and what incubators offer to their incubation projects. This leads to two research questions related to this process.

The results of Rothaermel and Thursby's (2005) research, that university linkages reduce the probability of firm failure and increase time spent in the incubation process, contrast in part with what other research suggests, namely that university inventions have a high fail-rate (Thursby & Thursby, 2004). This higher fail-rate has been explained as due to the tacit nature of inventions, that is, that there is a lot of knowledge that is not easily transferred by a patent and written information about the invention. This information is not enough to make use of an invention and develop it. Inventor cooperation in development increases the probability that the invention becomes commercially successful (Thursby, Jensen & Thursby, 2001; Thursby & Thursby, 2001, 2004). Researcher involvement in the transfer process is said to be an important determinant of the speed of the commercialization process (Markman et al., 2005). It was found to accelerate the speed of the process if the faculty inventor participated in the commercialization process, but only in later stages and not during the disclosure of the invention stage. This effect was explained in many instances by the researchers being the founders of the licensee firm. Therefore their interest in the invention working was well aligned with their own interests (Markman et al., 2005).

Here, it is interesting to explore how researchers are seen, in light of previous research deeming them slow, and how they are supported by incubator managers in the Swedish context.

University incubators provide many advantages to firms and projects. Research into the effect of would-be entrepreneurs being in the proximity of more experienced entrepreneurs within the confines of an incubator suggests that this helped firms overcome the liability of newness (Stinchcombe, 1965; McAdam & Marlow, 2008). The liability of newness was overcome by being situated and incubated in a credible incubator. This credibility takes time to build. Lasrado et al. (2016) highlight connectivity and the legitimacy that emanates from the host university as important. Connectivity entails being connected to other entrepreneurs, the incubator, and the connections of the incubator (Lasrado et al., 2016). In the same paper they conclude that firms that are being incubated in university incubators perform better than matched non-incubated firms, even after completing the incubation program.

Previous research on incubators has also focused on the importance of availability of different types of resources for the incubated firms (McAdam & Marlow, 2008; M'Chirgui et al., 2018). This research has used aspects of resource-based theory. Here, the firm is identified as the sum of its unique resources (Penrose, 1959); with the works of Barney (1991) and others, the theory became known as the resource-based view (RBV). Barney (1991) argued that "…strategic resources are heterogeneously distributed across firms and that these resources are stable over time…." Hence the same would be the case for the incubators, projects, and firms that I have studied. The (assumed heterogeneous) resources listed as important for firms undergoing incubation to have access to have been identified as access to networks, reduced rents, support services, and professional business coaching (Peters et al., 2004; Bergek & Norrman, 2008). There has, however, also been research that points to a mismatch between the needs of the projects and the offering by the incubators. Van Weele et al. (2017), for example, found that incubators see business knowledge as the most important offering, and incubated projects see access to tangible resources such as funding as the most important.

Survival and performance of incubated versus non-incubated firms after exiting the incubator has also been a topic of interest (Colombo and Delmastro, 2002; Lasrado et al., 2016). Other studies have looked into female entrepreneurship in relation to incubation, where Sweden was used as the study object with somewhat overlapping incubator data to that used in this PhD thesis (Dahlstrand & Politis, 2013). Dahlstrand and Politis specifically analyzed differences between male- and female-led ventures in Swedish incubators and found an under-representation of female-led ventures in the incubators (which averaged 14.7%) in comparison with the uptake area, defined as the nearby university female-student ratio (58.8%). They concluded that incubators were unable to attract female entrepreneurs. However, they argue that, compared to international numbers, the Swedish share of female-led ventures could not be said to be low (Dahlstrand & Politis, 2013). In the same study they also found "…partial support for Rothaermel and Thursby's (2005) finding that firms staying longer in the incubator tended to generate significantly higher revenues."

An incubation process is defined by Bergek and Norrman (2008) as having three main parts: selection, business support, and mediation. They explain that selection is the phase where incubators select which projects to accept to their incubator, while business support indicates the actual phase of incubation, where projects have access to coaching and other services. Arguably, mediation describes the last phase in their model, where Bergek and Norrman (2008) see the incubator as helping what are now firms to bridge the divide between the relatively safe space of the incubator and the harsh market outside. Although I find Bergek and Norrman's (2008) definition useful inasmuch as I have conceptualized the process as involving three different stages, I define the incubation process slightly differently than they do.

The three stages in my definition are: inflow of projects, incubation process, and incubation outcomes. Inflow of projects contains the selection of projects suitable for incubation, but it also contains a recognition of the varying sources of knowledge that these projects originate from. My second stage is the actual incubation process, where business support is the main component. The third stage, I have differentiated as the outcomes of incubation; here, "outcomes" refers to the type of firm that the incubator has helped to create. Hence, I have defined an incubation process in the following way:

> An incubation process is a process initiated by a selection procedure aimed at supporting founders with selected projects into becoming KIE firms.

The above reasoning and that in the previous section suggests that the particular institutional regime in Sweden might contribute to other differences in how researchers are seen as founders (among a diversity of other founders), which warrants a more explorative initial research question and a quantitative second research question that considers the potential influence of founder type on the number of projects in university incubators that progress to become firms. The following two research questions are substantiated further in Chapter 5 and Chapter 6 respectively. The literature in the above discussion does not, for example, take into account that incubator firm founders can be diverse in other ways. In coming chapters, I further explore the diversity in project types, which can originate both within and outside of the university.

Based on the above reasoning, I pose the following research questions:

> Research question 1: How do incubator managers describe and work with researchers, as compared to other founders, and the incubation process in an inventor ownership environment?
>
> Research question 2: To what extent does founder type affect the likelihood of projects completing the incubation process inside a university incubator?

Research question 1 is addressed in Chapter 5, and research question 2 in Chapter 6.

2.5.3 Incubation outcomes

This subsection addresses the phase of incubation outcomes. Incubator performance, represented in Figure 2.3 as the box on the lower right, has been explored in much previous research and is tightly coupled with the resources of the incubator (Peters et al., 2004).

Projects can be selected as fit for the market by the incubator, or as Bergek and Norrman (2008) would have put it, they are subjected to the exit policy of the incubator. As I align with Bergek and Norrman's (2008) definition of incubator performance as only measurable by what their own goal is, I leave this blank until I have investigated what their objectives are and whether they are similar across incubators.

Those projects selected as fit enough to emerge on the market to compete are represented by the green circle on the right, as knowledge-intensive entrepreneurial firms (KIE firms). The theoretical as well as conceptual definitions of these types of firms allow for more types of firms to be included.

The model ends at this stage, as this PhD thesis concerns how university incubators help create KIE firms and not what happens to them once they exit the incubator. The following paragraphs deal with the performance of incubators, how to measure it, and limitations on how to measure quality.

There are a lot of research that have analyzed performance in terms of knowledge transfer from universities to society (Knockaert et al., 2010; Caldera & Debande, 2010). Where Knockaert et al.'s (2010) study focused on how the transfer of tacit knowledge affect university spin-offs. Using a case study design, they concluded that this type of knowledge transfer where the knowledge is of a tacit nature, i.e. knowledge that is hard to transfer by means of verbal or written communication, can benefit the university spin-off more if the founding research team is part of the spin-off. In the research conducted by Caldera and Debande (2010) they analyzed how policies and procedures of the university affect the performance of technology transfer. They used data from 52 Spanish universities and their results suggests that universities that have experienced technology transfer offices (TTOs), as measured in the age of the TTO, and large TTOs tend to have higher performance in terms of the number of licenses, contract research and spin-offs being produced. Moreover, their results suggests a positive effect of having an associated science park. This research show the wide span of what performance in terms of knowledge transfer could entail. I am interested in performance related to university incubators and more specifically in terms of the process leading to KIE firms.

There has been much debate within incubator research as well as in policy and practitioner communities on the issue of measuring incubator performance and what this actually means (Aerts et al., 2007; Dee et al., 2011). Nonetheless, both of the above-mentioned studies conclude that firm survival is a good way of measuring true success of incubators, which is what they argue incubator performance actually is: a measurement of how successful the incubator is. They argue that incubated firms' survival indicates their ability to compete in the market and that it is therefore a good way of measuring the success of an incubator. Schwartz (2013), for example, has looked into firm growth before and after incubation and compared it to firm growth in non-incubated firms. Mas-Verdú, Ribeiro-Soriano and Roig-Tierno (2015) agree with Dee et al. (2011) and Aerts et al. (2007) that firm survival is the foremost way to measure an incubator's impact on the economy, with the (compelling) argument that only surviving firms can contribute to economic growth on the aggregate.

Mas-Verdú et al. (2015) found that incubators by themselves are an insufficient explanation of firm survival and concluded, rather logically, that there are more factors that affect this survival. The method used in their study allows them to identify combinations of factors that result in firm survival or death. They conclude that the use of an incubator in combination with other factors, such as firm size, is sufficient for survival. This way of looking into the combinatory factors, functioning similarly to interaction effects, in relation to the survival of firms rather than analyzing treated versus non-treated (incubated or not) firms (e.g. (Phan, Siegel & Wright, 2005), seems promising. Yet, the first best solution would be to compare incubated and non-incubated firms, where incubation would be a random treatment.

Another way to measure incubator performance, according to Peters et al. (2004), is to measure the number of firms being produced. Although this is also a rather rough proxy, they argue that it is the best available indicator of incubator performance.

However, Bergek and Norrman (2008) disagreed on a fundamental level with all of the above ways of measuring. They argued that no matter how incubator performance is measured, it has to align with the assumed diverse goals of incubators. They expanded on the research of, among others, Peters et al. (2004) by stating that specific goals might differ between incubators and that it is therefore important to connect the goals of an incubator with the performance outcome being studied. I will therefore use Bergek and Norrman's (2008) definition of incubator performance:

> Incubator performance is "…the extent to which incubator outcomes correspond to incubator goals."

Hence, uncovering the goals of incubators would be key in order to measure their performance accordingly. This goal will be explored in Chapters 4 and 5.

Note that I am aware that there is a larger issue with measuring incubator performance altogether, namely if an incubator's performance is measured by the firms it supports, the quality of said firms would also be of interest." Quantity is thus not the only thing that counts. However, measuring quality is harder, and even what is defined as quality is highly subjective. Quality in this case could range from increased employment, increased revenues, or high sales figures; all of these metrics indicate a contribution to the economy and thus measure the incubator's economic impact in some sense. At the core, though, one could argue that the market is the ultimate judge of firm quality. Thus, those firms that survive have gained some kind of quality during their formation that the market looks upon favorably. For a further discussion of the limitations of measuring incubator performance, see Chapter 3, Section 3.5.

After the goal has been assessed, I ask the following research question:

> Research question 3: What is the association with incubator type and resources on incubator performance?

This research question is addressed in Chapter 7.

2.6 Summary

In this chapter, I have reviewed relevant literature on university incubators as related to the inflow of projects, the incubation process, and the incubation outcomes in terms of knowledge-intensive entrepreneurial firms. Based upon my analysis of current literature through the literature review, I have chosen to use the following four definitions:

- University incubators are university owned and operated incubators that allow projects to have access to university resources and infrastructure (McKelvey & Lassen, 2013).

- An incubation process is a process initiated by a selection procedure aimed at supporting founders with selected projects into becoming KIE firms.

- Knowledge-intensive entrepreneurial firms are "new learning organizations that use and transform existing knowledge and generate new knowledge in order to innovate within innovation systems" (Malerba and McKelvey, 2020:6).

- Incubator performance is "…the extent to which incubator outcomes correspond to incubator goals" (Bergek and Norrman, 2008).

I have combined these definitions into my proposed process model, explained the positioning of my chapter on empirical context, and then derived three research questions. When going further with my literature review, I have used these definitions and previous literature in order to visualize this model (see Figure 2.3).

These three research questions are then used to guide my empirical studies. See Table 2.3 below for an outline of the research questions and what methodology is applied in each chapter.

Table 2.3 Chapter outline with RQs and specific methodology for each chapter

Chapter	Research question	Methodology
4	Empirical context	Explorative case study/descriptive statistics
5	How do incubator managers describe and work with researchers as compared to other founders and the incubation process in an inventor ownership environment?	Explorative case study
6	To what extent does founder type affect the likelihood of projects completing the incubation process inside a university incubator?	Competing risks (survival analysis)
7	What is the association between incubator type and resources on incubator performance?	Descriptive statistics and OLS based partly on risk data

In Chapter 4, I use an explorative case study approach together with descriptive statistics of Swedish incubators from 2005 until and including 2014 from Sweden's national incubator program to address the first research question. Chapter 5 provides an explorative case study aimed at addressing my second research question. In Chapters 6 and 7, I turn to a quantitative approach, using survival analysis and OLS regression to address the third and fourth research questions.

3. Research Design and Data

This chapter addresses the research design, including methodology, data collection, and data analysis, that I use and their relationship to my research objectives. My overall research design for the PhD thesis includes mixed-methods, in that I use first qualitative then quantitative research designs to fulfill my research objectives, and that the qualitative results inform later quantitative studies and connected chapters. The overall research design is introduced in Section 3.1. Section 3.2 turns to the specific details of the qualitative case study, explained in eight methodological steps. Section 3.3 deals with data management and two chosen methodologies in the quantitative studies based on data from the national incubator program. Section 3.4 turns to limitations in chosen research designs in relation to my research objectives.

3.1 Overall research design

I have chosen a mixed-methods approach to my research design, which will be discussed in terms of two complementary methodological approaches. Specifically, this PhD thesis uses both qualitative and quantitative approaches. The PhD thesis is thus a mixed-methods study, which is sometimes seen as a third research methodology (Creswell, 2016; Creswell, 2003). Using a mixed-methods approach can enable the researcher to triangulate results using different kinds of data and methods (Creswell et al., 2006). In mixed-methods there are three ways to mix your data: you can merge the data, connect the data, or embed the data (Creswell et al., 2006). I have used the second alternative, connecting the data. This means that my qualitative data forms (some of) the basis for raising questions in further investigation and for validation through quantitative data collection. My expectation is that, in using this mixed methods approach in my PhD thesis, the research results will be more robust and generalizable, as well as more descriptive and rich, than would be the case if the study were only qualitative or quantitative (Bryman, 2006; Creswell, 2003; Creswell et al., 2003).

My rationale for deciding to use a combination of qualitative and quantitative methods can be summarized through the main points made by Creswell et al. (2006). They argue that mixed-methods have strengths that address and bridge the weaknesses of each individual method. A mixed-methods approach makes a whole arsenal of data collection available and offers more comprehensive evidence than either method by itself. With no division between the two respective methodological fields, the approach encourages collaboration over the borders. There is no restriction to only one paradigm, and if one paradigm is not pragmatic, another can be used in order to answer a research problem. Below, I explain how the methods are used here.

In Table 3.1 below, the specific methods that I use are presented with the goal of each stage.

Table 3.1 Methodological aims

Stage	Methodology	Specific method used	Aim
I	Qualitative	Explorative case study using semi-structured interviews and analyzing policy documents	Investigate phenomena, generate insights
II	Quantitative	Survival analysis and OLS regressions (Chapter 6 using competing risks and Chapter 7 using OLS)	Test hypotheses, grounded in theoretical deliberations and qualitative findings

My research design is summarized in Table 3.1, which specifies that the initial qualitative case study added insights and some additional questions which, later, were addressed by consulting government databases. Thus, in terms of connecting the data to my research objectives, my research collection and data analysis process moved from qualitative to quantitative.

My decision to take this mixed-methods approach as my research design is also partly based on the creative and changing process of being a doctorate student. After conducting my first explorative qualitative study, I (1) felt the need to see larger patterns and to truly explore the university incubators that I found to be really interesting as they followed and supported founders from an initial idea to a functioning firm, and (2) got approval to use data from the national incubator program now residing at VINNOVA, which allowed me to explore this issue further.

Table 3.2 below provides a more specific overview into what RQ, unit of analysis, research design, and data sources have been employed in which chapter.

Table 3.2 Empirical chapters and their research design

Chapter	Research objective	Research question	Unit of analysis	Research design	Data sources
Chapter 4	2	Empirical background	Institutional regime and universities	Qualitative: explorative case study & descriptive statistics	Interview material, policy documents and VINNOVA databases 2005-2015
Chapter 5	2	How do incubator managers describe and work with researchers as compared to other founders and the incubation process in an inventor ownership environment?	Incubator as organization	Qualitative: explorative case study	Interview material and policy documents
Chapter 6	3	To what extent does founder type affect the likelihood of projects completing the incubation process inside a university incubator?	Projects	Quantitative: Survival analysis/competing risks regression	VINNOVA databases 2005-01-01 until 2014-31-12
Chapter 7	3	What is the association between incubator type and resources on incubator performance?	Incubator as organization	Quantitative: OLS regression with robust SEs/robust clustered SEs	VINNOVA databases 2005-01-01 until 2014-31-12

As can be seen in Table 3.2, the unit of analysis was initially the institutional regime and the university (in Chapter 4), then the incubator as an organization in the first empirical-analysis chapter (Chapter 5). In Chapter 6, the unit of analysis moves to what I differentiate as projects (i.e. the projects residing in the incubator). In Chapter 7, the unit is once again the incubator as an organization. These different changes in units of analysis are consistent with the mixed-methods research design outlined by Creswell et al. (2006), where the empirical study object is studied from various angles using different types of research methods.

In Chapter 5, as well as some parts of Chapter 4, the first explorative steps are taken with a broad qualitative approach (Eisenhardt, 1989) that produce qualitative findings that, in some cases, I deem interesting and possible to explore further in the quantitative study in order to analyze system-wide accuracy, and further explore differences. These findings include KIE firms as the desired outcome of commercialization, diversity of founder types and projects present at Swedish incubators, and researchers seen and described as different from other founders in a number of ways.

In Chapter 6, a comprehensive Swedish Innovation Agency database is used. This database contained data on most Swedish university incubators and gave further insights and validation. Here I have used a competing risk methodology (a type of survival analysis) to predict results obtained in Chapter 5 about the diversity of project founders.

In Chapter 7, the focus is once again put on the incubator, and insights are made into incubator performance in relation to the costs associated with supporting projects into becoming KIE firms.

3.2 Qualitative approach: An explorative case study

My qualitative research takes the form of an explorative case study. The case study explores the process of incubation from idea to startup company, specifically university incubators acting in a particular institutional regime. This qualitative investigation uses a case study methodology, championed by Eisenhardt (1989), in order to investigate the phenomenon of commercialization by university incubators in an institutional regime of inventor ownership, for example, where individual scientists own the intellectual property rights to their ideas. Thus, I use this methodology to address the second research objective: *Explore how managers at university incubators interpret national policy goals and work with researchers in relation to the formation of knowledge-intensive entrepreneurial firms*, which is reported in Chapters 4 and 5.

My case study is thus on the processes around university incubators. As Yin (1981) states, this type of case study is needed when "an empirical inquiry must examine a contemporary phenomenon in its real-life context…." My qualitative approach can be considered an explorative case study because of the need to focus on the complexity of organizations and the commercialization of science in the uncommon context of inventor ownership. My approach follows Eisenhardt (1989) and Eisenhardt and Graebner (2007), whose proposed research design created a flexible qualitative methodology that borrowed heavily from grounded theory, which itself was an attempt at making qualitative studies systematic and highly structured (Charmaz, 2006). Eisenhardt, a strategy and organizational scholar, has proposed a structured approach that resembles grounded theory but has more flexibility in the structure of interviews, coding, and analysis, which fits more with how fieldwork actually turns out than the idealized vision of other approaches. Qualitative researchers have long strived to agree on what constitutes good qualitative research (Lamont & White, 2008; Bennett & Elman, 2006). This difficulty in agreeing upon quality assurance is the main reason why I rely on the steps defined by Eisenhardt (1989) to aim for a structured methodology. I rely on Tracy (2010) to ensure that the study adheres to rigorous quality measurements. More on how I ensured good qualitative research can be found in reflections in the last section of this chapter.

In the following subsections, I explain the methodological choices I have made before, during, and after conducting my explorative case study. These choices and actions are organized under and follow Eisenhardt's eight steps. In Table 3.3 below, I outline each of Eisenhardt's (1989) original eight steps and describe briefly how I have used them in my study.

Table 3.3 Adapted from Eisenhardt (1988) and Eisenhardt & Graebner (2007): Going from cases to building theory

Step	**Activities suggested** (by Eisenhardt 1989)	**What I did**	**Reason given** (by Eisenhardt 1989)
(1) Getting Started	Definition of overarching research question and getting oriented in the literature on the subject	I defined my initial research question and started to read commercialization literature in general as well as some policy documents.	To focus the efforts and ground the constructs.
(2) Selecting Cases	Known population, theoretical sampling	As the population is known, I made a decision to contact innovation managers at three universities in the large research-intensive category and, for reliability, managers in one of the small education-intensive category of universities. This categorization is based on Ljungberg, Johansson, and McKelvey's (2009) differentiation of Swedish universities by research or education orientation and size.	Increases external validity and limits exogenous variation.
(3) Crafting Instruments and Protocols	Initial literature review before devising an interview guide	I did an initial (structured) literature review of more specific technology transfer and commercialization literature.	Triangulation of findings extends grounding of theory.
(4) Entering the Field	Semi-structured interviews, taking field notes, and collecting overlapping data	I conducted semi-structured interviews with innovation managers and collected governmental reports as well as official material suggested by the interviewees.	Enables investigator to get hold of material otherwise overlooked and allows flexibility in collecting evidence.
(5) Analyzing Data	Within and between cases to search for patterns and comparisons to policy documents	I searched within and between cases to identify patterns and made comparisons to governmental reports.	Gives familiarization of transcriptions. Gives insights into larger patterns.
(6) Shaping Hypotheses	Tabulation of intra- and inter-case evidence for each construct Replication and "why" logic utilized	I tabulated evidence of interviews with managers in the same organization as well as, and more importantly, between university incubators for each construct. Replication of this process and I used "why" logic.	Increases validity, measurability, and construct definition. Confirms theory and extends it. Adds to internal validity.
(7) Enfolding Literature	Specific literature on the studied subject (conflicting/similar)	At this stage I did a very specific (structured) literature review on Bayh-Dole regimes, changes from inventor to university ownership regimes, and the function of TTOs as well as on Swedish commercialization.	Similar and conflicting literature raises theoretical level and increases generalizability.
(8) Reaching Closure	"Theoretical saturation"	As I conducted the last couple of interviews and transcribed them, few new insights and or facts were added to my understanding of the subject.	Marginal improvements mark the end of the process.

Table 3.3 corresponds to the following subsections, where each step is discussed, and explained in greater detail, in relation to my PhD thesis.

3.2.1 Step 1 - Getting started

I conducted an initial literature review of university incubators in the Swedish context, and of commercialization of research more generally in order to familiarize myself with the subject. Reading key papers on university incubators and commercialization gave me a better understanding of functions and processes that the interviewees were subject to as well as an overview of some of the key research issues in the literature.

I also searched for, and read, governmental information on innovation policy and similar broader topics and retained that information before conducting the interviews. This gave me an initial understanding of the empirical context, including the institutional regime and university incubators. (Chapter 4 deals with the policy side of the second research objective stated above.)

3.2.2 Step 2 - Selecting cases

As the population of universities and their holding companies, innovation offices, and university incubators (the organizations that help with commercialization) is known, I assessed which universities would be theoretically important to analyze, and those are the ones I visited to interview. More types of innovation organizations than those associated with universities support entrepreneurship in Sweden. However, those associated with a university allow me to get insight into how the incubation process would function in the particular institutional regime of Sweden that affects researchers and universities. I based the selection of the four Swedish universities on a categorization of universities in Sweden done by Ljungberg, Johansson, and McKelvey (2009). Three of these universities are large research and teaching-intensive universities. This implies that a lot of research is ongoing that could lead to a good supply of researcher-based projects flowing to the university incubators.

The one university not in this category (as categorized by Ljungberg et al., 2009) was chosen with a view to making sure not to miss important aspects. However, this one university shows a low dependence on education and relatively high industry funding of its research. This aspect made it an interesting case, as industry funding of research ought to lead to interesting outcomes and perhaps influence the kinds of researcher ideas that the incubator and innovation office would receive and support. Table 3.4 below describes some aspects of these universities using data from Swedish Higher Education Authority (UKÄ).

Table 3.4 Descriptive statistics on the chosen universities (descriptive statistics from UKÄ 2020) and categorizations by Ljungberg et al. (2009)

University	University employees	Students	Approximative age of university	Research and teaching intensive	Education dependent	Industry funding
University A	<5.000	<10.000	50 years	No	Yes	High
University B	<5.000	>20.000	50 years	Yes	No	Medium
University C	>5.000	>30.000	100+ years	Yes	No	High
University D	<5.000	>10.000	150+ years	Yes	No	High

In Table 3.4, the two most important factors for choosing which universities to approach are seen in the figure under the headings "Research and teaching intensive" and "Industry funding."

Of these initial four universities, I was able to conduct interviews at three of them (two large research and teaching intensive and one smaller education dependent one). These three universities consist of two of the largest universities in Sweden (B & C), in terms of both the number of students and staff, as well as one of the few technical universities (A). Although Universities A, B, and C differ in some respects, they also have many similarities, such as that they all offer extensive support for researchers and others to help them commercialize ideas into projects and companies. All three of them also have organized innovation offices, holding companies, and university incubators to facilitate commercialization of university knowledge (as explored in Chapter 4).

In order to connect with innovation managers at the four universities, I contacted CEOs of the university incubators, innovation offices, and holding companies at the universities. Of the four universities, only three of the CEOs responded to my efforts to contact them. I first contacted all using email. However, as I did not get any response from one of the universities, I tried to contact them by phone. I was told that the CEO and their staff did not have time to participate in my study. Including the fourth university would likely have added more insights into how students could be involved in researcher projects, as the university's home page often mentions student involvement as something that is important and special about their incubator. By not being able to interview them, I have missed some of these aspects, however, the focus of this PhD thesis is not on how students help researcher projects. The initial validity / external validity is not affected for the general process, but it is likely that the specific insights into how students can be involved in facilitating firm creation are affected.

The specific approach I used, once the CEOs agreed to be part of my study, was to email them information about my study, including a brief description of the purpose. The CEOs then forwarded this email within their organizations and asked a number of managers/employees whom the CEOs judged to have a good understanding of their process, operations, and function to take part. Using this approach has some upsides and downsides. A downside is that it opens up for potential bias, as the CEOs suggested interviewees. An upside, however, is that it enabled me to have access to persons with deep insight into the phenomenon, who likely were more willing to take the time to answer my questions as it was suggested by their CEO.

Moreover, I held a junior business-coach position during a period (2013-2015) before my PhD studies at one of the university incubators that I visited. This meant that I had some prior familiarity with the empirical context and also with a few of the interviewees. I have reflected about the possible impacts this prior work relationship could have. I believe it allowed the aforementioned interviewees to be more candid with me in that they could provide more detail and accuracy in their answers. To offset any potential biases and add to the reliability of the study, the answers provided by the other university incubators and innovation offices were examined in close relation to the answers provided by those with whom I had a prior work relationship.

3.2.3 Step 3 - Crafting instruments and protocols

At this stage I did a second (this time larger) literature review to build on the first review done to familiarize myself with research in the field generally. The second review added insights into technology transfer offices (TTOs) and university incubators more specifically rather than on the general topic of university commercialization (see Appendix A). After this review, I constructed the interview guide (see Appendix B).

Yin (1981) argues that there is a need for a protocol that allows the researcher to keep track and make sure that topics of interest are covered. Charmaz (2006; 2014) points to the importance of having an interview guide as it provides a measure of structure as well as gives the interviewer confidence and makes it easier to focus on what the interviewee is saying instead of coming up with further questions on the spot.

According to Charmaz (2006), the interview guide is supposed to be short and to the point, allowing for elaborated answers. She argues that the previously debated question of whether the interview questions should or should not be based upon literature or personal insights on the subject is less of a debate today. Researchers cannot go into the field without their previous experience and pre-existing theoretical foundations. If they could, it would suggest that researchers can absorb knowledge without unconsciously putting it into context.

The interview guide for this first stage of the study is focused on general questions/topics. These questions are explorative on many areas of interest, and specific, based on:

- Previous experience in different types of organizations that support university/academic entrepreneurship (approx. four years of work experience in the sector)
- Literature on knowledge transfer, university interaction with society, and general evolutionary economics (institutional regimes, organization of universities, selection, adaptation, resilience, etc.)
- Innovation systems (e.g. What constitutes the system? What does the system produce?)

The interview guide consisted of six topics of interest; *the entrepreneurs*; *the process*; *the support system*; *organizational structure*; *data*; and *network*. For exact questions see Appendix B – The interview guide.

3.2.4 Step 4 - Entering the field

During this stage, three Swedish universities (A, B, and C) were visited and investigated using in-depth interviews. These interviews were held with managers and two business coaches holding senior positions at the respective universities' innovation support organizations, such as university incubators, university holding companies, and innovation offices. The managers held different positions at the university-owned support structures, as can be seen in Table 3.5 below. The data collected, from interviews as well as policy documents, forms the basis of my analysis, following the eight steps of Eisenhardt (1989).

Table 3.5 Job role of interviewees

(1) Role of interviewee	University A	University B	University C
CEO	1	2	1
Middle manager (MM)	1	1	1
Business Coach (BC)	0	1	1

The people behind the roles, as seen in Table 3.5, were selected by the CEOs, as previously mentioned, as key people who understood their respective incubation processes and had in-depth knowledge about the subject area. The interviews were held during the period 2015-12-15 to 2016-03-03. Later, I wished to complement the overall understanding and check my findings, so the interview with the policymaker featured in Chapter 5 took place over the phone in the autumn of 2019. This interview functions as a complementary view on a specific topic: the national incubator training program and the development of the incubators from 2005 to 2015. With the interview of the policymaker, the total number of interviews ended at 10. I would definitely argue that this number of interviews gave enough data, together with the policy documents collected, for making a meaningful analysis (described in Step 5). At the studied innovation offices and university incubators there were only a few people with in-depth knowledge about the subject area. As can be seen in Table 3.5, there are also business coaches represented among the interviewees, and they provided insights about the detailed processes they followed. Much of what was said in the last interviews had been said in previous interviews, and they kept getting back to aspects that had been mentioned before to such a degree that I felt confident in beginning to analyze their responses.

During the interviews I was careful about taking field notes as well as recording the interviews to ensure correct transcription. The recordings were made only after having obtained the interviewees' permission. The interviews were conducted in a semi-structured way, with (initially 23) questions organized under six overarching topics (the entrepreneurs, the process, support given, structure, data, network). This approach allowed me to be flexible and to add questions throughout the interview round. According to Charmaz (2006), this approach also allows interviewers to change direction during an interview if they hear something that is previously undiscovered or interesting in some way. She also adds that it accommodates investigation into these new aspects in the coming interviews. If I asked additional questions, they were of a *tell me more*, *do you have an example of that* character, or questions that I thought about during the interview. These questions were then added to my next interview.

Approaching interviewing in a flexible way proved to be an advantage, as the questions became slightly different depending on the interviewee's position in the organizational hierarchy and also on the nature of the organization investigated (i.e. holding company, innovation office, or university incubator). However, the frame of the interviews, the six topics of interest that the questions could be organized under, did not change during the study. All 10 interviews were conducted in Swedish. There is an almost equal distribution of female and male interviewees, described in Table 3.6 below, which resonates well with the specifics of these types of university innovation support structures that in general have about the same proportion of female and male employees (for more details, see incubator-specific descriptive statistics in Chapter 4).

Table 3.6 Interviewee gender distribution

University	**Male**	**Female**
A	1	1
B	2	2
C	2	1

I searched for and read policy documents from the home pages of government agencies and other policy providers to enable analysis of policy alone and policy versus practice (as described in Step 5). Policy documents came from the government, including from the Ministry for Business, Industry and Innovation, VINNOVA, Almi, and Innovationsbron. To find these I visited governmental home pages and used their search function, and I also did general searches using the Google search engine. These documents often cross-referenced each other, which enabled me to find more documents. Additionally, so as not to overlook key documents, I asked for recommendations from senior researchers at our Unit and a few external researchers whom I met with in person or called. This method proved to be important as some of the reports used were hard to find using search engines.

Moreover, after having conducted the interview round I also searched for and collected specific policy documents that the interviewees had referred to (such as inventor ownership, called the teacher's exception in the Swedish book of law).

These documents formed parts of the analysis as described briefly below and in more depth in Appendix C.

3.2.5 Step 5 - Analyzing data

The interviews were first transcribed (in Swedish) and then run through Nvivo software (to be able to handle the amount of text and to keep track of all the codes), where I coded the interviews (in English). The analysis process that followed is summarized in Figure 3.1 below.

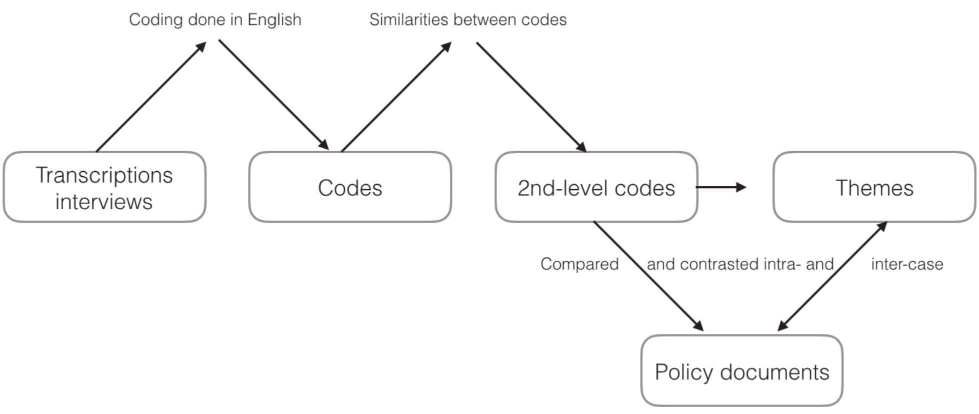

Figure 3.1 Summarized data analysis process

Figure 3.1 summarizes the data analysis process. It shows how I coded my transcriptions of the interviews. These codes were then made into second-order codes and then into meaningful themes. I then used the second-order codes and themes to compare and contrast the interviews in accordance with Eisenhardt's (1989) and Eisenhardt and Graebner's (2007) intra- and cross-case comparison methodology. At this stage I also contrasted the policy documents gathered with the interview themes to notice differences between what was stated and how the organizations worked in practice. This comparison between interviews and policy sources enabled me to analyze goals and practices, first separately and then together. The outcome of this analysis is accounted for in Chapter 4. The whole process of coding and analysis is described in Appendix C.

All the interviews were conducted in Swedish. After all, Swedish was spoken by all interviewees, and it would have caused more issues than added meaning by conducting them in English. According to Tracy (2010), the interview should be held and interpreted in the original language so as not to overlook important features and details. However, after transcribing the interviews, which were all recorded with the permission of the interviewees, all interviews were coded using English, and the coded parts were translated from Swedish into English. As all codes had the same language and the ordering of codes into focus codes and categories was done in the same language, I found it to be easier and more convenient, not least as the language used at our research unit is English. Table 3.7 below summarizes the interviews.

Table 3.7 List of interviews in relation to duration of interview and position in organization

Interview date	Interviewee affiliation	Duration of interview	Type of interview	Position in org.	Organization or unit
15/12 2015	University B Person A	45 min	In-person	CEO	Innovation Office/Holding Company
14/12 2015	University B Person B	1h 38 min	In-person	CEO	University Incubator
14/12 2015	University B Person C	1h 50 min	In-person	Operations Manager	Innovation Office
15/12 2015	University B Person D	1h 3 min	In-person	Middle Manager	University Incubator
2/12 2015	University A Person A	58 min	In-person	CEO	Innovation Office/Holding Company
1/12 2015	University A Person B	1h 10 min	In-person	Middle Manager	Innovation Office
14/3 2016	University C Person A	57 min	In-person	Middle Manager	University Incubator/Holding Company
21/3 2016	University C Person B	47 min	In-person	Business Coach	University Incubator/Holding Company
3/3 2016	University C Person C	47 min	In-person	CEO	Innovation Office
27/2 2019	Policymaker	1h 14 min	Phone	Involved in program + training program	N/A

As can be seen in Table 3.7, the interviews varied in length from 45 minutes to 1 hour and 50 minutes. At the end of these interviews the subject areas in the interview guide had been extensively covered. I am grateful to my interviewees for their gracious allowance of their time and knowledge.

3.2.6 Step 6 - Shaping hypotheses

During this stage I reread the interviews printed out on paper. I then divided the interviews by the previously constructed themes, which allowed me to ensure that I did not miss anything. I also added two new themes that emerged during this process.

Here, I also noticed a few interesting aspects of the collected data that I wanted to confirm on a larger, more complete, set of incubators (and their projects/firms): (1) the dynamics of having many different types of founders in the incubator, and (2) difference between university incubators and other types of incubators present in the Swedish context. These questions were then carried forward to the quantitative studies (see Chapters 6 and 7).

3.2.7 Step 7 - Enfolding literature

At this stage, I did a third, more rigorous, structured literature review, expanding on the previous one (see steps of the structured literature review in Appendix A). In the review, I included more specific key words such as: *Bayh-Dole Act*, *inventor ownership*, *university ownership*, *and technology transfer office*. This was useful for putting the themes in relation to literature. (See Appendix C for more info on the analysis process.)

3.2.8 Step 8 - Reaching closure

In relation to the specific topics that I asked about, at this time my last interviews added only a few new insights of the empirical subject. Much of what was said during those last interviews had already been mentioned before. I could also notice a diminishing return in the case of the literature review at a more general level of overarching mechanisms. Naturally, much more could be learned from the literature about specifics, but the broad strokes in the literature about commercialization of scientific knowledge became clear. Later, when doing literature reviews for the other chapter/studies, I went further into specific literature and was aided by the understanding of the broader mechanisms gained in this review.

However, several of the managers I interviewed highlighted the importance of policy and policymakers, and in particular the national incubator program, for the success of their incubators. In order to gain more insights into the policy side of commercialization, I therefore held one last interview, by telephone, with a policymaker involved in the incubator program. This interview gave a different perspective and proved to be of importance in enabling me to get a better picture of the historical events shaping the incubator program as well as how this was implemented. Although very topical and interesting, the interview with the policymaker is not explored thoroughly in this PhD thesis; rather, it provided me with a historical account of the different phases the incubators involved went through over the years.

3.3 Data and quantitative methods applied

My quantitative study focuses on outcomes from incubation and incubators in a particular institutional regime. I use the following methodology to address the third research objective: *Investigate the early formation of knowledge-intensive entrepreneurial firms by analyzing the differential outcomes of projects and incubators within the national incubator program*, which is reported in Chapters 6 and 7.

This section starts off with a description of the data used for the quantitative chapters (6, 7), and how the data used has been structured and worked with. The section then specifies the methods used in the different chapters. In Chapter 6, survival analysis using Kaplan-Meier, Cox regression, and competing risks regression was utilized on project-level data. In Chapter 7, the unit of analysis is the incubator as an organization, and the number of created firms and the cost of supporting these is first described using descriptive statistics and then used as the dependent variable using simple OLS regression.

Limitations on the availability of data used to be a large obstacle to performing empirical analysis on university incubators and their projects (Zhang, 2008). However, Sweden has a long history of collecting statistics on a governmental level. This enabled me to access data that few previous studies have been able to access. There are additional reasons to conduct the study on Swedish data. The first is what is discussed and analyzed in relation to my qualitative empirical results (see Chapters 4 and 8): inventor ownership, that is, all intellectual property rights stemming from research are allotted to the researchers themselves. The institutional regime makes the setting an excellent study object in and of itself, as discussed in Chapters 1 and 4. The second reason is that a national incubator program has been maintained since 2005, providing governmental funding to university incubators and coincidentally collecting large quantities of data in the process.

Sweden has many incubators founded mainly around the millennium and the following years. During the time period of 2005-2015 studied in this PhD thesis, just under 40,000 proposed ideas were evaluated by the studied Swedish incubators (42 at the end). These incubators were all partly funded by the Swedish Innovation Agency (VINNOVA). Out of the 40,000 ideas, only 38.7% came from the universities themselves and mainly from researchers and students. However, far from all of the evaluated projects and firms get admitted to an incubator, where they would gain different kinds of support. My study concerns the 8.4% (3383) that actually made the cut.

VINNOVA's requirements explicitly state that, for Swedish incubators to be eligible to receive funding from the national incubator program, they must support knowledge-intensive firms. The stated goal of the program is to, "…through high quality incubators, support the development of and value creation in new knowledge intensive growth firms in Sweden" (VINNOVA, 2015). In order to be considered for the funding, the incubator must be: "…aiming for high-tech and research based entrepreneurship [firms] with high growth potential" (VINNOVA Policy VP, 2002:2).

The resulting firms from the incubation process are considered to be knowledge-intensive entrepreneurial firms (KIE firms). University incubators can therefore be seen as one possible origin of such firms. KIE firms are said to have the potential to bring transforming innovations into the market and into our lives, and in so doing, to change the economy (Malerba & McKelvey, 2018). The creation of these types of firms then has to be of societal concern. Time to market is of importance as the cost of producing KIE firms is high. Therefore a duration model is suitable.

3.3.1 Data management

The dataset used in this PhD thesis comes from the Swedish Innovation Agency (VINNOVA). It initially had the appearance of being straightforward and complete, however, after some further examination, two major issues were discovered:

1. The datasets had been artificially balanced to enable time-series analysis, and the end year were used to do a sum up of the results of the funding program.
2. It contained duplicates intermingled with the 4800 projects, which had the following organizational forms: projects, sole trader, limited, two types of unlimited incorporation.

The main dataset that VINNOVA provided contained data on all the incubated firms in the studied time period from the 42 incubators with close connection to a university. This dataset had probably been used by VINNOVA to produce graphs of the changes over time and had therefore been artificially balanced (i.e. all firms and projects were present from the start of the dataset to the end, and no record of entry nor of exit existed). Thankfully, a separate dataset had the exact dates of exit, and the entry dates were taken from admission dates (to the various incubators) in the dataset (I will come back to this aspect later on). This makes sense as the data had been recorded by these incubators and then reported to VINNOVA. As the data had been collected by the incubators themselves, one could question the exact dates of entry and exit and therefore I used some margin of error with a monthly format instead of the exact date in Chapter 6. The database had approximately 4800 firms and projects recorded. I also limited the initial time span to 2005-2015 from the original 1997-2015, excluding the years before 2005, on the grounds that it was outside of the national incubator program funding and that it had almost no recorded projects. I retained the dataset in early 2016, which enabled me to access data up until 2015.

As mentioned above, I used the date of admittance as the starting date for the projects (origin date). This is in part due to the focus of my study, which concerns only the incubation period, and in part due to it being the only recorded date of entry in the dataset. From the funding program's point of view, this date also marks the very start of engagement with these projects. However, there was a problem of left truncation as some of these projects had entry dates earlier than 2005. Left truncation means that they came at risk before coming under observation in the database (Cleves, Gould & Gutierrez, 2008). I dealt with this issue by only keeping projects in the dataset that were admitted from January 2005 forward. There is also a case of right censoring in the sense that projects might still be in incubation at the end of the measuring period, that is, after December 2014. This problem is common in most types of survival studies as we do not observe a study object from its conception up until its demise.

3.3.2 Survival analysis and research method deployed in Chapter 6

I have applied survival analysis, which is a type of regression method. This type of method has a long history with roots in demographics and actuarial sciences and has been used in the medical sciences for a long time. It has also attracted attention, and has been used, in the social sciences (Cleves et al., 2008). Survival analysis is used in our field of innovation and entrepreneurship in many ways. Cefis and Marsili (2006) used survival analysis to measure the effects of firm innovations on survival and found it to have positive effects, conditioned on the firm's size and age; Buenstorf (2007) used it to trace industry evolution over a 40-year period, and Schwartz (2013) used it to measure firm survival after exiting an incubator.

Survival analysis is a powerful tool to use when dealing with time and it gives much greater insights than a standard linear (OLS) regression would produce. There are two main reasons why OLS regression is inappropriate for use on duration data like the data I retained from VINNOVA. Durations of time are not distributed normally and there is an issue of censoring (Cleves et al., 2008). To quote Cleves et al. (2008:2): "the assumed normality of time to an event is unreasonable for many events." They expand their argument by linking it to an event that has "… an instantaneous risk of occurring that is constant over time." This would lead to a distribution that becomes exponential with time, and thus an assumed normal distribution would not suffice.

The different survival analysis regression models can be categorized into three categories: parametric, non-parametric, and semi-parametric models. Parametric models use a predetermined assumed distribution of failure times (Cleves et al., 2008). A non-parametric method, on the other hand, uses no assumed distribution and "lets the data speak for itself" (Cleves et al., 2008). The downside with a non-parametric method is how it deals with censoring and other issues that are unique to survival data. However Kaplan-Meier and other similar non-parametric methods could be applied when the covariates are missing or are discrete, like gender, for example (Cleves et al., 2008). The most commonly used methodology within our field is a blend between these two methodologies called a semi-parametric model (Manjón-Antolín & Arauzo-Carod, 2007). Cox regression, a commonly used semi-parametric method, makes no assumption on the time-dependence of hazard, also called the baseline hazard. However, the functional form of how hazards depend on covariates needs to be specified, which means that the model computes the relative risk associated with the covariates (Cleves et al., 2008).

According to Manjón-Antolín and Arauzo-Carod (2007), Cox regression is by far the most used way of conducting survival analysis on firms. Therefore, I initially assessed the suitability of using Cox regression in my study and whether it could be used in order to answer my research questions. However, after some considerations and a test run using Cox, I realized the presence of competing risks in the data. There were two distinct ways a project could leave the incubator (failure or successfully completing incubation) and there was a large degree of right censoring, that is, projects remaining in the incubators after 2015 where my data ends. Competing risks instead became the method of choice.

Using the competing risks model of Fine and Gray (1999), the projects that remained in the incubator would be censored, just as they would be in a Cox model. However, the competing risks model does not censor projects that encounter the competing risk of failing. Rather, based on cumulative incidence functions, it calculates a proportional hazard model for the subdistribution hazard (Cleves et al., 2008; Gichangi & Vach, 2005). Thereby, the Fine and Gray (1999) competing risks method can predict causes of the two types of, mutually exclusive, events (Cleves et al., 2008; Gichangi & Vach, 2005). Competing risks analyzes subdistribution hazards (Fine and Gray, 1999), that is, projects leave the incubator (EXIT), but the only two ways they can leave are:

1. The project being canceled excludes it from becoming an alumnus.
2. A project being an alumnus excludes it from becoming aborted.

The Fine and Gray (1999) method thus censors the projects that remain in the incubator and does not censor the projects that encounter the competing risk (like a regular Cox regression would). Rather, based on cumulative incidence functions, it calculates a proportional hazard model for the subdistribution hazard. Therefore the dependent variable, or exit variable, is more complex than yes/no. Figure 3.2 below shows the two ways a project may leave the incubator.

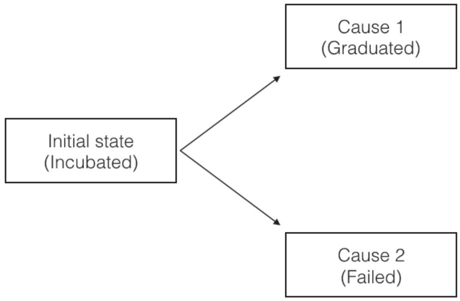

Figure 3.2 Competing risk model applied in PhD thesis, initial state and two mutually exclusive events leading to exit from the incubator

The data I used for this chapter and the next was provided by the Swedish Innovation Agency (VINNOVA). I have data on most Swedish university incubators (n=37) over a 10-year period, 2005-01-01 to 2014-12-31.

The number of participating incubators was 42 at the end of 2014. Five incubators have been removed from the data because

(a) three of them could not be classified as either municipality-owned or university-owned incubators, which I argue are two subcategories of university incubators (see Chapter 4 for the classification).
(b) Two of them participated during a limited period (less than three years) and had a very limited number of projects/created firms.

In Chapter 4, the descriptive statistics are based on 41 incubators, as one of the three incubators included in group (a) above, was an accelerator with a preset incubation time of three months. This affected the average for the whole group in terms of duration of stay or what it is commonly referred to as incubation time. See Table 4.7 in Chapter 4 for an account of the names of the 41 incubators. Chapter 4 includes 41 incubators because that chapter deals with different types of classifications of the included incubators. After Chapter 4, the total number of incubators is 37, due to reasons (a) and (b) set out above.

The databases provided by VINNOVA contained data on incubators and also on their projects. According to the Swedish Agency for Growth Policy Analysis (DNR: 2018:056), these databases account for nearly all Swedish incubators during the studied time period (2005-2014). The agency states that Sweden had roughly 40 incubators in 2014.[2] The data on incubators includes their total costs per year, cost of staff, number of screened ideas, type of ideas, how many business coaches they have, etc. The database on their projects, which is on a project-level, contains

[2] VINNOVA requires applicant incubators to be near a university in order to be eligible for funding from the National Incubator Program.

information about the project's founder, whether it originated in the university, whether it had revenues, etc. All information is either on a monthly or yearly basis for both the incubator and the project databases.

A total of 40,000 ideas were screened by the incubators during this period. Out of these, only 3383 were admitted. If we then look at the different ways projects can leave the incubators we see two main ways of either completing or not completing incubation. There are 1563 projects that completed incubation and 776 projects that were aborted during the period, leaving 1044 right-censored projects remaining in the incubators. Figure 3.3 below shows the different categories of how projects can leave the incubator with the vocabulary of the incubator management (alumni and canceled).

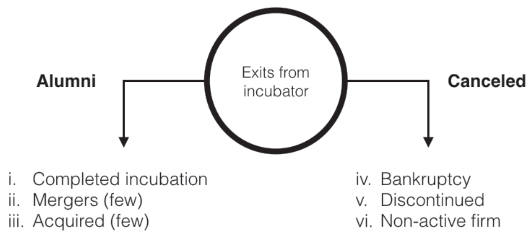

Figure 3.3 Ways for projects to exit incubation

In Figure 3.3, there are three ways projects can become alumni, or complete incubation, and three other ways for projects to leave the incubator that are associated with failure. Below, the specific ways of exiting incubation are elaborated.

i. *Firms that completed incubation:* A firm has successfully gone through all the steps of incubation and moved out. It is now considered an alumnus by incubator management.
ii. *Merged firms:* A project or firm can be merged with another firm. These mergers are few, however. Nonetheless they are considered to have completed incubation.
iii. *Acquired firms:* A project or firm can be acquired by another firm. These acquisitions are few, however. Nonetheless they are considered to have completed incubation.
iv. *Bankrupted firms:* Whether they entered as projects and then became firms or entered as formed firms, there is always the risk of bankruptcy.
v. *Discontinued projects:* Projects can be canceled by the project founders at any time during the incubation process, and it is also likely that incubator management cancels projects. The type of canceling that occurred remains unreported.

vi. *Non-active firms:* This reported status of firms indicates that the firm is inactive at the moment while most probably it will eventually go into bankruptcy. Sometimes, however, this status is changed back to active. These firms have been removed from the analysis.

3.3.3 The dependent variable and Fine & Gray's subdistribution hazard regression model

As the data from VINNOVA contained specific dates on admission and exit from different incubators as well as other information at the project and firm level, a survival methodology could be used. This method also fits well with the data and structure of this data for the following reasons:

i. There is a defined entry to the dataset by admission to the incubator.
ii. There is a defined exit from the dataset by bankruptcy, leaving the incubation process unfinished, graduating, etc.
iii. The dataset has a long time span of the dataset (2005-2014).
iv. The time (t) can be changed to be on a monthly basis as entry and exit are recorded in full-date format.

There are also deficiencies in the reporting on turnover and capital on project level, which makes the dataset ill-suited for any kind of growth study.

Figure 3.4 below outlines how I carried out my analysis of the data.

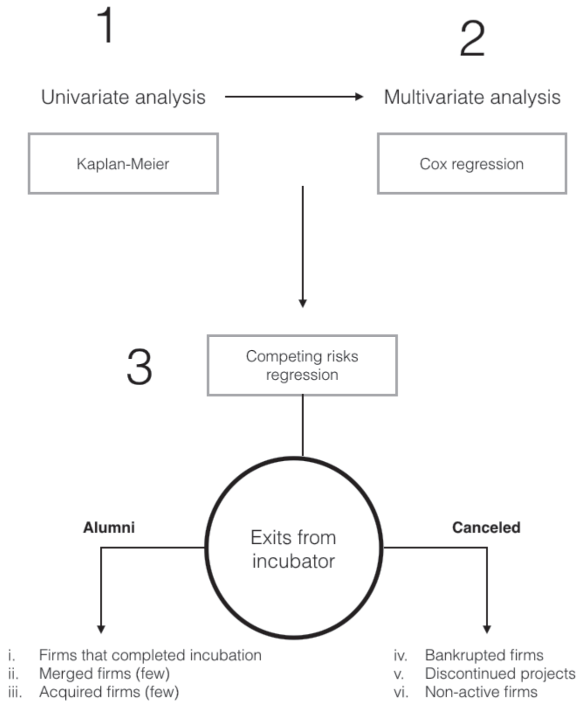

Figure 3.4 Survival analysis strategy used in this chapter

My analysis started with a simple univariate analysis using a Kaplan-Meier survival function to observe what the accumulated probability of completing incubation looked like over time in the raw data. The categorical variable (type of project founder) was then used. However, the Kaplan-Meier function has limitations. For example, you cannot control for more than the (categorical) variable you are looking at; it is a univariate analysis tool (Cleves et al., 2008). The next step, as the survival times of the different categories were more or less proportional and right-censoring present, a Cox regression analysis was tested (Cleves et al., 2008). A Cox regression model of hazard would mathematically be denoted in the following way:

$$h(t|\mathrm{x}_i) = h_0(t)\exp\left(b_1x_1 + b_2x_2 \ldots + b_ix_i\right)$$

Where t stands for survival time and $h(t|\mathrm{x}_i)$ represents the hazard function, which is determined by a set of i covariates ($x_1x_2 \ldots x_i$), the coefficients ($b_1b_2 \ldots b_i$) measure the effect size or impact of the covariates. h_0 denotes the baseline hazard. Baseline hazard is the value of hazard if all of the x_i are equal to zero and can be left unspecified. Hence, the model does not assume "…the hazard over time…//…it is assumed only that, whatever the general shape, it is the same for everyone" (Cleves et al., 2008:131).

However, with the presence of competing risks, a competing risks model (Fine & Gray, 1999) was then applied to predict causes of the two types of (mutually exclusive) events (Cleves et al., 2008; Gichangi & Vach, 2005). It is an analysis of subdistribution hazards (Fine and Gray, 1999). That is, projects leave the incubator (EXIT) but the only two ways projects can leave the incubator are by the project being canceled, which excludes it from becoming an alumnus, and the project being an alumnus, which excludes it from becoming aborted. If 1 stands for the project becoming alumnus and 2 stands for the project being canceled (in the equation below found in the survival function), the Fine and Gray (1999) sub-hazard function for cause 1 would be:

$$\bar{h}_1(t|\mathrm{x}) = \bar{h}_{1,2}(t)\exp(x\beta)$$

As can be seen in the above model, it is analogous to the Cox model. Fine and Gray modified the Cox model of proportionate hazards to include competing risks. Thus, the authors modified the Cox model by retaining the competing risk observations in the risk set, with diminishing weight (Pintilie, 2011). By doing this, the Fine and Gray model can modulate the subdistributions of hazard for events 1 and 2. The proportionate hazard assumption, as assumed in the Cox model, is still valid but for the subdistribution hazards.

In the models of Chapter 6, both types of events (successfully graduating and being canceled) have been run through as both 1 and 2. In order to clarify the results, these are presented in two sections. In Table 6.1, Models 1-4 present the hazard for successfully completing incubation as 1 (in the model above) and being canceled as 2. The opposite is presented in Table 6.1, Models 5-8. The reason for running the models in both these “modes” is that the Fine and Gray (1999) method censors the projects that remain in the incubator and does not censor the projects that encounter the competing risk (like a regular Cox regression would) but rather, based on cumulative incidence functions, calculates a proportional hazard model for the subdistribution hazard. The main issue with the Fine and Gray method, as compared to a cause-specific hazard model, is that it removes projects from the risk set when any type of event occurs (exit 1 or 2) and that this might not coincide with the focal event happening (EXIT) (Allison, 2018). However, in my study, all firms encountering risk event 1 or 2 also leave the incubator, which is the focal event, and therefore this criticism is mute for my study.

The reliability and validity of the competing risks model was assured by the Cox regression (multivariate and semi-parametric analysis) and the Kaplan-Meier (univariate and non-parametric analysis).

A consistency in results, throughout the models, tells us that the right-censoring of projects, that is, those projects that actually remain in the incubator when the study ends, did not affect failure times. The two first analysis tools on their own were unable to tell us if the failure times differed between true right-censored projects, that is, those projects that remained in the incubator at the end of the observation period, and the projects that encountered the competing risk (Cleves et al., 2008). The Fine and Gray model provides information on the ordering of sub-hazards ratios for the two competing events (1 and 2).

Measures

In order to explain and predict exit from the incubator, as measured in a project's probability to complete incubation or not, a number of explanatory variables and controls have been tested. These have been derived from theory, inspired by other similar studies, or have been of the more experimental nature.

Independent variables

At the project level, the *Type of founders* were investigated. In this study, type of founder refers to whether they come from the university (are 1. researchers, 2. students, or 3. technical staff or admin) or from other parts of society (4. independent inventors or 5. corporate spin-offs). These five categories are included in the project founder variable. As the university incubators have received funding from the universities themselves to support their staff and students, they should be prioritized. But all of the 37 studied incubators receive funding from VINNOVA, making them less dependent on the university. The funding from VINNOVA is also conditioned on supporting knowledge-intensive firms with potential to grow (VINNOVA, 2015). This dynamic is interesting to explore. This categorical variable, at the project level, is divided into five categories:

1. *Researchers* conduct research or teach at a Swedish university or research institute.
2. *Students* are admitted to a course or program at a Swedish university.
3. *University staff & related* consists of: technical staff (e.g. laboratory assistants); administrative staff (e.g. part of the business administration or student administration at the university); and non-researchers at research institutes.
4. *Independent inventors* are individuals who are unaffiliated with a company or a university and have ideas they want to develop. Due to the mixture of funding the incubators receive in Sweden, usually a wide variety of project founders are allowed to be admitted for incubation. This allows for independent inventors to be admitted and supported by Swedish incubators.
5. *Corporate spin-offs* are projects founded by another company. Due to the mixture of funding the incubators receive in Sweden, there are usually more types of project founders besides university researchers, students and

university staff allowed to be admitted for incubation. This allows for corporate spin-offs to be admitted and supported by Swedish incubators.

Breadth of admitted projects is a measurement that counts the number of different types of project founders the incubator admits for each month. The highest value is 5 as there is a maximum of five founder types.

Competition at entry measures the number of admitted projects out of the total number of projects applying each month.

Control variables
The variable *Applicants following month* measures the number of applicants that apply to the incubator in the month after the project got accepted. As the distribution is skewed, a logged version is used. There is also a measurement of the relative *public funding* to total costs measurement. This indicates dependence on public funding to account for differences in selection and support along the private-public divide. In Chapter 4, the uncertainty in categorization of incubators into clear categories such as private-public or university-private was initially explored. Although it is difficult to make a clear categorization, this public-private conundrum might still affect later models and is therefore addressed by a variable that indicates how much of the annual cost for incubators is paid for through public funding.

The *age of incubator* measures the experience of the incubator. It seems reasonable to expect that incubators learn over time, and therefore the variable experience as proxied by age of the incubator is included. It is a categorical variable that divides incubators into three equally big groups: old (<1999), middle-aged (1999-2004), and young (>2004). *Share of researcher-based projects* measures how many researcher-based projects the incubator has each month out of the total number of projects. This experimental measurement explores the role of researchers a bit further as compared to the individual projects. Previous studies, looking into incubators, although mostly concerned with post-graduation studies of firms, included *Incubation time* as their most important determinant (see Lasrado et al., 2016). Research into the effect of would-be entrepreneurs being around more experienced entrepreneurs within the confines of an incubator suggests that this helped firm founders to overcome the liability of newness (McAdam & Marlow, 2008). The liability of newness was overcome by being situated and incubated in a credible incubator. This credibility takes time to build. This is included, as in most similar studies, in logged format due to an uneven distribution.

The size of the firm or project would potentially also affect the outcome. It is known from firm survival studies that the size of the firm impacts its hazard (Coad, 2018). However, as these are all new or recently started firms, the revenue or number of employees as such is hardly something that you can proxy size with. Instead, one dummy variable indicating whether the (what is now a) firm has employees, and another variable indicating whether or not it has revenues is used as a proxy for firm size. If the project has access to more people, it will go through incubation faster than if the project only had its founders. If the project has revenues, it is most likely more ready for a life outside the sheltering incubator than if it has no revenues.

Industry, *region*, and *incubator* time-invariant controls are also used. Industry dummies, project level, indicate which of 20 industries the projects would operate within in the marketplace. A region dummies variable indicates where the incubator is located (to account for localization effects and availability of customers, financing, and other resources endogenous to the incubator). The dummies indicate in which of Sweden's 21 regions the incubator is located. For example, biotech projects must take long and arduous journeys before they can deliver a proven product to the market, therefore it is probable that the variation of industry has an effect upon how long this journey is and whether incubation is completed or not. The industry is controlled for by a categorical variable with 20 different reported industries. Incubator dummies are used as a robustness check to see if the other firm-level variables account for the same things. Incubator dummies and region dummies are not used in the same models as they intercorrelate greatly and thus cover much of the same type of unaccounted variance.

Table 3.8 below gives descriptive statistics on the variables used in this first quantitative study.

Table 3.8 Descriptive statistics for Chapter 6

	Variable	**Description**	**N (obs.)**	**mean**	**sd**	**min**	**max**
1	**Graduate**	Dependent variable 2 ways to exit: 1. complete Incubation (graduate) or 2, not complete incubation (canceled)	183,745.00	0.02	0.16	0.00	2.00
2	**Type of project founder**	Researcher-, student-, university staff & related-, Independent inventor-based projects	183,745.00	2.23	1.44	0.00	4.00
3	**Share of researcher-based projects in incubator**	% of researcher-based projects in incubator	183,745.00	0.35	0.26	0.00	1.00
4	**Variety**	Number of categories in incubator	183,745.00	4.30	1.02	0.00	5.00
5	**Competition at entry**	Number of admitted projects of total screened	182,927.00	0.14	1.56	0.00	61.83
6	**Applicants following month (logged)**	Number of screened projects the following month	175,595.00	2.04	0.80	-1.79	4.12
7	**Public funding%**	Share of public funding of total costs	182,489.00	0.82	0.23	0.00	1.78
8	**Age of incubator**	Old (<1999), middle-aged (1999-2004), young (>2004)	183,745.00	1.94	0.84	1.00	3.00
9	**Incubation time (logged)**	Number of months spent in incubation	176,296.00	2.90	0.79	0.00	4.62
10	**Have staff**	Having staff 1, have no staff 0	183,745.00	0.93	0.26	0.00	1.00
11	**Have revenues**	Having revenues 1, have no revenues 0	183,745.00	0.88	0.32	0.00	1.00
12	**Industry**	20 different	183,745.00	10.70	6.55	1.00	20.00
13	**Region**	20 different regions where incubators are located	183,745.00	13.88	7.00	1.00	25.00
14	**Incubator**	37 incubators	183,745.00	23.88	13.17	1.00	37.00

Below. Table 3.9 gives the correlation scores for the variables used. There are a few cases of an intercorrelation above the 30% threshold. Variables 7 and 13, 8 and 14, and 10 and 11 have a score greater than 30%. Variables 8 and 14 are the ones that are decidedly over the threshold. These variables, age of incubator and incubator dummies, are not regressed in the same models, however, as incubator is one of the two fixed-effects variables used and accounts for all firm-level effects.

Table 3.9 Correlation table for Chapter 6 (14 not used in same models as other firm-level controls)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.0000													
2	0.0064	1.0000												
3	-0.0047	-0.2281	1.0000											
4	-0.0075	-0.0213	0.0392	1.0000										
5	-0.0018	0.0162	0.0024	0.0082	1.0000									
6	0.0025	0.0824	-0.0142	0.2831	0.0675	1.0000								
7	-0.0021	0.0591	-0.1370	0.0913	-0.0102	-0.0135	1.0000							
8	0.0063	0.0999	-0.0608	-0.0818	0.0015	-0.1008	-0.0788	1.0000						
9	-0.0200	-0.0892	0.1220	0.0232	-0.0096	0.0368	0.0447	-0.1058	1.0000					
10	-0.0080	0.0132	0.0058	0.0880	-0.0167	0.0051	0.0405	0.0092	-0.0987	1.0000				
11	-0.0350	0.0500	-0.0188	0.0848	-0.0375	0.0358	0.0346	0.0320	-0.1026	0.3463	1.0000			
12	-0.0028	-0.1356	0.0766	0.0065	-0.0103	-0.1052	-0.0554	-0.0421	0.0075	-0.0542	-0.0633	1.0000		
13	-0.0033	0.0467	0.0112	0.0565	-0.0191	-0.0558	0.3660	0.0802	0.1123	-0.0091	0.0085	0.0221	1.0000	
14	-0.0039	-0.0680	0.0559	0.0982	0.0149	0.2615	0.2234	-0.5216	-0.0354	-0.0253	-0.0155	0.0907	-0.0213	1.0000

3.3.4 Research method deployed in Chapter 7

This study uses VINNOVA data on 37 Swedish incubators (21 university incubators and 16 public incubators). The discrepancy in the number of incubators used and the number found in the data material (42) originates in (a) three incubators not being either municipality-owned or university-owned incubators and (b) two incubators having too few observations, that is, they do not appear in the dataset for more than three years and do not help create more than 10 KIE firms. The following three steps were used to prepare the dataset for this study and devise a dependent variable:

The first step was to calculate the number of firms produced per year (the number of firms that graduate), that is, how many of its projects that exited the incubator are still active as firms for each year and incubator.

The second step was to devise the first dependent variable (KIE Cost), which would measure cost per produced firm based on the operational costs of each incubator divided by its number of graduated firms each year. To ensure that year-to-year variations were kept somewhat stable, a three-year average was estimated. The dependent variable thus measured the cost of “producing” one KIE firm for an incubator.

The third step was to regress the dependent (continuous) variable using ordinary least squares regression (OLS). The OLS models were first regressed using ordinary standard errors, but after performing BLUE-post estimations I detected heteroscedasticity. Hence, I reran the models using robust clustered standard errors for Models 1-3 and heteroscedastic robust standard errors for Models 4 and 5 (see more on this issue in Section 3.5). I used the following independent and control variables:

- **Incubator type** (public incubator or university incubator): See Chapter 2 for the theoretical categorization and Chapter 4 for the empirical categorization.
- **Researcher KIE firm share:** Number of produced researcher-based KIE firms divided by all other types produced: students, university employees, independent inventors, and corporate spin-offs.
- **Breadth of projects admitted:** See Chapter 6 for definition and justification.
- **Incubator experience:** (Age: Old (<1999), middle-aged (1999-2004), young (>2004)) See Chapter 6 for definition and justification, and see Section 3.3.2 (above) for definition and justification.
- **Screened ideas** (the number of ideas the incubator selects from each year): See Section 3.3.2 (above) for definition and justification.
- **Projects** (the number of projects in incubation for each incubator and year): The number of projects in the incubator can, for example, be an indication of industries of scale; it affects how many potential KIE firms can feasibly be produced at any time.
- **Business coach share** (the share of business coaches per total staff of each incubator and year): Indicates how many of the incubator staff are dedicated to the actual support of the incumbent projects.
- **Region** (the region in which the incubator is located): See Section 3.3.2 (above) for definition and justification.
- **STEM:** Control for share of produced KIE firms in the following industries: clean tech – energy, clean tech – environment, nanotechnology, space technology, life science – health, life science, life science – medical.
- **Incubator development phase** (different strategies as the incubator generations evolve – group level): See Chapter 5 for more information. It indicates four distinct incubator development phases, described in the interview with a policymaker featured in Chapter 5. Starting with development phase 1 (2000-2005), phase 2 (2006-2010), phase 3 (2010-2012), and phase 4 (2013-onwards).

Table 3.10 below shows descriptive statistics of the variables above.

Table 3.10 Descriptive statistics for Chapter 7

	Variable	Description	N	mean	sd	min	max
1	**KIE Cost**	Incubator operational cost/no of produced firms – 3 year averages (measured in thousand SEK)	311.00	3,319.79	3,606.44	104.17	16,756.33
2	**Incubator type**	(1) public incubator (2) university incubator	311.00	1.59	0.49	1.00	2.00
3	**Researcher KIE firm share**	Share of researcher KIE firms out of total produced KIE firms per incubator and year	311.00	0.19	0.21	0	0.67
4	**Breadth of projects admitted**	Number of types of KIE projects admitted (max 5 types at any time: researchers, students, non-researcher university employees, independent inventors and corporate spin-offs)	311.00	3.97	1.25	0	5
5	**Incubator experience**	Age of incubator (old, middle-aged, and young)	311.00	1.96	0.89	1.00	3.00
6	**Screened ideas**	The number of evaluated ideas per incubator and year	311.00	108.11	105.81	0.00	742.00
7	**Projects**	Projects in incubator for each incubator and year	308.00	19.48	11.41	1.00	69.00
8	**Business coach share**	The number of business coaches over the total number of staff	307.00	0.64	0.20	0.00	1.00
9	**Region**	The region in which the incubator is located (21 Swedish regions, 20 of these have incubators in them)	311.00	12.96	6.70	1.00	25.00
10	**STEM**	Share of produced KIE firms from: clean tech, nanotechnology, space technology, and life science.	309.00	1.52	2.38	0.00	26.00
11	**Industry development phase**	4 phases (2000-2005, 2006-2009, 2010-2012, 2013-present)	311.00	2.81	0.79	2.00	4.00

Below, Table 3.11 displays the correlation scores between the variables used. There is one intercorrelation that is slightly above 30%, that between the variables *projects* and *STEM*. This is because some of the projects in the incubator, at any time, would be of STEM character. However, STEM measures the number of the "produced" firms having STEM characteristics and not how many of the projects residing in the incubator are STEM. Therefore, I do not see this as a problem going forward. Otherwise, the intercorrelations are all below the 30% threshold except the correlation between the dependent variable and all of the independent variables, however, this is only to be expected. If not, the independent variables proposed would not be able to explain changes in the dependent variable.

Table 3.11 Correlation table for Chapter 7

	1	2	3	4	5	6	7	8	9	10	11
1	1										
2	0.343***	1									
3	0.429***	0.172**	1								
4	-0.0537	0.0516	-0.285***	1							
5	-0.324***	-0.0646	0.102	0.0129	1						
6	-0.124*	0.0489	-0.106	0.266***	0.0273	1					
7	0.0890	0.221***	-0.0691	0.211***	-0.106	0.310***	1				
8	-0.154**	-0.0389	-0.101	-0.0200	0.127*	0.0686	-0.0476	1			
9	-0.0352	-0.193***	-0.00472	-0.00727	0.0806	-0.0505	0.212***	-0.0243	1		
10	-0.246***	0.0601	-0.206***	0.133*	-0.0210	0.134*	0.347***	-0.0693	-0.0691	1	
11	-0.120*	-0.0349	-0.129*	0.148**	0.0808	0.0398	0.0647	0.0254	0.0015	0.191***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.4 Limitations in chosen methodology in relation to my research objectives

The limitations of my qualitative study in terms of validity and reliability concern the following:

In Table 3.12 below I describe the eight “big tent” criteria for qualitative research (Tracy, 2010). The text under the table elaborates my thoughts on these criteria in relation to my research.

Table 3.12 Tracy's (2010) Eight big tent criteria and what they mean

Criteria	**What they mean**
Worthy topic	A worthy topic needs to be relevant and timely for the research community or other people who might be affected by the study.
Rich rigor	The study has appropriate and sufficient theoretical constructs, data has been collected in the field, and all other aspects of a good qualitative analysis have been carried out in a sufficient manner.
Sincerity	Self-reflection is used by the author and transparency about how methods are used and potential problems with the execution of that method is explored.
Credibility	The descriptions should be extensive and be of a showing nature rather than of a telling nature.
Resonance	Transferable findings add resonance.
Significant contribution	A significant contribution to research is made in one or several ways, i.e. as a theoretical, practical, or methodological contribution.
Ethics	The researcher should consider ethical aspects, such as procedural ethics in relation to interviewees.
Meaningful coherence	The purpose is fulfilled or the goals set are reached, and there is a fit between the research question and the specific method used.

In Table 3.12, I describe Tracy's (2010) criteria for qualitative research. My qualitative study investigates the process of university incubation in the institutional regime of inventor ownership. This is a topic concerning a way of transferring knowledge to society via firms. Exploring this process and finding potential issues could provide policy and practitioner communities with valuable insights as well as contributing to research on universities and their interactions with society. The process of university incubation in this regime has been a topic of research before, but how researchers are differentiated and managed among other types of founders in an incubator setting has not been a topic to the same degree. This would constitute a *worthy topic* according to (Tracy, 2010), as more insights into this phenomenon would provide the research field as well as practitioners and policymakers with valuable knowledge of the university process of incubation. *Rich rigor* was assured by (1) conducting several interviews at each university, during the fall of 2015 and spring of 2016, and (2) my having some prior experience in the practical field before entering doctoral studies, which added an advantage of orientation in the subject and an ability to understand the difficult processes described. This may also have been a disadvantage, as basic questions could have been overlooked. However, having an interview guide that began with the basics and then progressed helped overcome such inefficiencies and addressed the disadvantage; *sincerity* is therefore of importance. When it comes to *credibility*, I try to convey the story with rich quotes, allowing the interviewees' voices to be heard, representing a lot of different perspectives. The findings in this study have transferability as (1) the interviewees are experts in the field and do relate to other universities during the interviews, and (2) the sampled universities represent a theoretically meaningful sample, selected within a known population. The research conducted should therefore have *resonance.* Coming back to the worthy-topic argument, I believe that this study adds a *significant contribution*. The contribution is discussed in the last chapter of this PhD thesis, but for this study in particular it has to do with uncovering more knowledge about the process of university incubation in inventor ownership regimes. During the interview process, having an *ethical* approach has been key. Not only towards the interviewees, by asking about taping the interview, speaking one-on-one, etc., but also in the resulting transcriptions and the conclusions drawn from the analysis of the same. That my study has *meaningful coherence* is something that has been developed during my PhD process, but the purpose of the study and the research objectives as well as individual research questions have been addressed directly (Tracy, 2010).

The limitations of my quantitative studies in terms of validity and reliability concern the following:

The general limitations relate to selection and are applicable to both quantitative chapters (6 and 7). Namely, do firms and projects that are in these incubators systematically vary from the ones that do not undergo incubation (selection bias)? If there is systematic variation between these two groups, this could entail a so-called Harvard effect. The Harvard effect can be summarized as follows: brilliant students are admitted and therefore brilliant graduates are produced, with unclear treatment effects (James, Alsalam & Conaty, 1989). By this, I mean that it is hard to assess whether some founders are successful because they got support from the incubator or whether they were better than other founders to begin with. The data used in this study is only on projects that have actually been chosen by the incubators, therefore it is hard to know if they systematically vary from the population (of projects) that are not admitted or indeed the population of projects at large. If the admitted projects are intrinsically more adept, more promising, one could imagine them becoming firms and graduating with minimal treatment effect.

To deal with the above issue, I focus on (1) within-group variation of admitted firms and their exit from the incubator and (2) devising a selection-control variable in which a relative proportion of admitted projects to applicant projects is being used. This control variable proxies for how restrictive the admission policies at the individual incubators are. The admitted firms for each year over the number of applicants would proxy this by producing a ratio that indicates how selective each incubator is as well as how much competition the projects are subject to at entry. Judging by the mere 8.4% that actually made it into the incubators, it seems that they are selective and that there is a lot of competition.

In Chapters 6 and 7, other limitations concerning validity and reliability are related more specifically to the individual studies, which are also reported in Chapters 6 and 7.

In the quantitative study in Chapter 6, I analyze differences between different types of projects and their respective hazard of successfully completing incubation with the competing risk of failing. The reliability and validity of the competing risks model were assured by the Cox regression (multivariate and semi-parametric analysis) and the Kaplan-Meier (univariate and non-parametric analysis). Consistency in results throughout the models tells us that the right-censoring of projects (i.e. those projects that actually remain in the incubator when the study ends) did not affect failure times. As mentioned earlier, the two first analysis tools on their own were unable to tell us if the failure times differed between true right-censored projects, that is, those projects that remained in the incubator at the end of the observation period, and the projects that encountered the competing risk (Cleves et al., 2008).

In the quantitative study in Chapter 7, incubator performance differences are analyzed on the identified subsets of university incubators: university owned- and municipality-owned incubators (see Chapter 4 for the identification of these two subcategories of university incubators). I address incubator efficiency while recognizing that incubator performance can be studied with a great many criteria and measurements. I used the cost of supporting projects that end up as firms as my measurement of efficiency. The first limitation of this study relates to the many ways to measure incubator performance, namely that the ability of firms that are supported to become firms at the end of the incubation process is not studied. The second limitation relates to the quality of the firms that leave the incubator; there is no way of accurately assessing their quality as I do not compare them with non-incubated firms on the dimensions of revenues, growth and such. Previous research provides varying results on the survival of firms supported by university incubators. Lasrado et al. (2016) suggest that they survive to a larger degree than matched non-incubated firms, while Schwartz (2013) cannot find any significant differences in survivability. If a firm survives, it is able to contribute to economic growth by generating income and providing a product or service to the society.

The third major limitation, related to human capital, I address empirically. No human behavior is recorded in the data that I had access to. Therefore, I devised a human capital quality measure with the salary per employee, but it was found to have no effect and was therefore left out of the final models due to intercorrelation with the other human capital measurement I used, number of coaches per employees. I also addressed the issue of a lack of observations of actual human behavior. I did this by creating a proxy for their shared methodological knowledge in the form of VINNOVA's training program (more on the training program is found in Chapter 4). The constructed proxy measurement for this shared methodological knowledge was found to have significant effects on the efficiency aspect of incubator performance.

Finally, I ensure validity and reliability in OLS models by initially comparing results to descriptive results to ensure consistency. Further, the R_2 measurement indicates the part of the variation in the dependent variable explained by the independent variables (Albright, Winston & Zappe, 2006). As the models became more advanced, the R_2 increased from an initial 0.14 in Model 1 to 0.59 in the last model, Model 5. This indicates that a substantial share of the variance is explained by my models. All models had significance on the model level.

Further, using a Breusch-Pagan/Cook-Weisberg test to test for potential heteroscedasticity in residuals, I came up with significant results, suggesting the presence of heteroscedasticity. The distribution of the dependent variable KIE cost is somewhat left-skewed but otherwise normally distributed and therefore a logged dependent was also tried, but with similar results. To further address the question of heteroscedasticity, an additional robust model was tried. The robust standard errors model was clustered on the incubator variable following Cameron and Miller (2015). This way, the dependent variable is still interpretable and the efficiency issue is addressed. The results from this model were consistent with the other results but with greater standard error and in some cases lower significance levels. Other BLUE (OLS) tests came back insignificant. I only report models with robust standard errors clustered on the incubator variable and heteroscedastic robust standard errors with fixed effects.

Using a mixed-methods approach allowed me to gain empirical insights that could be used together with hypotheses based on theoretical deliberations in the later quantitative investigation, as explained below. After conducting the qualitative investigation using interviews and policy documents, I found interesting results from the perspective of the incubator management regarding the special role of researchers. Innovation managers' perception of researchers was that researchers had great ideas with big potential to make an impact in the market but also had difficulties, for a number of reasons discussed and analyzed in Chapter 5, with actually starting firms based on their ideas with the help of the incubator. The analysis of this issue leads me to uncover five strategies that innovation managers use to mitigate these difficulties. In finding this result, I also further read the literature around this, which suggested that researchers are a different category of founders entirely. To follow up on this, both what came up empirically and what the literature suggested, I further quantitatively compared and contrasted researchers to other founder groups within the specific incubator type of university incubator. The data used in Chapters 6 and 7 comes from VINNOVA and is data from their national incubator program during the time period 2005-2014.

4. Empirical context: Institutional regime as why commercialization is done differently in Sweden

This chapter contextualizes how research is commercialized with the help of incubators in Sweden. The empirical context is relevant in order to explain the institutional regime as the reason why commercialization is done differently in Sweden.

In the first section (Section 4.1), I use extant research to establish that, and explain how, the institutional regime in Sweden differs from other national contexts and why it may matter to university incubators. In Section 4.2, I use different empirical sources to set the empirical context. I provide an overview of a subset of the Swedish innovation system related to commercialization of research, and describe the relation between what the university incubator does and what policy states. In Section 4.3, with the use of VINNOVA's national incubator program database, I set the empirical context and demonstrate that there is much activity and many ideas supported by university incubators in Sweden. I also find a diversity of incubator and founder types inside university incubators. I thereafter define the founder types.

4.1 Institutional regimes

This section discusses the institutional regimes relevant for commercialization of research results. It provides an overview of how researcher IP is allocated in the US and most of Europe, and how it is allocated in Sweden. It begins with the discussion found in the introduction about the generic model, that is, university ownership, and its roots in the Bayh-Dole Act of 1980 in the United States. It then goes into how European countries emulated this type of legislation and the consequences of doing so. This end ups with how researcher IP is allocated in Sweden. University ownership refers to when the university is responsible for, and potentially profits from, commercializing research results obtained by its researchers.

Government ownership refers to when the government is responsible for, and potentially profits from, commercializing research results (Von Proff et al., 2012).

Inventor ownership refers to when the individual researcher doing the research, him- or herself is responsible for, and potentially profits from, commercializing research results (Kenney & Patton, 2011).

Institutional regimes matter for incubation processes based upon research results. See Chapter 1, Section 1.2, for details on how it matters.

4.1.1 Institutional regime of university ownership

Many Western European countries have, since the Bayh-Dole Act of 1980, followed suit and introduced university ownership laws similar to this act. A crucial difference is that they often changed to university ownership from individual ownership, and not from government ownership as in the US (Von Proff et al., 2012). In Figure 4.1 below, Sweden is seen as the constant in the left corner, remaining with individual ownership, while Germany changed from inventor to university ownership.

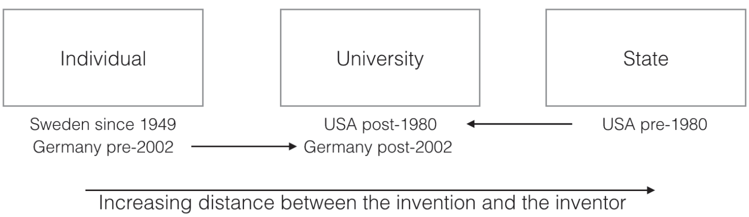

Figure 4.1 Positioning Swedish legislation on distance between invention and inventor (adapted from Von Proff et al., 2012)

This increases the distance between invention and inventor. This is a factor that Von Proff et al. (2012) use to explain the negative to non-existent effects of that change as compared to the change in the US. In the US, the distance between invention and inventor diminished instead, and the consequences are seen as positive. This detail has been of interest and is offered as an explanation for the non-existent increase in patent output after the IP regimes in Germany were changed to university ownership (Von Proff et al., 2012; Czarnitzki et al., 2016). Indeed, the *Knowledge Creates Markets* reform in Germany, introducing university ownership, seems to have had interesting effects. It resulted in a shift in ownership, not unexpectedly, from individual researchers to firms and to a lesser degree to universities (Von Proff et al., 2012; Czarnitzki et al., 2016). However, co-patenting with industry decreased (Czarnitzki et al., 2016). Czarnitzki et al. (2015) conclude that a decrease in university patenting was evident after the 2002 reform. Findings from the first Italian reform introducing university ownership indicate the same effects, and the reform did little to increase the total amount of patents taken (Baldini et al., 2006).

Before the Bayh-Dole Act (henceforth the Act) of 1980, the government, or rather the public agency that funded the university, was the owner of the intellectual property. Von Proff et al. (2012) argue that the following reform brought the IP closer to its inventor, which could help to explain the (debated) effects of the Act. Both before and after the Act, the main way universities have disseminated knowledge has been through their graduates, and commercialization can be considered a complementary way of doing this (Henderson & Trajtenberg, 1998). Henderson et al. (1998) conclude that the Act did increase the rate and extent of patenting and licensing at universities but did not increase the number of commercially viable inventions. According to Mowery et al. (2001), three earlier developments were important, perhaps even more important than the Act itself, for the growth of patenting in the 1980s and onwards:

1. The research composition at universities changed.
2. It became easier to patent in the biomedical field.
3. The government made better international protection possible.

These developments had little to do with the Act according to Mowery et al. (2001), who suggested that an increase in patenting would have happened even without the Act. However, the Act did make universities interested in patenting and licensing.

However, after a tough decade with internal turmoil for the United States, the Patent and Trademark Act, more popularly called the Bayh-Dole Act of 1980, has been hailed, in retrospect, as a great success and one of the key ingredients for the rapid technological development that occurred during the following decades (see e.g. The Economist, 2002 and 2005).

> Overnight, universities across America became hotbeds of innovation, as entrepreneurial professors took their inventions (and graduate students) off campus to set up companies of their own (…). A goose that lays such golden eggs needs nurturing, protecting and even cloning, not plucking for the pot. (*Innovation's golden goose - The Economist, 12/14/2002)*

The Act gave IP rights over patentable results from government-financed research to the university and not the government, as had been the case before 1980 (Mowery, 2001). Issues with the university ownership system have been raised by, for example, Kenney and Patton (2011). They argue that, besides the reporting issue outlined in the previous section, faculty members have ways to work around the system if they so choose and that this is a major problem with university ownership. In earlier research by the same authors, they outline two alternatives to university ownership, namely inventor ownership or having all researcher IP publicly available through an open source solution (Kenney & Patton, 2009).

The virtues of university ownership as compared to, in this case, government ownership, might be substantial, at least to some extent. But, and this is important, in many European countries, the shift to the institutional regime of university ownership is in fact the transition from inventor to university ownership. The effects of these transitions have been studied, and some studies suggest that the only effect is a shift in the ownership of academic patents away from individual researchers to universities themselves and not the intended increase in academic patenting (Baldini et al., 2006). Other studies even find a slight decrease in the total amount of academic patents since the reform (Czarnitzki et al., 2016). Most of these studies have had patents as the measuring device of knowledge transfer. A few exceptions need to be recognized (e.g. Kenney & Patton, 2011).

Using patents as a measuring device makes sense, as patents are a good way to package technology in order for it to be sold (i.e. transferred). And yes, this could prove to be a good measuring method under inventor ownership as well, as pioneered by Lissoni et al. (2008). They focused on inventor and not assignee names. The findings and subsequent studies based on them concluded that academic patenting was as common in Europe as in the US. These findings contradict the so-called European Paradox, which states that the amount spent on research does not yield the same patent output as in the US after the Act (Link, Siegel & Wright, 2014). There is even evidence that the number of academic patents owned by companies is higher in Sweden, France, and Italy than in the US, indicating a successfully executed third mission (Lissoni et al., 2008). This also suggests that other channels besides licensing are perhaps more important to achieving commercialization, building on the reasoning of Mowery and Sampat (2004).

Under inventor ownership, the individual has all the rights to any commercial research results, and thus knowledge transfer becomes different from that in a university ownership context. Arguably, under the American Bayh-Dole Act, researchers can “buy/or license the technology back” for a fee and start a business based on the result from their research, what are usually referred to as academic spin-offs (Link et al., 2014). Under inventor ownership, researchers could simply start their own business and use the findings from their research directly without the consent of the university or the liability of a license agreement, however generous that agreement is.

Kenney and Patton (2011), doing a six-university comparison with both inventor and university ownership universities in North America, found the inventor ownership university, University of Waterloo (in Canada), to be more efficient in producing spin-offs both in terms of per dollar and per faculty than the other university ownership universities. They even suggest that governments should try inventor ownership models instead (Kenney & Patton, 2009; Grimaldi et al. 2011; Kenney & Patton, 2011). In an earlier study, Mowery et al. (2001) found that three other reasons could be the real catalysts as to why, after the 1980 Bayh-Dole Act, the US underwent such phenomenal development. They argue that it was mainly due to changes in legislation on intellectual property rights (IPR), both nationally and internationally, and a shift in the research composition at US universities (Mowery et al., 2001).

Research conducted on the change of regime from inventor ownership to university ownership in the Nordic countries has indicated negative effects of the change. In Denmark, which had similar inventor ownership legislation, university ownership was introduced in 2000. The results of this have been studied by Lissoni et al. (2009), who conclude that there is no evidence of an increase of patenting, only a shift in the ownership in Denmark. In 2007, Finland, the eastern neighbor of Sweden, also changed their legislation to university ownership from inventor ownership, with negative consequences on the level of researcher patenting (Ejermo & Toivanen, 2018). This change was predated by an announcement in 2004 allowing for universities and researchers to prepare for the coming change from inventor ownership. Ejermo and Toivanen (2018), using individual-level patent data, like most other similar studies, conclude that despite this adjustment period the result of the change was negative on researcher patenting, which declined by 46%. However, Hvide and Jones' (2018) study of the effects of the change in Norway found a -50% change in patenting and entrepreneurship activity. Further, they assessed that the quality of said patents and new firms declined as well. The effects and studies are summarized in Table 4.1 below.

Table 4.1 Effects on changing to university ownership

Country	Ownership going from	Ownership going to	Patent output change	Faculty – industry Co-patenting change	Academic entrepreneurship change	References
USA	Government	University	Positive	N/A	N/A	(Mowery & Sampat, 2004; Kenney & Patton, 2009)
Germany	Inventor	University	Neutral, shift in ownership/ negative	Decrease	N/A	(Czarnitzki et al., 2016; Von Proff et al., 2012; Czarnitzki et al., 2015;)
Italy	Inventor	University	Neutral, shift in ownership	N/A	N/A	(Baldini et al., 2006)
Denmark	Inventor	University	Neutral, shift in ownership	N/A	N/A	(Lissoni et al., 2009)
Finland	Inventor	University	Negative	N/A	N/A	(Ejermo & Toivanen, 2018;
Norway	Inventor	University	V. negative	N/A	V. negative	Hvide & Jones 2018)

The Bayh-Doyle Act of 1980 in the United States was introduced to increase knowledge transfer from the universities to society, making the university the owner of all intellectual property from its researchers and staff, and was mostly successful in its mission (Wennberg et al., 2011). However, in the US, the predecessor to university ownership was government – not inventor – ownership. With the Act came the technology transfer offices (TTOs) that would facilitate this commercialization process.

4.1.2 Inventor ownership in Sweden

The institutional regime in Sweden is inventor ownership. Hence, in the Swedish setting it is quite the opposite of the above institutional regimes, with individual researchers being the sole owners of their own intellectual property. This law was implemented in 1949 and more specifically said that individual researchers own the rights to their research and any potential output in the form of patents or/and ideas that could be sold or otherwise commercialized (Swedish book of Law, LOU 1 § 2 paragraph (1949:345)). This regulation has remained largely unchanged, although later regulations have reflected the two sides of this issue (SOU 2005:95):

1. Inventor ownership might be a hurdle for alternative commercialization.
2. If inventor ownership were to be changed into university ownership, the freedom of the researcher might be lost.

Ways of dealing with what is perceived as the negative side of the teachers' exception are on their way to being implemented in certain university holding companies; this will be discussed further in Chapter 5. In the Swedish setting, innovation offices would be the equivalent of TTOs. They were introduced rather recently, described in Section 4.2.3, with much the same functions in mind as TTOs. These innovation offices offer different kinds of support for the researchers, staff, and students of the university and thus the notion that the sole responsibility for commercializing research results falls on the individual researcher and not the university, as argued by Ollila and Williams-Middleton (2011), would benefit from being nuanced.

Ever since the introduction of the 1949 law, Sweden has been maintaining inventor ownership. This suggests that Sweden may be a counterfactual study object, such as the one Mowery et al. (2001) called for. In a 2003 study, Goldfarb and Henrekson argue that there is an "impression" of less commercialization activity going on in Sweden as compared to the US; at the same time, they argue that there is no empirical data that could be used to prove this claim. Moreover, they theorize that this is due to two factors, namely the academic culture in Sweden and Swedish policies. In the US, they continue, the competition between universities has created a sort of academic freedom of involvement in new firms and interaction with industry (Goldfarb & Henrekson, 2003). Later studies have since shown no difference in commercialization activity, as measured by academic patenting activity and compared between the two countries. If academic patenting activity is instead measured on the individual level, the academic patent output as share of total patenting in Sweden not only compares to the US, but exceeds it (Ljungberg et al., 2013; Lissoni et al., 2008). Lissoni et al. (2008) also suggest that the perceived gap in university patenting between Europe and the United States is largely overstated.

This warrants my interest in looking into the particular case of university commercialization leading to new KIE firms in Sweden, assessed as the innovation leader in the European Union 2017, and one of only a few remaining inventor ownership-countries in Europe.

According to the *right to employees' patentable inventions*, the Swedish 1949 law, employees have, in general, the same rights as any inventor. However if the employee is involved in research and/or development as a job assignment, all IP rights go to the employer. If the invention is in line with the employer's business, the employer has the right to be informed and to buy the IP at a reasonable price. However, for teachers there is an exception. They own the rights to their own patentable inventions. There is, however, no definition of teacher in the law text, making it a question of definition. Most universities have interpreted it as covering all staff at the university. Another strong praxis is that any teaching material that the teacher produces belongs to the teacher. With these two exceptions, teachers in Sweden have the freedom to commercialize by themselves and have advantages in mobility by being able to bring any teaching material with them to their next job.

4.1.3 National policy goals, VINNOVA's incubator program and a policymaker's views on the program

VINNOVA, the Swedish Innovation Agency, provides a large share of the financing for university incubators through a large project named the national incubator program. Financing of university incubators through this program can be approved for four years at a time.

As stated in the requirements to be eligible for financing, incubators should be: "Aiming for high-tech and research based entrepreneurship with high growth potential" (VINNOVA Policy VP, 2002:2). The incubator also needs to be located near a university and the financing from the program can at most cover 50% of the overall costs for the incubator (VINNOVA Policy VP, 2002:2). Later evaluation reports from VINNOVA highlight the purpose of the government mission to VINNOVA – to support incubation: "The purpose for the government incubation support is to, through high quality incubators, support the development of and value creation in new knowledge-intensive growth firms in Sweden" (VINNOVA, 2015). Figure 4.2 below illustrates the connection between policy goals, whom they concern, and the desired outcome of this policy.

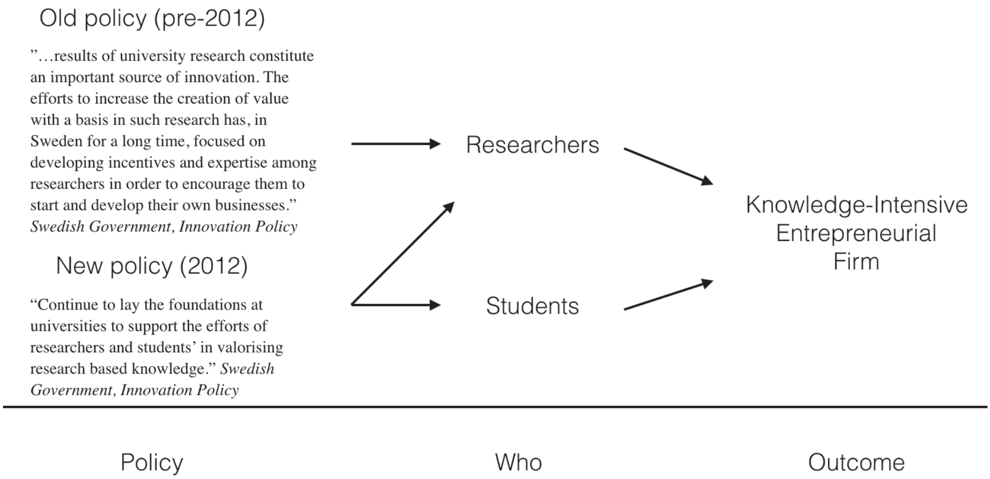

Figure 4.2 National innovation policy in Sweden and outcome of the same

As can be seen in Figure 4.2, in recent years the national innovation strategy outlined by the government of Sweden has added students as an important way to commercialize knowledge from universities. The shift to include students as important potential entrepreneurs in a university setting was made in 2012. It came with the new national innovation policy implemented by the center-right government that took office in 2006, in the first term (i.e. Alliansregeringen). In this strategy, the role of the innovation offices is highlighted as a bridge between universities and society.

Concurrently with the national incubator program, a national training program for incubator coaches has been in operation since 2012. However, testing and evaluating of the incubators started earlier, in 2008. Table 4.2 below outlines the program in contrast to certain development phases that the Swedish incubators have undergone, according to the policymaker I interviewed in 2019. The policymaker described the program and the general offerings of incubators as developing concurrently. Below, the four development phases that Swedish incubators have gone through are contrasted with the training program. At the end of 2013, 190 incubator employees had undergone training. The training consisted of training in the *five disciplines of innovation* methodology developed by the Stanford Research Institute (SRI). This is a customer/market-needs-driven methodology that has its origin in the turnaround of then near-bankrupt SRI (Denning, 2017). According to Denning (2017), in 1998, the new CEO, Curt Carlsson, started to develop a new innovation methodology which led to a turnaround for the company and such successes as Apple's Siri.

Table 4.2 VINNOVA training program for incubator employees and the evolution of Sweden's incubators, based on interview with a policymaker (involved in the incubator program as well as the training program)

Industry development phase	Incubator offering	Logics	VINNOVA training program	Timeline
I	• Office space • Heterodox solutions of support for projects at each incubator	"Putting promising projects together, it works in Silicon Valley"	No	2000-2005
II	• Office space • Linear modular support phases	"Enter in one end and exit through another" support given to projects based on the convenience of the incubator	(2008) training for business coaches for a more business-oriented coaching began	2006-2010
III	• Office space • Non-linear flexible modular support phases	VINNOVA vision of incubators taking on the role of "Pichler, the ski-trainer who ran beside his disciple into success"	2012 actual program began, 4 times a year (3 in Sweden, 1 in Silicon Valley); Cost of program circa 1 million SEK/year	2010-2012
IV	• Office space • Non-linear flexible modular support phases • Needs of the projects first	Vide adoption of value-creation thinking	In total, 190 incubator employees trained	2013-*onwards*

However, the national innovation strategy does not focus solely on academic entrepreneurship but also on collaborative research and similar forms of academic engagement. The strategy is seen as a policy instrument through the funding of many of the university incubators via the national incubator program. The key aspect of collaborative research is also visible as a focus in the national innovation strategy in 2012:

> [The goal is to] Continue to develop incentives and structures for collaboration between universities and the surrounding society, including long-term collaboration with a view to developing knowledge and solutions to address societal challenges as well as key enabling technologies with wide applications in many areas of society. (*Swedish Government, National Innovation Policy, 2012*)

Policy conclusions

Both the government, through the Swedish Innovation Agency, and the universities, by operating the innovation offices and university incubators, have increased availability of support for faculty members and students wanting to develop an idea or research result into a KIE firm. Results presented in this chapter suggest that these efforts have been successful. Further studies on the actual output and performance of the mechanism are of course essential.

Policymakers in Sweden have not been passive in relation to the international discussion on institutional regime change that has been ongoing since the Bayh-Dole Act of 1980. Sweden did not alter its policy of inventor ownership like her neighboring countries, although there were discussions, and a report was produced (SOU2005). Rather, Swedish policymakers have financed, and encouraged, universities to carry out commercialization activities and support their researchers and students in these types of activities.

According to the innovation managers at the studied universities, the universities themselves have been active in establishing a well-functioning support mechanism for their researchers, employees, students, and even those not associated with the university.

4.1.4 In summary

In summary, due to Sweden having the inventor ownership institutional regime, (1) the individual researcher is important. (2) The policy goal with incubation is to create knowledge-intensive entrepreneurial firms.

4.2 How universities are organized to facilitate incubation processes

This section gives an overview of Swedish universities and university colleges in order to provide context for the qualitative case study. Moreover, in this section, I specify the main organizations associated with the incubation processes. The section aims at showing the presence of infrastructure that facilitates incubation processes at most Swedish universities while highlighting the commonalities, in this respect, in how countries using the generic model of allocating researcher IPR (university ownership) facilitate university commercialization.

4.2.1 Universities and university colleges in Sweden

Universities in Europe operate in a fairly regulated sector closely connected to government funding and public policy decisions (Ljungberg et al., 2009). According to Ljungberg et al. (2009), government spending still accounts for most research-linked income in the European context, but a shift can be observed with an increase of external funding. Sweden has 16 universities and 14 university colleges. The difference between these two types of universities in Sweden is that, historically, a university college has been an institution for higher learning similar to a university but without the right to graduate doctoral students. However, this distinction has changed and many university colleges can now graduate doctoral students. Today the main difference can be found in the right to receive direct government funding for research (Swedish Higher Education Authorities, 2016). Below is a table of all higher education institutions (HEI) in Sweden. The artistic university colleges and other private HEIs are also included in this list but do not have access to university holding companies, which are key in offering innovation support. They are thus left out of this PhD thesis. With regard to the small difference between universities and university colleges, it makes sense to include both under the umbrella term "university." Table 4.3 below summarizes the university landscape of Sweden.

Table 4.3 Universities, university colleges, artistic university colleges, and other private HEIs in Sweden (Swedish Higher Education Authorities, 2016)

	Universities	**University colleges**	**Artistic university colleges**	**Other private HEIs in Sweden**
1	Chalmers University of Technology	Blekinge Institute of Technology	Beckmans College of Design	University College of Music Education in Stockholm
2	University of Gothenburg	Swedish Defence University	University College of Arts, Crafts and Design (Konstfack)	The Red Cross University College
3	Stockholm School of Economics	The Swedish School of Sport and Health Sciences	Royal Institute of Art	Sophiahemmet University
4	Karlstad University	Dalarna University College	Royal College of Music in Stockholm	The Newman Institute University College
5	Karolinska Institute	University of Borås		Gammelkroppa skogsskola
6	Royal Institute of Technology	University of Gävle		Högskolan Evidens
7	Linköping University	Halmstad University College		Skandinaviens Akademi för Psykoterapiutveckling
8	Linné University	Skövde University College		Johannelund Theological Seminary
9	Luleå University of Technology	Kristianstad University College		Svenska institutet för kognitiv psykoterapi
10	Lund University	Väst University College		Ersta Sköndal University College
11	Mid Sweden University	Jönköping University		The Erica Foundation
12	Stockholm University	Malmö University College		Stockholm School of Theology
13	Swedish University of Agriculture	Mälardalens University College		
14	Umeå University	Södertörn University		
15	Uppsala University			
16	Örebro University			

4.2.2 Larger research and teaching intensive and smaller education dependent HEIs

Besides the traditional way of dividing Swedish universities into universities and university colleges, there are alternative ways of separating different types of universities. Ljungberg et al. (2009), for example, divide universities into two categories, namely *larger research and teaching intensive* and *smaller education dependent* HEIs. Table 4.4 below reproduces Ljungberg et al.'s (2009) categorization on Swedish universities, HEI or higher education institutions as the Swedish context has universities and university colleges, as discussed in the previous section.

Table 4.4 larger research and teaching intensive HEIs and smaller education dependent HEIs (Ljungberg et al, 2009:147)

Larger research- and teaching intensive HEIs	Smaller education dependent HEIs
Lund University	Karlstad University
Uppsala University	Örebro University
University of Gothenburg	Mid Sweden University (college)
Stockholm University	Växjö University
Karolinska institute	Malmö University College
Royal Institute of Technology	Södertörn University College
Umeå University	Malardalens University College
Swedish University of Agriculture	Jönköping University College
Chalmers University of Technology	Kalmar University College
	Gävle University College
	Blekinge Institute of Technology
	Dalarna University College
	Halmstad University College
	Skövde University College
	Borås University College
	Kristianstad University College
	Väst University College
	Gotland University College

	Luleå University of Technology
	Stockholm School of Economics

The quotes found in this chapter as well as in the next chapter come from interviews held by the author at three Swedish universities. According to the above categorization, in Table 4.4, two of these are included in the larger research and teaching intensive HEIs and one was part of a smaller education dependent HEI.

All 10 of the universities identified by Ljungberg et al. (2009) as larger research and teaching intensive HEIs have a university holding company and accompanying innovation offices. Of the universities found in the other category, only five have university holding companies and only two have their own innovation offices. However, a few more universities have access to an innovation office. The lack of access to their own innovation office for the second category could imply that the first category is more focused on commercialization to create KIE firms and can therefore be linked to high research intensity. Naturally, the need to commercialize research should be the greatest at these universities as they are the most research intensive, making it a logical decision for the government to instigate university holding companies and innovation offices at these universities.

4.2.3 How universities commercialize in Sweden

A large swath of the innovation support organizations in Sweden get some sort of public funding, either through direct financing from municipalities, such as the incubator THINK in Helsingborg, or via different types of project financing, such as the incubator CREATE in Eskilstuna. Besides public funding, most Swedish incubators are also affiliated with a university. This, however, does not automatically make them university incubators. To qualify as a university incubator the incubator needs to be at least partly owned by a university. This ownership is, with a few exceptions, exerted through a so-called university holding company. The relationship between the different types of university infrastructure (or organizations) and the universities is also characterized by an exchange of services and ideas best summed up by one of the interviewed university holding companies' CEOs:

> So there is not just a flow from within [the university] to the innovation office and holding company [but also] out to the incubators, but the flow is rather cyclic. It is not linear in that way but rather it can be researchers who already are a part of an innovation project within the institution or outside of it in the incubators need some sort of innovation office resource."[3] (*CEO Holding Company/Innovation Office - University A*)

All three of the universities studied had extensive commercialization support mechanisms and the interviewees were reflective of the role they played in the greater scheme of university-society interaction, both on a regional and a national level. They emphasized the importance of researchers and their ideas and also highlighted the role of students, both in terms of the students themselves generating ideas and particularly their potential role in other constellations.

In summary, Sweden has a total of 16 universities and 14 university colleges. Three main types of entities were identified that facilitated commercialization at these universities. These were university holding companies, innovation offices, and university incubators. The studied universities (A, B, and C) each operate a holding company. The holding company usually has only one function, to be a way to operate and own other organizations. The innovation office is connected to the holding company or organized as a part of the university. This is the first entity that researchers and students typically meet should they want to seek advice or help in

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[3] Translated text: Så det kommer inte bara ett flöde inifrån till innovationskontoret och holdingbolaget ut till inkubatorerna utan det går ju lite runt. Det är ju inte linjärt på det sättet utan det kan vara så att forskare som redan befinner sig i ett innovationsprojekt inne på myndigheten eller ute utanför i inkubatorerna behöver någon sorts innovationskontorsresurs.

commercializing an idea or research result. The innovation office is supposed to give advice and should help at an initial stage but then refer the researchers or students to the university incubator if their idea has commercial potential. The inventor ownership legislation in Sweden not only allows researchers to have complete ownership over any patentable research results but also gives them the right to any teaching material they produce during their employment at the university.

Between 1994 and 1995, the Swedish government created the first holding companies at universities in Sweden. Today there are 18 university holding companies, and since 1998 the stewardship of these holding companies was transferred from the Department of Business to the universities themselves (Swedish government, Prop. 2008/09:50:124 and FUHS).

The university holding companies have an important role in the commercialization of research results. Their main role is to work for the successful growth and development of innovative companies that are sprung from research. The holding companies should also own and administer shares of these companies to be able to help commercialize research results (Swedish government, Prop. 2008/09:50:125).

It is through these holding companies that universities operate innovation offices (similar to technology transfer offices, present in the generic model of researcher IPR) as well as different kinds of university incubators. Table 4.5 below shows a mapping of the holding companies and innovation offices of Sweden.

Table 4.5 University holding companies and innovation offices in Sweden (as of 2017)

University holding company	Innovation office (IO)
Chalmers Ventures AB	Yes
GU Ventures AB	Yes
Högskolan i Borås Holding AB	Yes, connected with the IO at Chalmers
Högskolan Kristianstad Holding AB	Yes, connected with the IO at LU
Högskolans i Halmstad Utvecklingsaktiebolag	Yes, connected with the IO at Chalmers
Karlstads universitet Holding AB	Yes *
Karolinska Institutet Holding AB	Yes
KTH Holding AB	Yes
Linköpings universitet Holding AB	Yes
Linnaeus University Development AB	Yes *
LU Innovation System AB	Yes
LTU Holding AB	Yes
MIUN Holding AB	Yes, coordinating part in a shared IO together with Karlstad University, Linnaeus University and Örebro University (marked *)
SLU Holding AB	Yes
Stockholms universitet Holding AB	Yes
Uminova Holding AB	Yes
Uppsala universitet Holding AB	Yes
Örebro Universitet Holding AB	Yes *

Innovation offices are part of the universities, however, the responsibilities and duties associated with them can be outsourced to the university holding company for at least three reasons:

1. The public information act does not apply to the university holding company.
2. The researcher or student who has a business idea might be discouraged from going to his or her own employer in order to get help realizing it.
3. The innovation office's operations are naturally closer to those of the university holding company or the university incubator than those of the university itself.

As of September 2019 there are a total of 12 innovation offices throughout Sweden, and all universities that have holding companies are attached to, or have their own, innovation office (see Table 4.5 for a complete account). The mission of these innovation offices is aptly explained by one of the university holding companies' CEOs:

> Our mission is before all else to work with and for university employees – researchers, teaching staff, PhD students but also technical and administrative staff. It can be research engineers and the like – and of course university students, but to a certain extent we also work with research institutes. [4] (*CEO Holding Company, University B*)

As developed in Chapter 2, I have conceptualized a university incubator as providing specific services, intended to develop an idea into a KIE firm. In the narrower definition of university incubators, universities own and control the incubator either indirectly, through a holding company, or less commonly, directly by the university.

> Yes, the innovation office has a broader mission than academia. Our missions coincide when it comes to commercialization. They [the innovation office] are even located here. We work closely together, so I see it as a box. We might have different roles within this box and formally different places of employment… We work closely together and we have a strong focus on building good companies and they have a broader focus so they connect with a lot of people. – (*CEO University Incubator, University B*)

The narrower definition of university incubators in Sweden can be divided by their specialization. These two categories could be described as traditional and niche incubators. Whereas traditional incubators tend to admit and work with ideas from a

[4] Translated text: vårt uppdrag är ju företrädelsevis att jobba mot universitetsanställda – forskare, lärare, doktorander även teknisk- och administrativ personal, det kan vara forskningsingenjörer och liknande – och naturligtvis universitetsstudenter men vi jobbar även i viss utsträckning mot forskningsinstitut.

wide array of fields ranging from biotech and ICT all the way to forestry and social innovations, niche incubators usually cater to only one of these categories. In Umeå, for example, a niche university incubator would be the Umeå Biotech Incubator (UBI), which offers specific help for biotechnology ideas and can offer a laboratory environment. Another example would be University of Lund's niche incubator, the Lund Life Science Incubator, which offers an incubation process especially geared towards life science projects. Both examples are also closely affiliated with the more traditional university incubators Uminova Innovation (Umeå University) and Ideon Innovation (University of Lund).

4.2.4 The Swedish Agency for Innovation's support of commercialization

The Swedish Agency for Innovation, or VINNOVA, as it referred to in Swedish, was created in 2001 to support innovation and research, leading to innovation (Vinnova.se/en/about-vinnova 2017). They implement their mission by funding different initiatives through project-based funding. VINNOVA's (2017) vision:

> …is for Sweden to be a world-leading country in research and innovation, an attractive place in which to invest and conduct business. We promote collaborations between companies, universities, research institutes and the public sector. We do this by stimulating a greater use of research, by making long-term investment in strong research and innovation milieus and by developing catalytic meeting places. VINNOVA's activities also focus on strengthening international cooperation. In order to increase our impact, we are also dedicated to interacting with other research financiers and innovation-promoting organisations. Every year VINNOVA invests about SEK 2.7 billion [SEK] in various initiatives.

The national incubator program, which supports incubators close to universities (i.e. mainly university incubators), is one of VINNOVA's funding projects. The funding covers activities aimed at supporting idea providers that have scalable ideas that can lead to knowledge-intensive startups with growth potential (VINNOVA, 2015).

In particular, managers at one of the university incubators that I visited talked about the importance of financing from the national incubator program. The interviewee was very meticulous in describing the process of getting financed and how to apply for more:

> We have applied for it and were granted all that we applied for. This is with a lot of competition between all incubators in Sweden, who also were eligible to apply and there was less money to divide. So we got the money and, for four years, or if it's two plus two years but it feels great

> having the financing. So now we do not have to apply for another three years. (*Middle Manager University Incubator, University B*)

The goal of the national incubator program is rather narrow and aims at one particular outcome:

> An incubator that gets funding from VINNOVA is an incubator where the ideas have to be scalable and be ready straight away for an international market and have a turnover of 15 million SEK within three years. (*CEO Innovation Office/Holding Company, University A*)

The above quote from one of the interviewed innovation managers illustrates the emphasis put on supporting founders with high-impact ideas, with the end goal of the ideas ending up as KIE firms.

4.2.5 In summary

In summary, as established in Chapter 2, I have conceptualized a university incubator as providing specific services, intended to develop an idea into a KIE firm. Relative to this, I have chosen both larger research and teaching intensive universities and smaller education dependent ones (see Chapter 3, Section 3.3.2). I will initially study university incubation processes in Chapter 5 and then move specifically to university incubators as organizations and the projects within them.

4.3 University incubators and projects in Sweden

This section explores quantitative data from VINNOVA's national incubator program that covers (and funds) most university incubators in Sweden. The data is on the years 2005 to 2015. The aim is to establish the scope of projects applying, getting accepted, and eventually becoming KIE firms in Swedish university incubators, although the unit of analysis here is projects (e.g. before they become firms).

This descriptive section tries to categorize and compare a large portion of Sweden's university incubators and their projects. Overview of subsections:

4.3.1 Different ways to categorize the Swedish incubators studied
4.3.2 The university incubators in numbers
4.3.3 Applicant pools – taxonomy of founders
4.3.4 Selected projects
4.3.5 Industry distribution of selected projects

4.3.1 Different ways to categorize the Swedish incubators studied

All of the 41 observed incubators are part of the national incubator program, administered by VINNOVA and are found in the database. This funding program has certain requirements for incubators wanting to be accepted into it. In Sweden, there are approximately 70 incubators and science parks (SISP.se). This means that not all of these incubators are accepted to the program. The selection process aims at promoting incubators that support knowledge-intensive firms. Further, VINNOVA's policy document states that incubators accepted to the national incubator program have to be:

> Aiming for high-tech and research based entrepreneurship with high growth potential… […] The incubator also needs to be located near a university and the financing from the program can at most cover 50% of the overall costs for the incubator. (VINNOVA Policy VP, 2002:2)

This implies that all the observed incubators are close to universities. But, does this imply they are all university incubators? No, even though overall the observed incubators have a very high degree of public funding they are not exclusively owned and operated by universities. A useful way of comparing these incubators would therefore be to categorize them in a number of different ways. Since this PhD thesis looks at how Swedish university incubators transfer university knowledge to society in the form of knowledge-intensive firms, a natural starting point is to use the definitions of four different types of incubators that support knowledge-intensive firms, outlined in McKelvey and Lassen (2013) and described and defined in Chapter 2 of this PhD thesis. In Table 4.6 below, incubators included in the VINNOVA data are matched with their respective categories.

Table 4.6 Categorization of incubators (using McKelvey & Lassen's (2013) model)

Type of incubator	**Category**	**Main rationale**	**Number of incubators *in the material***
Business Innovation Centers (BICs)	1	Institutional or public operators that have economic goals of local, regional, and national economic growth (through increased employment, technological advances, and so on). Mainly dependent on public funding.	16
University Business Incubators (UBIs)	2	Facilitating the flow of knowledge from the university to the society in the form of new KIE firms.	21
Independent Private Incubators (IPIs)	3	Specialized incubation as a mean to produce firms is a service market that reaps profits. Speed to market is one of the most important aspects for IPIs.	3
Corporate Private Incubators (CPIs)	4	Developed as a response to an effective usage of internal knowledge is to create a firm around it and spin off from it.	None

The Swedish incubator population, included in VINNOVA's program, presents difficulties when I try to classify the four categories, and especially between the first two variants. This becomes apparent when trying to classify incubators that on the surface look like business innovation centers (BICs) but where actually a university also has a stake in it. Kalmar Science Park, for example, is mostly owned by the municipality and the university only owns a 5% minority stake in the incubator (kalmarsciencepark.se). These incubators are legally classified as either limited incorporations or foundations. Some are financed through the university but not owned by it. They can also be owned by the university directly or through a holding company. In Table 4.7 below, the age of the incubator, which could be said to be a proxy for experience, is included.

Table 4.7 Incubator, type, and age

Incubators	**4 types**	**Type number**	**Age**
Ideon Innovation	UBI	2	Old
GU Holding	UBI	2	Old
Karolinska Institutet Innovations AB	UBI	2	Old
Create Business Incubator Mälardalen AB	BIC	1	Young
Science Park Jönköping AB	UBI	2	MA
Brewhouse Create Business	BIC	1	Young
Stockholms Universitets Innovation AB	UBI	2	MA
Encubator AB	UBI	2	Young
Science Park Gotland	UBI	2	Young
Lund Life Science Incubator	IPI	3	Young
Atrinova Affärsutveckling AB	BIC	1	Young
Serendipity Innovations	IPI	3	Young
SSE Business Lab	UBI	2	MA
Lift	BIC	1	Young
LEAD i Östergötland AB	UBI	2	MA
Kalmar Science Park AB	BIC	1	Old
Blekinge Business Incubator AB	UBI	2	Young
Stockholm Innovation and Growth AB	BIC	1	Old
Uppsala Innovation Centre AB	UBI	2	MA
Stiftelsen Teknikdalen	BIC	1	Old
Stiftelsen Chalmers Innovation	UBI	2	Old
Föreningen Framtidens Företag	IPI	3	MA
Minc i Sverige AB	BIC	1	MA
Umeå Biotech Incubator AB	UBI	2	Old
Inkubatorn i Borås AB	BIC	1	Young
Åkroken Business Incubator	BIC	1	Old
Arctic Business Incubator	UBI	2	Young
Företagsfabriken i Kronoberg AB	UBI	2	Young
Medeon AB	BIC	1	MA
Sahlgrenska Science Park AB	UBI	2	Old
Inkubera i Örebro AB	UBI	2	Young
Sciencepark Halmstad AB	UBI	2	Old
Entreprenörsarenan Bohuslän	BIC	1	Young
Science Park-systemet i Jönköpings län	UBI	2	Young
Innovatum Inkubator	BIC	1	Old
Inkubatorn@MSSP	BIC	1	Young
Uminova Innovation AB	UBI	2	MA
Stiftelsen Inova i Wermland	UBI	2	Old
Gothia Innovation AB, Gothia Science Park	BIC	1	Old
Movexum AB	BIC	1	Young
Krinova Incubator & Science Park	UBI	2	MA
Total (41 incubators)			

The observed incubators have an average public funding to operating cost of 86% (mean estimation over a 10-year period). Hence, an alternative way of categorizing these university or university-close incubators would be to look at the degree of public funding. In Table 4.8 below, the average degree of public funding over the 10-year period 2005-2014 (the studied time period) is calculated and a further divide upon the distribution of the variable is made into three categories: level 1 (up to the 25th quantile) level 2 (from the 25th quantile up to the 75th quantile) and level 3 (equal to and above the 75th quantile), where level 1 indicates low level (≤ 71%) of public funding and level 3 a very high level (≥ 97%) of public funding. This way of categorizing is used throughout this chapter in conjunction with a division of the incubators depending on their age, which indicates experience, to look at differences and similarities between the observed incubators on many levels. Incubator experience is proxied by age, where old defines incubators that have operated since before 1999 (a total of 14), and middle-aged (MA) between and including 1999 and 2003 (a total of 10); young incubators started after 2003 (a total of 17).

Table 4.8 Degree of public funding to total costs and categorizations (*average 2005-2014)

Incubators	**Degree of public funding***	**SE**	**Funding level 1**	**Funding level 2**	**Funding level 3**
Ideon Innovation	55%	0.0015	Yes		
GU Holding	65%	0.0031	Yes		
Karolinska Institutet Innovations AB	28%	0.003	Yes		
Create Business Incubator Mälardalen AB	55%	0.0015	Yes		
Science Park Jönköping AB	66%	0.022	Yes		
Brewhouse Create Business	67%	0.0036	Yes		
Stockholms Universitets Innovation AB	53%	0.006	Yes		
Encubator AB	64%	0.0017	Yes		
Science Park Gotland	64%	0.002	Yes		
Lund Life Science Incubator	64%	0.003	Yes		
Atrinova Affärsutveckling AB	45%	0.0056	Yes		
Serendipity Innovations	5%	0.004	Yes		
SSE Business Lab	5%	0	Yes		
Lift	56%	0.0033	Yes		
LEAD i Östergötland AB	85%	0.0015		Yes	
Kalmar Science Park AB	86%	0.0005		Yes	
Blekinge Business Incubator AB	80%	0.0018		Yes	
Stockholm Innovation and Growth AB	77%	0.0013		Yes	
Uppsala Innovation Centre AB	84%	0.0011		Yes	
Stiftelsen Teknikdalen	90%	0.001		Yes	
Stiftelsen Chalmers Innovation	73%	0.002		Yes	
Föreningen Framtidens Företag	90%	0.0015		Yes	
Minc i Sverige AB	83%	0.0009		Yes	
Umeå Biotech Incubator AB	75%	0.0053		Yes	
Inkubatorn i Borås AB	87%	0.0012		Yes	
Åkroken Business Incubator	84%	0.001		Yes	
Arctic Business Incubator	91%	0.0018		Yes	
Företagsfabriken i Kronoberg AB	85%	0.0017		Yes	
Medeon AB	76%	0.0036		Yes	
Sahlgrenska Science Park AB	86%	0.003		Yes	
Inkubera i Örebro AB	95%	0.0013		Yes	
Sciencepark Halmstad AB	80%	0.001		Yes	
Entreprenörsarenan Bohuslän	74%	0.0054		Yes	
Science Park-systemet i Jönköpings län	94%	0.0012		Yes	

Innovatum Inkubator	114%	0.006	Yes
Inkubatorn@MSSP	97%	0.0007	Yes
Uminova Innovation AB	110%	0.0024	Yes
Stiftelsen Inova i Wermland	96%	0.001	Yes
Gothia Innovation AB, Gothia Science Park	97%	0.0007	Yes
Movexum AB	99%	0.0015	Yes
Krinova Incubator & Science Park	97%	0.005	Yes
Total (41 incubators)			

As can be gathered from the above work, it has been hard to reach a clean classification of Swedish incubators into the four categories suggested by McKelvey and Lassen (2013). In order to be able to confidently state the difference between the categories, I will further explore McKelvey and Lassen's (2013) first two categories. However, I need to rename the types into two subcategories of university incubator. The change in terminology is due to the conditions incubators are subjected to in order to be able to participate in the national incubator program (see earlier in this section for the exact terms from VINNOVA). From earlier, we know that the incubators have to be near a university, a description that refers to the greater category of university incubator. Figure 4.3 below illustrates my classification in relation to the four main types of incubator that McKelvey and Lassen (2013) identify.

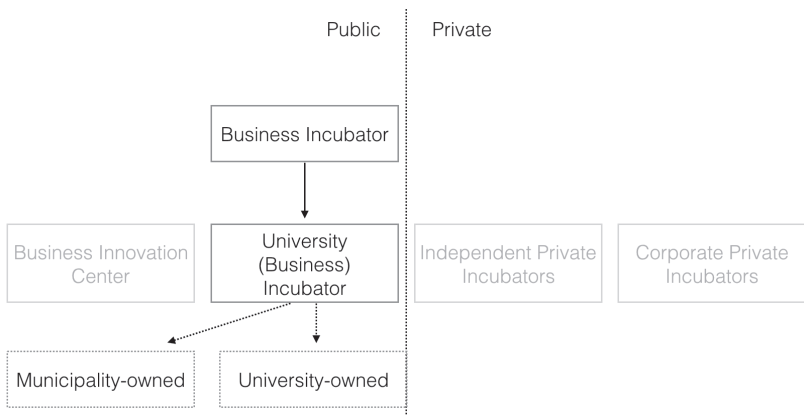


Figure 4.3 Types of incubators represented in my data material, main category of university incubator and further divided by ownership structure into university-owned and municipality-owned.

Hence, I use the term "municipality-owned" to describe what I have classified as BICs and "university-owned" for what I have classified as university incubators in further analysis. Thus only 37 incubators are included in the further analysis of the data material provided by VINNOVA in Chapters 6 and 7 (16 municipality-owned and 21 university-owned incubators).

Of the original 42 incubators found in the data material, one was removed a priori because it was a so-called accelerator with a pre-determined incubation process of only three months (*Think Accelerate*). Moving forward from this chapter, four more incubators were removed: the three incubators classified as private (*Serendipity;*

Föreningen Framtidens Företag; Lund Life Science Incubator) and another incubator that only participated for a very limited number of years (*SSE Business Lab*). These five incubators only accounted for a very small amount of the available data.

4.3.2 The university incubators in numbers

The founding of the Swedish university incubators included in this study spans 22 years from the youngest, which was founded in 2009, to the oldest, founded in 1987. The observed incubators have an average age of 19 years (mean start year of 1999). As can be gathered from Table 4.9 below, the middle-aged incubators have the most employees on average and also have the largest operating costs. The reasons for the disparity in operating costs of the younger incubators are discussed in Chapter 7.

Table 4.9 Incubator age category, operating costs and number of staff

Incubator age	Old	SE	Middle-aged	SE	Young	SE
Staff	6.75	0.29	8.33	0.02	4.80	0.01
Operating cost (TSEK)	9,063.76	16.90	9,431.63	20.89	5,801.16	12.62

Both the average number of employees and the average number of business coaches have increased slightly over the studied period, reaching a fairly stable level of around 6 employees and of these 4 business coaches the last three years, as can be gathered from Figure 4.4 below. Business coaches are the incubator staff that are supposed to help project founders with their business projects.

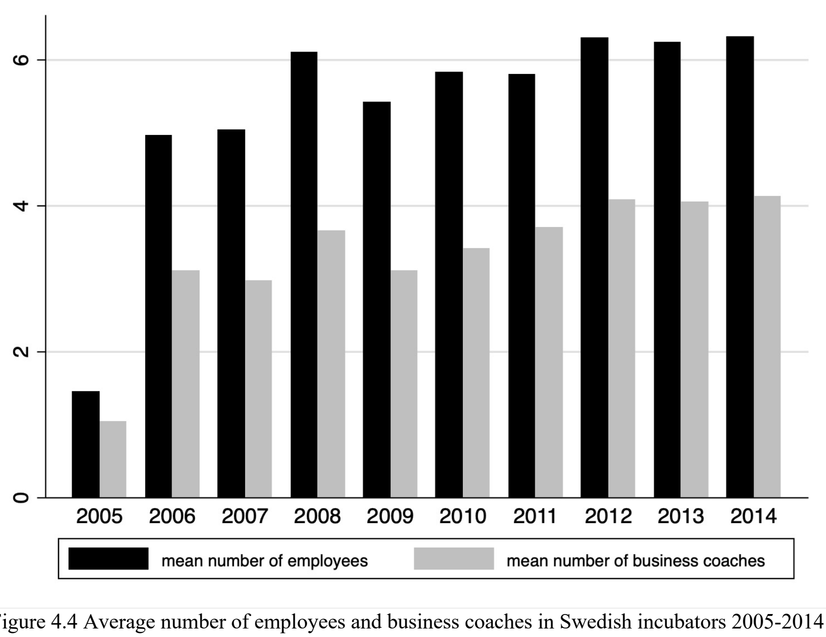


Figure 4.4 Average number of employees and business coaches in Swedish incubators 2005-2014

4.3.3 Applicant pools – taxonomy of founders

As could be gathered from the methods and data chapter, five distinct pools of applicants can be observed in the data. These are researchers, students, other university staff, independent inventors, and corporate spin-offs. The three first ones are strongly related to the university. Researchers create new knowledge by doing research and they transfer that knowledge to students; this is the most common form of knowledge transfer (Salter & Martin, 2001). Students get access to knowledge and are being taught how to search for new knowledge. University staff is a category that makes sense from the point of view of the Swedish context. As the first section of this chapter has shown, the praxis of inventor ownership includes more categories of university staff than researchers. This allows technical staff, for example, to develop a KIE firm based on the IP created on the university premises. Independent inventors, on the other hand, exist outside of the university. Yet they are a prominent category within the data material from VINNOVA. Even industry spin-offs are part of this data.

Based on the grouping of incubators according to their respective ages, there is a lot of variation between the age categories. In Table 4.10 below, this becomes evident looking at the broad category of university ideas (which contains the three first types: researchers, students, and university staff). The average number of university ideas is highest with the middle-aged incubators. These incubators also have higher averages of female founders (almost half of applicants are female) and foreign founders that are being screened. Moving forward, the age of the incubator will be included in all quantitative models (Chapters 6 and 7) both for the reasons mentioned above and for the reason of using it as a proxy for experience in dealing with business development.

Table 4.10 Type of ideas screened by Swedish university incubators

Type of idea evaluated	Old	SE	Middle-aged	SE	Young	SE
University ideas	31.46	0.14	69.05	0.28	31.87	0.20
R & D ideas	17.46	0.82	26.49	0.09	12.71	0.07
Business-originated ideas	35.48	0.17	36.66	0.13	33.04	0.25
Research institute ideas	1.64	0.02	1.69	0.01	1.51	0.18
Public sector ideas	2.80	0.02	5.51	0.24	3.89	0.33
Independent inventor ideas	42.47	0.17	39.00	0.25	34.49	0.24
Total evaluated ideas	114.17	0.29	152.36	0.40	105.25	0.49
Ideas from female founders	33.49	0.13	44.11	0.13	33.02	0.21
Ideas from foreign founders	17.54	0.06	32.13	0.15	15.99	0.11

4.3.4 Selected projects

However, the observed incubators all have more applicant projects every year than they take on. This implies that they have some form of selection process to decide which projects to admit into the incubator and which to deny. More on this will be discussed in Chapters 6 and 7.

4.3.5 Industry distribution of selected projects

The projects admitted to the incubators are spread between 20 different industries. In Table 4.11 below, the information and communications technology (ICT) industry stands out as the most common industry for incubator projects. Counted together with the broad industry general category, they account for nearly 40% of total number of admitted firms. Looking at the division of incubators into different categories, there is little overall difference in what industry their respective projects are in depending on the different funding levels. However, some industries stand out. Incubators with the lowest level of public funding have, for instance, more than eight times as many projects in the nano-technology industry. Almost the same goes for the very niche space industry. Life science projects are also much more common in the incubators with the lowest level of public funding. A possible reason for this would be that the potential for financial rewards is high in this industry. Venture capital firms are usually very interested in firms of this type as their risk management models are based on life science firms entering different stages and decisions are made after each stage on whether to continue financing them or take the loss (Metrick & Yasuda, 2010). This type of firm has a substantial upside of financial reward if the stages are successful.

Table 4.11 Distribution of incubated firms according to industry and divided by funding level and age of incubator

Industry	**Overall %**	**Funding level 1**	**Funding level 2**	**Funding level 3**	**Old**	**Middle-aged**	**Younger**
Clean Tech - energy	4.17	5.52	3.83	3.53	5.52	3.63	4.06
Clean Tech - environment	3.14	2.96	3.13	3.33	2.73	2.68	4.03
ICT - games	3.18	1.53	3.71	3.76	4.63	3.07	2.55
ICT - general	24.41	22.27	26.76	21.77	21.12	28.51	23.56
Agricultural	0.63	0.55	0.59	0.78	0.33	1.11	0.33
Industrial design	7.28	4.30	9.92	5.02	6.17	7.25	9.45
Vehicles	1.15	0.71	1.29	1.29	1.70	0.57	1.25
Packaging	0.52	0.40	0.48	0.73	0.81	0.32	0.37
Foodstuffs	1.80	0.40	1.46	1.89	1.41	1.88	2.36
Materials	2.26	2.41	1.88	1.54	2.35	2.27	3.06
Media industry	6.25	3.74	7.10	5.75	6.92	5.85	6.23
Nano-technology	0.72	5.06	0.63	0.27	1.22	0.55	0.57
Space	0.19	1.35	0.21	0.11	0.14	0.33	0
Security	2.52	0.26	2.82	2.34	2.66	2.38	2.61
Manufacturing	3.49	2.09	3.76	3.99	3.25	2.28	5.63
Experience/entertainment	4.09	3.54	4.06	4.72	2.07	4.65	6.83
Industry - general	14.45	12.14	14.31	17.04	12.67	15.12	13.36
Life Science - health	5.01	4.77	4.55	6.17	3.91	5.08	4.91
Life Science - general	9.19	16.18	5.16	10.27	12.99	7.68	4.60
Life Science - medtech	5.54	7.74	4.37	5.70	7.39	4.78	4.24

Looking at the distribution of projects depending on the relative age of the incubator in Table 4.11 above, old indicating established before 1999 and younger established after 2003 and forward, and the years in between designated middle-aged, there is also some variation. Many previous studies use the age of a firm or an organization as a proxy for its experience (Coad, 2018). By using these three categories and sorting on what industries the respectively aged incubators take on, I got some interesting results. In the experience/entertainment industry we can see an increase in the number of admitted projects the younger the incubators are, whereas the opposite is true when it comes to the life science industry.

4.3.6 In summary

In summary, university incubators provide services to project founders, aimed at creating KIE firms. And as outlined in Section 4.2, they provide services not only to researchers, as expected, but I also find that they provide these services to people unrelated to the university. I also identify a variety across university incubators in terms of founder types and expected industry of their projects. By uncovering the characteristics of the identified variety, I open up for further analysis of founder types inside one broad category of incubators – university incubators – and in so doing am able to address a research gap on diverse founder types within the same type of incubator. This will be explored further in Chapter 6.

4.4 In conclusion

Commercialization in Sweden is different in a number of ways, and this chapter has discussed some of these differences. Specifically, it has discussed that (1) the individual researcher is important due to Sweden having an inventor ownership institutional regime, therefore (2) as established in Chapter 2, I have conceptualized a university incubator as providing specific services, intended to develop an idea into a KIE firm. University incubators provide these services to researchers, as expected, and I also find that they provide these services to (3) people unrelated to the university. I identify a variety across university incubators in terms of founder types and expected industry of their projects.

This empirical context chapter informs my analysis in later chapters in the following way:

- National policy, VINNOVA funding requirements, and what the incubator managers state is the key outcome from university commercialization all align, the key outcome being KIE firms. Hence, the call from Bergek and Norrman (2008) to measure incubator performance by the goals of the incubators themselves would revolve around facilitating the creation of new KIE firms. There is variety in founder types at university incubators in Sweden. Given the context of inventor ownership, I want to understand how researchers act and are perceived to act towards commercialization. This is explored in Chapter 5.

- Apart from researchers and students, there are also non-researcher university employees, independent inventors, and corporate spin-offs. Swedish university incubators accept founders not only of the type we would expect, such as researchers and students, but also these other ones. Therefore Chapter 6 focuses upon founder types.

- In the Swedish context, university incubators can be divided into two subcategories depending on who actually owns them. The two types are university-owned and municipality-owned incubators. These types may matter for the performance of the incubator, and therefore Chapter 7 analyzes incubator performance in relation to these two types and the key outcome of commercialization in this context: KIE firms, as reiterated from the first point.

4.4.1 Adding what we have learned to the emerging empirical model

This chapter has also contributed to the model of how commercialization of knowledge-intensive entrepreneurial firms is facilitated by university incubators in Sweden.

Figure 4.5 below outlines this model with added details uncovered in this empirical context chapter, in bold.

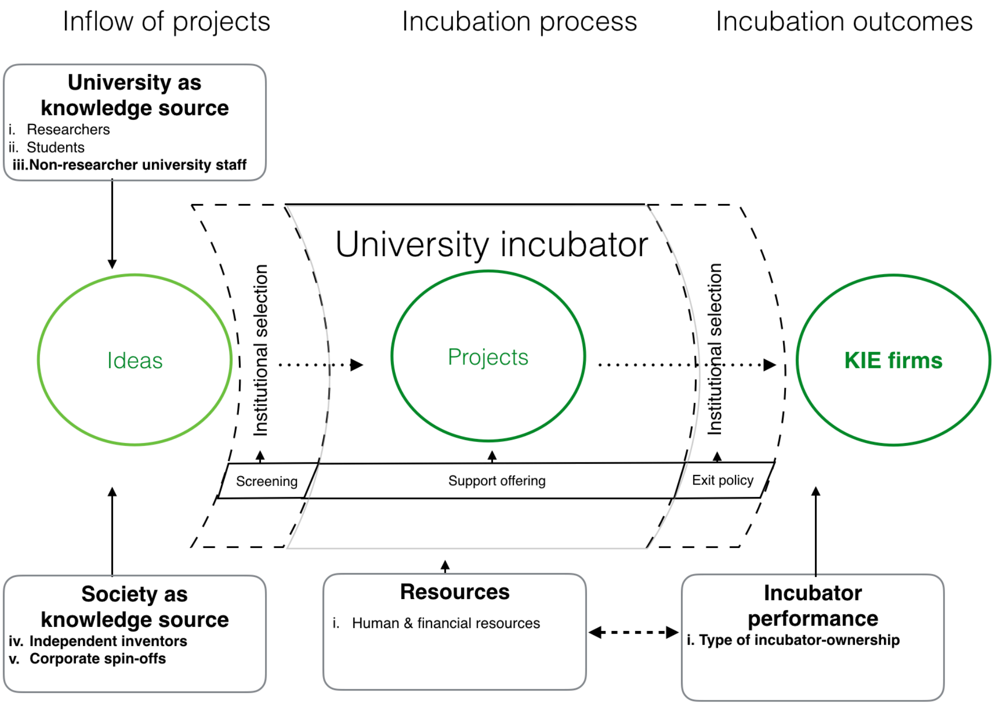


Figure 4.5 Conceptualization of how university incubators facilitate the formation of KIE firms with empirical findings from Chapter 4 added.

Specifically, in Figure 4.5 I have added more founder types. In the upper-left corner I have added non-researcher university staff to the founder types that university incubators offer help to. I have also added a new box in the lower-left corner, with the title: Society as knowledge source. I use "society" here for lack of a better word to describe founders that do not have obvious connections with the university. I have also added that the type of incubator could be an interesting aspect to investigate in connection with incubator performance, as seen in the lower-right box.

Finally, this empirical chapter has confirmed that KIE firms are the preferred outcome of both national policy and the interviewed managers. This finding leads me to investigate the role of researcher and the incubation process as described by incubation managers in Chapter 5, the impact of founder type on the likelihood and timing of completing incubation for projects in Chapter 6, and the performance of two subsets of university incubator in Chapter 7.

5. Incubating KIE firms in Swedish universities

This chapter aims at addressing the following research question:

> Research question 1: How do incubator managers describe and work with researchers, as compared to other founders, and the incubation process in an inventor ownership environment?

I address the above research question by conducting interviews with managers at university incubators and innovation offices. The incubation process (1) is described as beginning with screening ideas and ending these projects (called exit) either as a firm that leaves the incubator or as a project that failed during the process. (2) During the incubation process, the university incubators provide coaching aimed at giving the potential founder entrepreneurial skills. The incubators also help with market validation, subsidizing rents, and occasionally subsidize patenting. (3) Researchers are seen as especially difficult to encourage to start firms. These three reasons are given: lack of time, stuck on technical verification, and unwilling to become entrepreneurs. However, incubator managers also value researchers' ideas as having the highest potential impact if successful. (4) To deal with researchers, university incubators have two main strategies: to start a firm or attempt to transfer the IP/idea to industry in order to take these special ideas to the market with or without the active participation of the researcher who owns it. Involving students in the project is often part of the strategy to deal with researchers.

5.1 Generic commercialization process and university incubation process

Research done at universities generates a lot of results that can have commercial applications (Friedman & Silberman, 2003). Universities and governments want this knowledge to generate growth and advantages to create a strong domestic industry. In order for this to happen, the knowledge produced in universities needs to disseminate or be transferred by some mean to society. Technology transfer offices (TTOs) were created by many US universities in the wake of the Bayh-Dole Act with this purpose in mind, ideally to act as a bridge between the university and industry (Siegel et al., 2004). More specifically, they were created in order to govern and license out the universities' IP. TTOs are related to university incubators. McAdam et al. (2012), found that the TTOs they studied managed several incubators in diverse sectors and that in order to do this they had to expand staff and focus on developing skills in these areas. In this PhD thesis, TTOs, which affect researchers especially, are included in the qualitative analysis on this more inclusive ground, and in this chapter I use the term "TTO" to include both the actual TTO and the university incubator.

The TTO should function as the intermediary between the faculty that created the IP and the industry or startup that wants to acquire it (Siegel, Veugelers & Wright, 2007). However, Macho-Stadler, Pérez-Castrillo and Veugelers (2007) and Bercovitz and Feldman (2008) argue that this system is dependent on (1) the faculty member disclosing the invention to the TTO in order for the technology transfer process to begin (Bercovitz & Feldman, 2008), and (often) on (2) the faculty member providing help with further development after the license agreement (Macho-Stadler et al., 2007).

The first precondition is quite straightforward: if the faculty does not report a commercially viable invention to the TTO, the TTO cannot search for and disseminate this knowledge by doing a license deal with industry or another party. The second precondition is a well-established fact that transferring knowledge seldom involves just handing over an idea or a patent, but rather it requires the faculty to be involved in the transfer and quite possibly in further developing the idea or patent into a product or service (Jensen & Thursby, 2001; Agrawal & Henderson, 2002). Jensen and Thursby (2001), for example in a large survey study sent to US TTO directors and licensing officers, concluded that researcher ideas tend to be embryonic, requiring inventor cooperation to achieve commercialization. This, they argue, gives a moral-hazard problem, which requires a closer tie between researcher cooperation and financial reward. According to the responding TTO directors and licensing officers, reciprocating by sponsoring the aforementioned researchers' future research was enough.

University ownership means that the university is the owner of the IP and therefore the researcher cannot commercialize without striking a deal with the university. Bercovitz and Feldman's (2008) study on participation in commercialization at American universities, under the theory of new organizational behavior, concludes that there are many different factors that determine participation in these activities. They found that among the two most important factors were whether the department chair or coworkers actively engaged in commercialization. Further, Bercovitz and Feldman (2008) found that there is a difference in participation both between universities and within them and that universities in the US created TTOs in order to support and encourage this process. These universities commonly have some sort of royalty sharing scheme to encourage and reward researchers to report their inventions (Jensen et al., 2003). The exact division of returns between the involved parties varies, but it involves the researcher and the university and sometimes the faculty as well (Jensen et al., 2003). There are other reasons for having a royalty sharing scheme; many studies highlight the inventor being part of the transfer process as a key factor to a successful knowledge transfer (Jensen & Thursby, 2001; Agrawal & Henderson, 2002; Jensen et al., 2003).

In Sweden, under inventor ownership, the researchers themselves reap all potential benefits, but also take on all the risks and responsibility of managing, selling, or otherwise transferring the results to the market. Older studies on commercialization in Sweden, however, indicate that rather than creating new ventures, faculty members prefer to participate in other university-industry activities such as collaborative research or contract research (Klofsten & Jones-Evans, 2000). However, results from a more recent study based on a large-scale survey suggest that Swedish researchers, in science and engineering, are positive towards commercialization in general as well as patenting and venture creation (Bourelos et al., 2012). In another recent study, of 64 faculty members at Swedish universities, Borlaug and Jacob (2013) listed the need "…for funding for their research and their students" as the most important underlying factor to commercialize. They also conclude that there might be a sort of mainstreaming of university interaction with society, indicating that this array of activities is becoming more widely adopted by faculty (Borlaug & Jacob, 2013).

The aim of university commercialization is to transfer knowledge produced at the university to society in some form. In the US context, the TTO has two main missions: to manage IP and to pursue license deals originating from the university. This would imply that the outcome of the system would be the same, that is, mainly transferred, or sold, patents or non-patented ideas. Under inventor ownership this becomes more complicated. In Sweden there are many different types of support available for faculty members wanting to commercialize (e.g. from the Swedish Innovation Agency), but it is up to the faculty members-inventors to choose where to go, what to do with the results, etc. since they own the results.

Much of the licensing revenue at Columbia University, Stanford University, and University of California comes from a select number of biomedical inventions (Mowery et al., 2001). In the biomedical industry, patenting is also considered the industry standard of protecting a valuable investment such as a new drug or medical solution. The Bayh-Dole system also prioritizes patentable inventions as these are more easily licensed away (Jensen et al., 2003).

Jensen et al. (2003) state that a TTO has to balance objectives of the faculty who create the inventions and who want to be compensated for them, with the objectives of the university that owns the inventions. The mission of the TTO is to sell and manage IP owned by the university. A TTO can also function as a signal of quality to a potential licensee, thus making it easier to close a license deal (Jensen et al., 2003). Mowery et al. (2001) even went as far as renaming them technology licensing offices (TLOs), highlighting the one important job they were supposed to carry out.

See Figure 5.1 below for a simplified outline of the functions of a generic TTO (operating under university ownership).

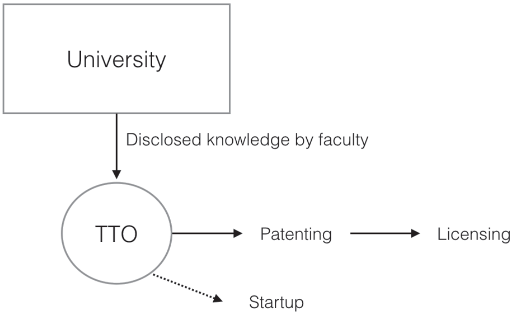


Figure 5.1 TTO organization and mission in a Bayh-Dole context

In Figure 5.1, potential inventions can be seen coming from research, represented by the university box, and are disclosed to the TTO by the researcher. The TTO then evaluates patentability of the idea, patent and tries to seek a licensing partner. In some cases the end result is a startup that the researcher can receive some equity in or be part of. A startup is, however, not the common outcome (Damsgaard & Thursby, 2013).

According to a paper by Jensen et al. (2003), some TTO sources claim that less than half of researchers' ideas with commercial potential are reported to the TTO. However true this statement, TTO directors viewed disclosure as one of their main problems (Jensen et al., 2003). An issue outlined by TTOs was that university ownership, when it has been in effect for a while, creates serious issues dealing with faculty members not reporting commercially viable ideas to the TTO. This issue is seen as a problem by TTOs in the institutional regime of university ownership, as TTOs are supposed to handle and potentially profit from these ideas. However, it would probably be an issue in all contexts where action is taken only after researchers have the responsibility, under law, to disclose potential profitable results.

Table 5.1 below contrasts the logic found in the literature review underlying the generic model of university commercialization with that underlying inventor ownership.

Table 5.1 Main issues and how they are addressed under university ownership

TTO logic	University ownership
Main issue	Disclosures by researchers
Underlying reasons according to managers	Researchers unwilling/unknowing to disclose. Individuals cheating the system
Incentives	Increased reimbursement
Punishments	Legal and administrative requirements for researchers

Under university ownership the TTO experiences failure to disclose by the researchers as the main issue (Jensen et al., 2003). Bercovitz and Feldman (2008) found that US universities had royalty-sharing schemes to incentivize researchers to disclose. In the US context, disclosing to the TTO is a requirement as the university owns the IP. However, universities use royalty-sharing as an incentive for researchers to report their inventions to the TTO. If for whatever reason the researcher tries to cheat the system as Kenney and Patton's (2009) study indicated, it can always be tried in court.

TTOs have also been studied in the Swedish context. For instance, a study by Bengtsson (2017) on Scandinavian TTOs concludes that all three nations (Sweden, Norway, and Denmark) have expanded their TTO systems despite their respective differences in regulations. Further, he argues that the technology transfer regime relates to more than regulatory aspects, including business development competence, resources, governance, and monitoring activities of the TTOs. Bengtsson (2017) argues that it is the interplay between these factors that determines whether TTOs commercialize by a licensing or startup strategy. The regulatory component is argued to be influencing Norwegian and Danish TTOs to mainly use the first strategy and Swedish TTOs to mostly use the latter strategy, if other factors also support academic entrepreneurship.

5.1.1 Incubator offering

University incubators provide many advantages to firms and projects. Research into the effect of would-be entrepreneurs being in the proximity of more experienced entrepreneurs within the confines of an incubator suggests that this helped firms overcome the liability of newness (McAdam & Marlow, 2008). The liability of newness was overcome by being situated and incubated in a credible incubator. This credibility takes time to build. Lasrado et al. (2016) highlight connectivity and legitimacy that emanated from the host university as important. Connectivity is in the sense of being connected to other entrepreneurs, the incubator, and the external connections of the incubator (Lasrado et al., 2016). In the same paper they conclude that firms that are being incubated in university incubators as compared to matched non-incubated firms perform better, even after completing the incubation program.

The importance of university linkages for the projects and firms in incubation has been explored by Rothaermel and Thursby (2005). They found strong linkages to reduce the probability of firm failure, but at the same time, having strong linkages retarded timely graduation. The second result rhymes well with other research that suggests that university inventions have a high fail-rate (Thursby & Thursby, 2004). This has been explained as due to the tacit nature of inventions, that is, that there is a lot of knowledge that is not easily transferred by a patent and written information about the invention. This information is not enough to make use of an invention and develop it. Inventor cooperation in development increases the probability that the invention will become commercially successful (Thursby et al., 2001; Thursby & Thursby, 2001, 2004). Researcher involvement in the transfer process is said to be an important determinant of the speed of the commercialization process (Markman et al., 2005). It was found to accelerate the speed of the process if the faculty inventor participates in the commercialization process, but only in later stages and not during the disclosure of invention stage. This effect was explained by the fact that many of the researchers were also founders of the licensee firm and therefore had a personal interest in ensuring that the commercialization of the invention succeeded (Markman et al., 2005).

The resources listed as especially important for firms undergoing incubation to have access to have been identified as follows (Bergek & Norrman, 2008; Peters et al., 2004):

- Access to networks
- Reduced rents
- Support services
- Professional business coaching

However, there has also been research that points to a mismatch between the needs of the projects and the offering by the incubators (Van Weele et al. 2017), in that incubators were found to see business knowledge as the most important offering and incubated projects see access to tangible resources such as funding as their most important need.

5.2 Swedish commercialization process and university incubation process to support the creation of KIE firms

Managers agree that the main output from the studied universities' commercialization processes ought to be knowledge-intensive entrepreneurial firms and to a lesser degree licensing. These KIE firms are usually started during the incubation period in the university incubator or as a result thereof. An innovation office operations manager (University A) describes their part of the process as preparing the project for incubation:

> …and this means that the cases that have been through our process, before they go to the incubator, have achieved a higher degree of maturity as compared to those coming straight off the street to the incubator.

The process at the university incubators was seen, by the managers, as being effective and followed current trends in the *lean startup* methodology. The manager below also pointed out creating a "startup culture" as important for the process as well:

> It is the customer development methodology, it is scarily effective at weeding out ideas. By so doing, you are weeding out both people and ideas… If it fails, they might want to be part of another thing or they will come again with another idea and talk well about how fun this is, so more people get the feeling that they can also go for and realize their idea. We work a lot with the startup culture and we can see signs of the success already. (*CEO University Incubator, University B*)

The incubation process was described as starting with a selection between different ideas, with criteria such as feasibility and potential impact (Universities B & C). The ideas that were then accepted would gain access to their activities and offerings, such as subsidized rents (Universities B & C), business coaching (all), and external consultants (Universities A & B). The incubation process was described as ending in one of two ways: failure to become a functioning firm or successful incubation leading to a KIE firm (described by managers at Universities A & B).

There are other activities that the innovation offices and university incubators engage in according to the managers. Table 5.2 below highlights the most important ones.

Table 5.2 Activities innovation offices and university incubators engage in

Quote	Activity	Theme
"…and they get one of Sweden's best entrepreneurial educations for startups, they learn an astonishing amount during this journey that they, even if they fail, can bring with them to another startup or whatever. Researchers that have been through our process have a huge knowledge in this regard and on this topic really." *CEO University Incubator, University B* "…and then there are all of these indirect effects of people who learn new skills and use them in different contexts, they are also lost from all statistics." *CEO University Incubator, University B* "..and that is the key strength in that many come to us and they may come with an immature idea but they are through a process and then we say that you are not finished with this and you might need to do more research on this. Alright, then they go back but they have with them the new way of thinking. Plus our ambition …what	The researcher ideally gains entrepreneurial skills and experiences in the interaction with the innovation office and the university incubator.	(Potential) knowledge flow back to the university

we strive for… is for the researchers to think of these things already before starting a new research project.” *CEO Innovation Office, University A* “…these very important values that perhaps are hard to measure in ones and zeros but more like a team is created.” *Middle Manager University Incubator, University B* “…and this can be seen in all of the people that join others' ideas… and this is what is so interesting when you measure the output of these kinds of operations. Direct output is measurable, how many firms, how do they grow, how does it look three years after exit, how many are still alive, how many jobs are created. And this you can do, but the indirect societal effects are probably much greater and they are really hard to measure. If you have been around for a while and had a look, there is a hell of a lot… Knowledge is hard to measure.” *CEO University Incubator, University B*		
“When we interact with potential markets … when we interact with the market it results in the industry saying: good idea, good technology, exciting, but we are not interested in it, but we do want to conduct research with your university.” *Operations Manager Innovation Office, University A*	Market validation could give the side effect of industry contacts that can become research money, in the form of collaborative research or contract research.	(Potential) research money flow back to the university
“it is simple to burn a million on a case [project] if you like. Send away a patent application, there you spend a 100 000 SEK and we do this… but only as an exception do we take on the patent fee here. We try to say that a patent is the result of our work, that is, should you protect it or not. It is nothing that you should apply for just because.” *Operations Manager Innovation Office, University A* ”…they are going to publish in two months and now it's all about having the IP and this is really totally crazy, if you do not know if there's a need [Haha].” *CEO University Incubator, University B*	Patenting as an exception, the need for market validation beforehand.	Subsidized patenting (if need for it)

As can be gathered from Table 5.2, the researchers that go through the incubation process ideally gain entrepreneurial skills and experiences in the interaction with both the innovation office and the university incubator. Market validation is often done by both the researchers themselves but also by external consultants (Universities A & B) or the innovation office staff (University A). This validation process could potentially lead to a researcher or innovation office employee getting industry contacts that in turn can lead to research money. This money is often in the form of collaborative research or contract research. Patenting is seen by the interviewed managers as important but not something that should be done before market validation or before assessing the need for it.

5.2.1 In summary

In summary, university incubators primarily provide services and resources around the incubation process. This process, as established in Chapter 2, I have conceptualized as involving many activities aimed at supporting the creation of KIE firms. As expected, managers describe the process as beginning with screening and ending in one of two ways.

5.3 How managers at innovation offices and incubators perceive researchers as KIE entrepreneurs

Managers at the studied universities described four types of potential KIE entrepreneurs that come with ideas or are approached in the research environments at the university. These four groups are researchers, students, other university staff, and those not from the university. Innovation managers in two of the studied universities only supported the first three categories, while managers at the other university, managers of the university incubator to be precise, were open to admitting people not employed or studying at the university. Researchers, students, or university staff with ideas or results with market potential can be divided into, those who are:

1. Actively seeking help from the innovation office or university incubator
2. Going somewhere else (cannot be accounted for in this study)
3. Being scouted by the innovation office proactively for having interesting research results.

The managers, especially managers at the technical university studied, suggested that most projects at the incubator with researchers as founders were what was left from university-industry collaborations:

> First of all, not everybody comes to us with their ideas; the ideas that are most mature instead go straight to the industry. The ideas that come to us are either what is left or when the researchers start to think early about … yes, I have a new project next year, I was thinking … what do you think of innovations within this? (*Operations Manager, Innovation Office University A*)

5.3.1 Researchers as KIE founders

A CEO of a university incubator expressed his frustration with researchers never being truly done with their research nor ready to bring the product to market. Managers at the two other universities also mentioned this as a reason why they perceived researchers as an issue, that is, that they get stuck on technical verification. Especially managers at University A, as a technical university, expressed this reason as a critical step to overcome in their process. The second, more generic, reason the managers expressed was that the researchers do not want to become entrepreneurs themselves. The third reason, lack of time, was expressed by many of the managers as a reason why researchers did not want to pursue commercialization, but the argument was also raised as a reason for students. Table 5.3 below outlines the grounding for the emergent themes.

Table 5.3 Why some researchers are unwilling to pursue commercialization

Quote	Reason	Theme
"…when dealing with researchers you need to know (1) is the research part really finished? This is of course super-easy to know. [Laughs] It is the gap between if it works on a square centimeter to if it works on a square meter, in order to be able to sell it." *CEO University Incubator, University B*	Scaling and technical solutions can be tricky and researchers tend to always want to do it better.	Stuck on technical verification
"…I would say that researchers are the group that distinguish themselves because they usually do not want to become super-entrepreneurs and come here to the incubator and start a firm; rather, they see an opportunity in their research results with a possibility to do something…" *Middle Manager University Incubator, University B*	Unwillingness of researchers, in particular, to engage in entrepreneurship.	Do not want to become entrepreneurs
"It is mainly researchers and students… mainly researchers, that we focus our support on. They have very limited amounts of time." *Operations Manager Innovation Office, University B* "We had the hypothesis that students may have limited amounts of time to work with their business ideas and verify them during the semesters… we have had a lot of inspiration activities geared towards students, where a lot of ideas have been generated, but then you lose track of them… there is a new course and yes…" *Operations Manager Innovation Office, University B*	Researchers and students have limited amounts of time to pursue entrepreneurial activities	Lack of time

The effects of the policy instruments of public funding of university incubators are quite evident in all of the studied universities. A manager at University C, for example, had a strong focus on KIE firms as the outcome of commercialization. The manager outlined two alternative ways for projects getting admitted and invested in by the university incubator. The first was to write a project contract agreeing on an ownership distribution (if the idea was seen as too immature to become a KIE firm) or alternatively, starting a KIE firm straightaway and adding the researcher as a majority owner. Before admitting and investing in the researcher, due diligence is said to be carried out, which is supposed to take one month:

> …meet people who know the area, do an IP mapping and negotiating with the researcher about ownership distribution between the incubator and the researcher. (*Operations Manager University Incubator, University C*)

A manager at University B also highlighted the preferred outcome of new KIE firms:

> We strive, all the time, for this [to achieve commercialization through supporting ideas into KIE firms] and it is the requirement from the national incubator program that they only want their resources to go to knowledge-intensive firms with international growth potential and a scalable business model. (*CEO University Incubator, University B*)

Although managers at the studied universities expressed it differently, all had thoughts about and perceived problems with researchers as entrepreneurs and their willingness to commercialize. Some did not go into detail about why that would be, but rather expressed it as follows:

> Most of them are researchers and do not want to go into the whole entrepreneurship thing and take that step. And maybe do not think of all of these ideas as anything that can be commercialized… (*CEO Innovation Office, University C*)

The same interviewee proposed a solution to this perceived problem of researchers being uncertain about what could be commercialized by having them go out to research environments and see for themselves and talk to the researchers involved. Many interviewees mentioned that researchers tended to want someone other than themselves to drive the development to a commercialization outcome:

> 80% are researchers from the university, often with a research result that they think has potential. Usually they want someone else to drive the process. (*Operations Manager Holding Company/University Incubator, University C*)

A manager at University C proposed a solution to this perceived problem:

> In that sense, we are the entrepreneur or at least we fix financing in order to recruit a real entrepreneur that can act as a driver for the case… We can invest and want them to remain as majority owners, either we can start a firm right away or we can sign an activity agreement. Usually, we want a stake of 10-40% and the idea givers get the rest… We do not buy, we finance the company, not the researcher. (*Operations Manager Holding Company, University C*)

5.3.2 In summary

Researchers are seen as more difficult to support in the commercialization and incubation process than other types of founders, but also, their projects are seen as having great potential impact.

5.4 How to deal with researchers – A managerial perspective

If a researcher has a great idea but for whatever reason does not want to actively commercialize that idea, the problem outlined earlier in this section, what happens then under inventor ownership? Most people would argue that nothing happens, as the responsibility, and potential financial reward, is on the individual researcher or research group. The managers at the studied universities, however, described a number of potential options. Five main ways of dealing with the perceived issue could be interpreted from the interviews, as shown in Table 5.4 below.

Table 5.4 Solving the problem

Quote	Activity	Theme
"…with a result that they think has potential and they usually want someone else to drive the process. In that sense we are the entrepreneurs or at least we fix financing so we can recruit a real entrepreneur that can drive the case… We can invest and want them to be majority owners, either we start a firm or we sign an activity agreement. Usually we want a stake of 10-40% and the idea givers get the rest… We do not buy, we finance the company not the researcher." *Operations Manager Holding Company / University Incubator, University C*	Start and finance a firm and hire an entrepreneur to drive the firm	1. Buying it
"At the same time, experienced business coaches do not grow on trees. You drain your operations at the same time as… it's the financing, but it was more of a test. We did it in a number of cases and it is possible to do but they are really expensive." *CEO University Incubator, University B*	Staff and finance the firm to get it going on its own and then get the resources back, repeat	2. Catch and release
"But to give it away, then it was not interesting. If it does not cost anything, then it has no value." *Operations Manager Innovation Office, University B*	Giving away ideas and IP that the researchers did not want to commercialize themselves	3. Giving it away for free
"…finding somebody that can take over the idea. And you will get a lower return, but for me it's more important that we get a return to begin with, and preferably what we have invested and some more because we are going to fail sometimes. If we can do this we will generate money for new projects." *Operations Manager Innovation Office, University B*	Acting like a TTO and trying to sell IP/ideas to the industry	4. Idea bank
"…in the project summer entrepreneur, we work with placing students as entrepreneurs or under-consultants to existing verification projects or existing incubator firms or other more established firms." *Middle Manager University Incubator, University B*	Engaging students as drivers for a firm or project that lacks a founder with the drive to do it by themselves	5. Students as cheap labor

Managers at University C described their solution to unwilling researcher-entrepreneurs as taking a stake in the KIE firm and investing in it, not the individual researcher or group of researchers that originated the idea.

At University B, the innovation office and university incubator had previously worked with a strategy that involved having the researcher in a back-seat role and remaining as a part-owner of the idea. The university incubator instead took control over the project and assembled a team and worked on what they described as a "catch and release" basis – the release part being if/when the created KIE firm was seen as able to sustain its own operations. However, this strategy involved having business coaches be part of that team, working in an operational role as opposed to the usual coaching approach to the project/firm. The incubator also lent the KIE firm money to get started, expecting it to be repaid when it was self-sustaining. The idea was simple: a way to get what was seen as great ideas going even if the researchers behind the idea were not interested in doing it themselves. However, this solution was perceived as expensive for the incubator as well in that it involved lending out a business coach to the new venture. The latter caused an unexpected problem as the business coach had to focus solely on this one firm, instead of coaching, for example, 10 other projects at the same time. Managers described this as inefficient and indicated that it also had as a potential consequence that the coach was, in many cases, recruited by the KIE firm as its CEO if the business took off. This, they argued, left the incubator drained of valuable human resources, but perhaps left the KIE firm better off.

When talking about practices of other universities, one manager pointed out a different take by another university that had another way of transferring knowledge to society. At this university, researcher IP that lacked a willing researcher entrepreneur was instead given away for free. The strategy, if it had been rolled out on a national level with a functioning platform, could have been a success, according to the interviewed manager. The premise, however, was that all of the universities would have to share the platform and strategy in order for it to work. The *idea bank project* is a VINNOVA-sponsored project that aims at doing something with researcher ideas with potential but where the researchers do not want to realize the idea themselves. The outcome in that project would be making a licensing deal. This activity closely resembles that of the traditional TTO.

Managers at Universities A and B described having special programs for students to take over a researcher's idea and receive a salary for it during a limited time period. The costs of this would be covered by the university and the students did not do this within the frame of their education, nor did they receive course credits for it. Managers at University C had a positive view of engaging students to be champions, described as the driving force, for researchers' ideas. University C also offers a course where masters students evaluate potential ideas from researchers. The approach of engaging students in different ways was a popular one at all three universities:

> … I must say, that became a success! (*Operations Manager Innovation Office, University B*)

Innovation offices and university incubators put effort into countering what they perceive as the unwillingness of researchers to commercialize their findings with market potential. Managers try to manage researchers that they see as being stuck on technical verification, unwilling to become entrepreneurs and researchers, and in general, being short of time. They do so by employing one of five, identified, options or strategies:

1. *Buying the idea* – this seemingly clear-cut approach would in another context perhaps indicate that the university is going to sell the idea somehow. However, in this context, the university starts a firm and lets the inventor stay on as a majority owner.
2. *Catch and release* – by starting a firm for the researcher and then staffing and financing it until it can survive on its own, this strategy also involves starting a firm.
3. *Openly distribute* – by giving the idea away to industry, this strategy is intended to still get research results out to the marketplace. However, what is the value of something that is priced at zero?
4. *Idea bank* – by trying to sell the idea, IP, to industry and negotiating with the researcher about the division of returns, this strategy was initiated by the innovation agency.
5. *Students as cheap labor* – students could be used to evaluate, develop, and staff a startup, or to take on some of the responsibility for taking the idea to a market by means of entrepreneurship in the researcher's stead.

5.4.1 In summary

In summary, university incubators have adopted or tried a number of ways of dealing with the perceived issue that researchers are unwilling to commercialize. Students have a dual function in university incubators and are often involved in supporting researcher projects in different ways.

5.5 Discussion

This chapter has addressed:

> Research question 1: How do incubator managers describe and work with researchers, as compared to other founders, and the incubation process in an inventor ownership environment?

I found that Swedish universities aim at producing new KIE firms and promoting academic entrepreneurship. In Figure 5.2 below, I present my interpretation of a process view of how the TTO in the Swedish context works. The TTO in this context can be said to be both the innovation office and the university incubator. According to managers at both types of organizations, they complement each other. Knowledge (represented by the solid lines in the figure below) does not flow in a single direction from the university through the TTO to society in the form of KIE firm formation, according to managers. Instead, entrepreneurial knowledge is acquired by the researchers and students that go through their processes. Interest from industry may also be a positive side effect of the innovation office's measures to market validate researcher ideas with the local industries. The network of the innovation office was said to be important for this validation.

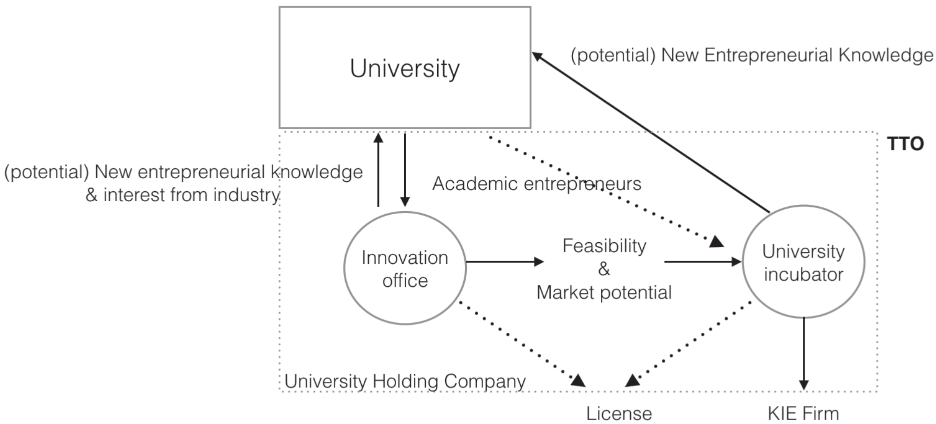


Figure 5.2 How the TTO works in Sweden (at the three studied universities)

Figure 5.2 presents a model of how TTOs in Sweden work. As mentioned earlier, I include in the term "TTO" innovation offices and university incubators. The solid lines indicate that this is what managers deem to be the usual path of knowledge flow, beginning with researchers being approached by (or themselves approaching) the innovation office. Then, these potential founders would, when their ideas are mature enough, access the incubator, and in the end new KIE firms would emerge. The dotted lines represent what the managers deemed as less likely and less desirable. Less desirable for them would be for the researchers to approach the incubator without first going to the innovation office, where they would potentially get help in determining feasibility and market potential. According to managers, at the innovation office they would also get advice on how to assess ownership of the idea/invention as well as the potential patentability of the idea.

The main difference as compared to the simplified generic process seen in Figure 5.1 is the complexity of the process as it involves more organizations and mainly produces KIE firms. In a simulation study of the two types of ownership environments, Damsgaard and Thursby (2013) found new firms to be the most likely outcome of commercialization in an inventor ownership context and licenses in the university ownership context. Bengtsson's (2017) findings, when comparing TTOs in the Nordic countries, were that indeed the inventor ownership environment in Sweden encourages academic entrepreneurship, if the TTO has access to business development capabilities. This further substantiates what I found at the three studied universities, which had all developed infrastructure, together with governmental funding agencies, to facilitate academic entrepreneurship.

Regarding the financing of the innovation offices and university incubators, instead of originating mainly from the university, it for the most part came in project form. The financiers were, for the most part, the government and innovation agency, which preconditions the financing on the creation of knowledge-intensive entrepreneurial firms. Thus the penultimate goal of incubation processes in Sweden is KIE firms.

Moreover, managers outline three reasons as to why they perceive researchers as especially difficult to handle. Researchers can be stuck on technical verification, do not want to become entrepreneurs themselves, and simply have limited time.

Further, managers describe five ways they have either handled this issue of unwilling researchers directly or heard of another incubator or TTO handling it. These five ways can be summated into two core responses, as shown in Figure 5.3 below:

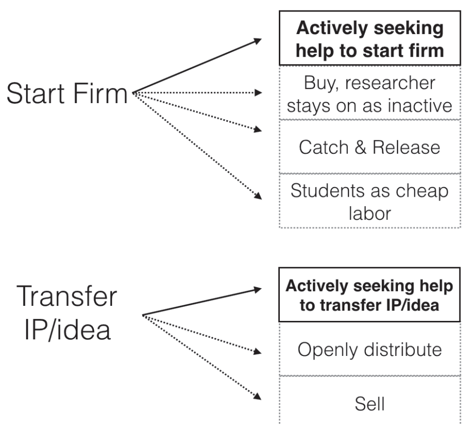


Figure 5.3 Two possible outcomes, two desired ways of achieving them, and five alternative paths to achieving commercialization if the researcher is unwilling to become an entrepreneur

If the Swedish university incubation processes were to encompass only researchers, perhaps the first strategy to tackle what they see as unwilling researchers, namely buying the idea and starting a firm in their stead, could be a suitable solution to the unwillingness problem. Hence, taking it even further, this could be a suitable compromise that could replace both university and inventor ownership. The main issue with this strategy, according to managers, was the risk of losing competent business coaches. However, from the viewpoint of the KIE firm or the economy as a whole, having a business coach onboard as the entrepreneur would perhaps be critical to the success of said KIE firm, as it lacked an entrepreneur to begin with. This could potentially impact the wider economy if the resulting innovation was market transforming enough. This strategy closely reassembles one of Kenney and Patton's (2009) alternative regimes. However, (1) one of the managers at the technical university indicated that in the Swedish context many of the commercialization activities are carried out in cooperation with industry, with unclear division of ownership of the resulting IP, and (2) not only researchers get help starting their company at the innovation offices and university incubators studied.

5.6 In conclusion

University incubators primarily provide services and resources around the incubation process. This process, as established in Chapter 2, I have conceptualized as involving many activities aimed at supporting the creation of KIE firms. As expected, managers describe the process as beginning with screening and ending in one of two ways: a new firm or failure. Further, researchers are seen as more difficult to support in this process than other types of founders, but also, their projects are seen as having great potential impact. University incubators have adopted or tried a number of ways of dealing with this perceived issue. Students have a dual function in university incubators and are often involved in supporting researcher projects in different ways.

When moving on to the following two chapters, the reader should keep the following in mind:

- Incubator managers interviewed describe selection among ideas. Researcher ideas are seen as ideas with much potential to become important innovations. However, the potential founders of these ideas are seen as stuck on technical verification, unwilling to become entrepreneurs themselves, and simply as having limited time.
- The incubation process, to simplify the description by Bergek and Norrman (2008), can end in either a new firm or the founder's failure to complete the process.
- Students can be founders themselves but they can also be hired to work on researcher projects where the founder is unable to.

5.6.1 Adding what we have learned to the emerging empirical model

In Figure 5.4 below, new details about how university incubators help facilitate the formation of KIE firms are added, in bold.

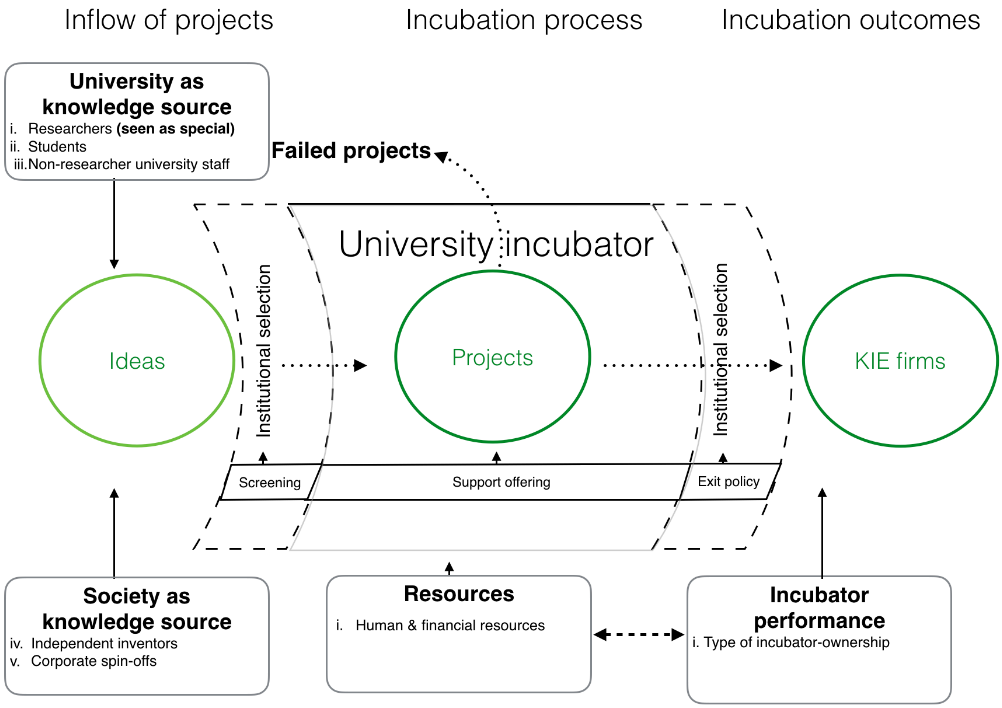


Figure 5.4 Conceptualization of how university incubators facilitate the formation of KIE firms with empirical findings from Chapter 5 added.

In Figure 5.4, in the upper-left box, researchers have been emphasized as being special from the point of view of the incubator managers. In this model, "special" denotes having ideas with great potential but also being seen by incubator management as less likely to start a business for a number of already outlined reasons. In the middle-top of the model, a dotted arrow is pointing to failed projects. This illustrates one of two ways founders leave the incubator: either failing to create a KIE firm or successfully creating a KIE firm. This holds for all types of founders, not only researchers.

6. Analyzing KIE project types' probabilities of becoming firms in university incubators

This chapter aims at addressing the following research question:

> Research question 2: To what extent does founder type affect the likelihood of projects completing the incubation process inside a university incubator?

I address the above research question by quantitatively analyzing the competing risks of projects either failing or successfully completing incubation at Swedish university incubators. I explore how the diverse backgrounds of different types of founders (researchers, students, other university employees, independent inventors, and corporate spin-offs) may affect their likelihood of completing incubation and creating KIE firms. As expected, (1) researcher-based projects have a lower probability of completing incubation in a timely manner than all other types of projects. However, (2) having research-initiated projects in an incubator seems to create spillover effects on all other projects, increasing their likelihood of survival. Moreover, (3) the probability of projects successfully completing incubation increases if the university incubator has less breadth, as measured in admitting fewer types of project founders, and (4) if the incubator has more experience, as measured in age.

This chapter includes a discussion on the ways projects can exit the incubator. The analysis is based on longitudinal data (2005-2014) from the national incubator program administered by VINNOVA. I apply a competing risks hazard model on the data. In previous chapters, the empirical setting of Sweden, and what makes it unique and interesting as a study object, has been explored. In this chapter, the special role of universities as producers of new knowledge-intensive entrepreneurial firms (KIE firms) and thus as contributors in a more direct way to economic growth is studied in greater detail and with projects as the unit of analysis.

6.1 Theoretical considerations for the chapter

In the sections that follow, I present and develop literature related to founder types in incubators, ending up with two hypotheses.

6.1.1 University incubators and type of KIE founder projects

Universities regard both TTOs and university incubators as important in their quest to transfer knowledge and technology to society in many forms (McAdam et al., 2012). One thing they do is support a wide variety of projects initiated by researchers, students (Culkin, 2013), other university employees, and even individuals without prior ties to the university. The effects of this diversity in terms of founder types have not yet been investigated in an incubator setting. This diversity is interesting in relation to starting KIE firms due to their differing prior knowledge as well as potentially different incentives and risks when attempting to commercialize ideas.

In a comparison study of the likelihood of becoming an entrepreneur, university employees were found to be less likely than non-university employees to do so (Åstebro et al., 2019). In the same study, the authors compared these rates across countries, specifically, the US and Sweden, to investigate whether the likelihood of becoming an entrepreneur differed. They found that the likelihood indeed was higher for Swedish university employees as compared to the US university employees. Åstebro et al. (2019) conclude that their results point to a positive effect on academic entrepreneurship in countries with the professors' privilege. I expect the co-location of projects within an incubator would lead to beneficial effects on project founders' likelihood of completing incubation as they would learn from other project founders. Earlier research findings on which resources were valued as important by project founders include access to networks and business coaching (Bergek & Norrman, 2008; Peters et al., 2004). These services would be of benefit for all project founders. However, I expect that how much projects would benefit from being co-located, and how much variation in founder types affects incubation processes for other projects, will vary by the types of project founders being co-located (incubated) at the same time. Moreover, I expect the background of the founders to be of importance for the likelihood of their interacting, as well as their technological backgrounds (Nooteboom et al., 2007; Bode, Buenstorf & Heinisch, 2019). These considerations suggest that both founders' own backgrounds and the composition of all projects at the incubator can condition the success of the incubation process. Below, I therefore reason about five theoretically meaningful types of founder projects. Three of the founder types are related to the university, while two are not.

Researchers

Researchers are early or late career university employees and faculty, pursuing an academic career. Following a long line of research on different incentives and logics

(Dasgupta & David 1994), Siegel et al. (2003) differentiate between a business person and a researcher in terms of what drives the person to commercialize. The authors describe the driving force behind commercialization, for researchers, as being acknowledgement of their research in the wider academic community as compared to the profit and financial motives of the business person. Researchers are, hence, thought of as seeking awards that are non-market-based, such as recognition by the scientific community for being first to discover something new or the number of citations (Stephan, 1996).

Researchers that pursue commercialization are not less productive than their peers when it comes to publishing (Buenstorf, 2009). Rather, there is a positive connection between participation in commercialization activities, such as starting a new firm based on research results, and publishing activity (Lowe & Gonzalez-Brambila, 2007); however, Buenstorf (2009) does not find this positive relationship. This productivity, as measured in published papers, does not appear to decrease after firm formation either (Lowe & Gonzalez-Brambila, 2007).

Jensen and Thursby (2001), in a large survey study of US TTO directors and licensing officers, concluded that researcher ideas tend to be embryonic, requiring inventor cooperation to achieve commercialization through a company. This, they argue, gives a moral-hazard problem, which requires a closer tie between researcher cooperation and financial reward. Surprisingly, the TTO directors and licensing officers did not think sponsored research was enough to compel researchers to bring their potential inventions to the TTO. Roach and Sauermann (2010), conducting a survey study on 400 PhD students, found that the students who expressed a preference for industry employment after becoming PhDs have a weaker "taste for science" than the students with a preference for an academic position. Fini, Grimaldi and Sobrero (2008) argue that entrepreneurial attitude is not the driving force behind venture creation by academics, but rather the desire to further their own academic position. Researchers at universities tend to commercialize through academic patents in specific fields, especially biotechnology and medicine, but where commercialization may take place through a large existing company (Lissoni et al., 2008). In relation to entrepreneurship, Bourelos et al. (2012) found that 76% of surveyed researchers in science and engineering fields in Sweden have positive attitudes towards commercialization, and also found a positive relationship between the use of incubators and commercialization of research through patents or spin-offs.

My interpretation is that researchers are subject to different kinds of risk than other founders. One such type of risk relates to job security, for example, the risk of an established researcher losing their job, or of an early-stage researcher not obtaining a permanent job. The other type has to do with fulfilling the norms of science, publishing, and being able to obtain project funding. The above considerations lead me to hypothesize the following:

> ***Hypothesis 6.1:*** *Researcher-based projects have the lowest probability of completing incubation and subsequently the highest probability of being canceled as compared to projects by other types of founders.*

Peer effects are the effects of peers on an individual's performance and behavior, and this has been applied to entrepreneurship. It has been used to explain why scientists become entrepreneurs (Moog et al., 2015). The authors identify (1) researchers with entrepreneurial peers and (2) researchers with a more diverse and balanced skill set to be more likely to have entrepreneurial intentions. Tartari et al. (2014) found that the effect of researchers with entrepreneurial peers being more likely to engage in entrepreneurship themselves is likely a mechanism of researchers competing with their peers for achievements and status.

Moog et al. (2015) conclude that researchers should be exposed to a variety of tasks, have balanced time allocation between a variety of activities, and participate in research collaborations with entrepreneurially experienced peers. There would be a greater probability of learning across disciplines and experiences if incubated with other types of entrepreneurs.

Students
Studying entrepreneurship among students has expanded, also as a consequence of the increasing amount of entrepreneurship education (Honig & Karlsson, 2010). Students have been identified as more likely than researchers to engage in entrepreneurship. In one study, Åstebro, Bazzazian and Braguinsky (2012) argue that compared to their peer group, that graduates generate firms equal in quality to those generated by researchers. Students have also been identified as both bringing their own ideas to university incubators and also being engaged in incubation projects based on researcher IP (Culkin, 2013). The same study called for policy action in the UK for additional support of students exploring their ideas with the support of university incubators, and crucially the incubators' business networks.

Other university employees
I include this category in the Swedish context. Due to the praxis of interpreting inventor ownership legislation in Sweden, other university employees besides researchers/teachers are usually awarded the same rights as researchers (SOU 2005). Åstebro et al. (2019) find that the likelihood of university employees becoming entrepreneurs was lower than that of non-university employees, but higher in Sweden than in the US. Their explanation is that Sweden has inventor ownership whereas the US allots the ownership of commercial research outcomes to the university instead. Karlsson and Wigren (2012) found that university employees who were older and engaged in more research were less likely to start a firm compared to other university employees. Further, they identified within-university activities, such as scientific publishing, as not having any effect on the propensity to start a firm, while external activities such as publishing in popular science publications, maintaining

relationships with the business community, and participation in contract research were identified as positive.

Corporate spin-offs

Other types of founders have been explored in earlier research, but from the presumption of likeness when entering one incubator type or another, as in corporate spin-offs coming from corporate incubators, for example. However, these project types have not been investigated within one particular type of incubator, although, research has studied growth of different types of founders (Dahlstrand, 1997a). Hence, there are good reasons to think that corporate spin-offs would have advantages, not only in firm formation, but also post-incubation in the marketplace (Dahl & Reichstein, 2007). Corporate spin-outs are also included in the project type designated as corporate spin-offs. This means that the category includes both spin-offs from existing firms as well as spin-outs from employees (Klepper and Sleeper, 2005). Advantages to other type of firms can be summarized as endowments related to resources such as capital, human capital, knowledge, and know-how from the mother-firm and market insights. However, much research suggests that this comparative advantage diminishes with time and that university spin-offs have advantages in the long run (e.g. Ortín-Ángel & Vendrell-Herrero, 2014). For this project founder type I would expect these projects to benefit from their links (both formal and informal) to companies. Moreover, it is not unlikely that these founder types are more business oriented than researcher founders.

Independent inventors

Independent inventors may also be involved in university incubators in the settings my study includes, although they have not been previously analyzed much in relation to university incubators. Independent inventors refer to individuals who, by definition, may lack the inherited endowments and resources associated with corporate spin-offs. In a report by the Ratio Institute, Sandström (2014) analyzes the inventors behind Sweden's 100 most important innovations, finding that 47% of them came from existing firms (employees), 33% from independent inventors, and the remaining 20% from researchers. Although surely important, independent inventors are a heterogeneous group. Dahlin, Taylor, and Fichman (2004) used patent data on 225 tennis racket patents and found independent inventors to be over-represented in both the most- and the least-influential patents in that industry. A possible explanation could be that they are more free-thinking and work from an un-entrenched position, that is, they are less affected by industry assumptions than other types of inventors (Dahlin et al., 2004; Lettl, Rost, and Wartburg, 2009). This can be interpreted as both beneficial, as they can "think outside the box," and detrimental, as they may lack necessary networks and depth of knowledge (Lettl et al., 2009). Moreover, this suggests at least that independent inventors may matter in my empirical context and incubators are usually open to supporting their projects. The above considerations and reasoning lead me to hypothesize the following:

> ***Hypothesis 6.2:*** *Diversity, seen as breadth of different types of founders accepted to incubators, has a positive effect on the probability of all types of projects completing incubation.*

The method employed in this chapter to address the research question and hypotheses is survival analysis with competing risks. I use a large national dataset provided by VINNOVA, containing 42 incubators (37 of which are used in this PhD thesis, see Chapter 3, Section 3.3.2, and Chapter 4, Section 4.3.1, for details) and a total of 3383 projects over a 10-year period (a description of the specific research design and data management for this chapter can be found in Chapter 3, Section 3.3).

6.2 Results

Table 6.1 provides my results. It has two sections to reflect the heterogeneity of exit types, that is, that there are two ways a project can leave an incubator in my dataset: completing incubation (graduation) or, alternatively, failing. The left-hand part of Table 6.1 (Models 1-4) displays results of models that have graduation as the exit event and cancellation as the competing event. The right-hand part of Table 6.1 (Models 5-8) uses the opposite definitions. I will discuss these results in two separate subsections. Projects remaining in the incubator at the end of the observation period (2014-12) are right-censored.

The differences in failure times between the two sets of models (and indeed sections) are driven by these censored projects. The number of censored projects remaining in the incubators affects the failure probability (of exit 1 or 2). This makes it necessary to have different settings to calculate the failure probabilities of each type of exit event (graduate or fail).

6.2.1 Graduation (cancellation as competing risk)

Figure 6.1 below visualizes the accumulated probability of completing incubation (exiting by graduating). The accumulated probability increases during the first four years. Few projects complete incubation afterwards. The accumulated probability reaches a value slightly above 50%.

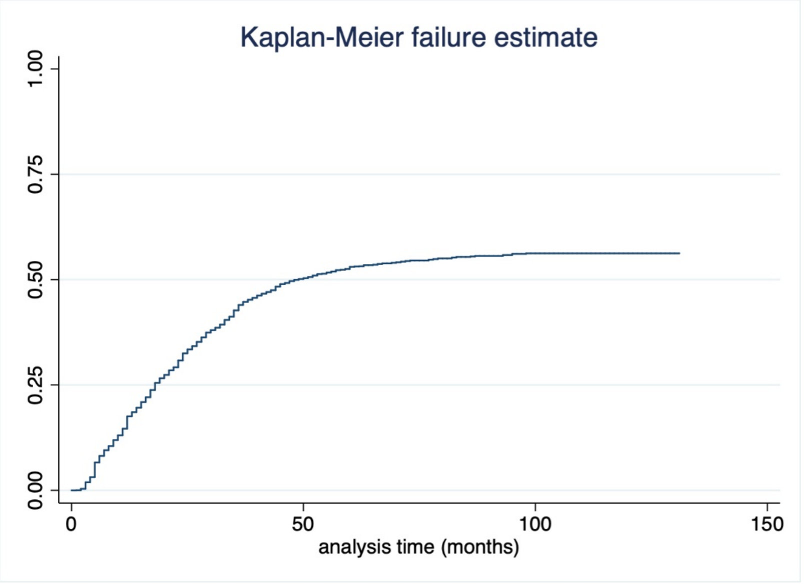


Figure 6.1 Kaplan-Meier failure function

Figure 6.2 below visualizes the accumulated probability of completing incubation by type of project founder. As can be gathered from the graph, researcher-based projects have the lowest probability and student-based the highest.

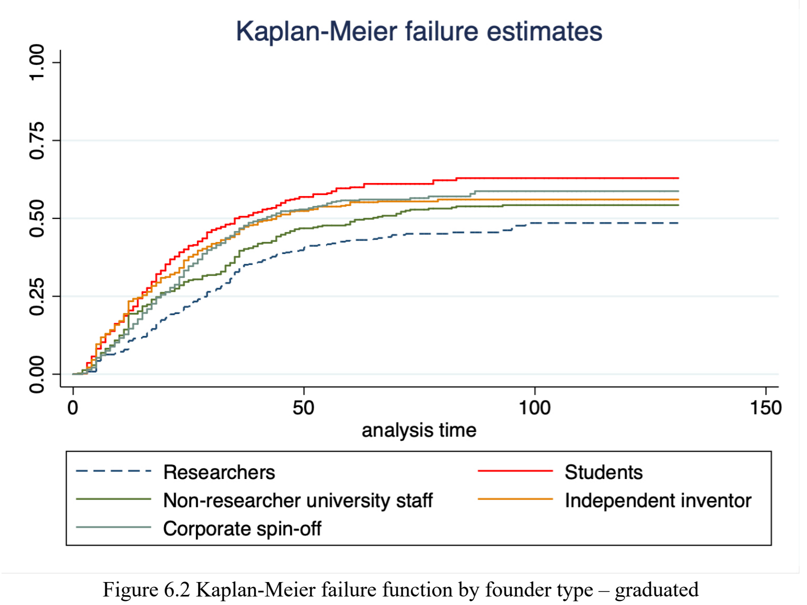


Figure 6.2 Kaplan-Meier failure function by founder type – graduated

Econometric results corroborate that there are systematic differences among project founder types' chances of completing incubation. Model 1 in Table 6.1 and Figure

6.2 illustrates this. Researcher-based projects are estimated to have a lower probability of completing incubation than all other types. Student-based projects seem to have the highest probability of completing incubation. However, in the complete model with all controls (Model 4 in Table 6.1, differences among categories are reduced, and point estimates suggest that projects by university staff may have the highest probability of completing incubation.

Breadth of admitted projects, measured in terms of how many types of founders are admitted to the incubators, is associated with lower hazards of completing incubation. This finding remains relatively constant between models. In other words, the opposite of breadth, or incubator specialization (measured in terms of fewer types of projects admitted) seems to be positive for projects' probability of completing incubation.

The intensity of the selection process around admitting projects also seems to matter. More competition for entry to the incubator appears to have negative effects on the probability of projects completing incubation, but the number of next-month applicants seems to be positive for projects that are already in. These coefficients remain roughly the same throughout the models.

The probability of projects completing incubation increases with the share of researcher-founded projects present in the incubator. Increasing incubator reliance on public funding seems to have adverse effects on projects' probability of completing incubation, particularly in the full model with all control variables (Model 4, Table 6.1). Experience of the incubator (as proxied by incubator age) only seems to matter for the most recently established incubators. Their projects have a significantly reduced hazard of completing incubation. Finally, my results suggest that it makes a difference where an incubator is located and what industry they aspire to enter. Specifically, projects incubated in the capital region of Stockholm had the highest chances of graduating from the incubator. Regarding industry, projects active in ITC (the largest category) had a higher probability of completing incubation than those active in most other industries, whereas being active in biotech yielded the lowest probability.

Table 6.1 CR results table, hazard for a project to complete incubation (1-4) and failing (5-8) at Swedish incubators

Co-efficient (z-score)	Model 1 (competing risks graduate - yes)	Model 2 (competing risks graduate - yes) FE region	Model 3 (competing risks graduate - yes) FE incubator + industry	Model 4 (competing risks graduate - yes) FE region + industry	Model 5 (competing risks graduate - no)	Model 6 (competing risks graduate - no) FE region	Model 7 (competing risks graduate - no) FE incubator + industry	Model 8 (competing risks graduate - no) FE region + industry
Project founder Researchers	*Reference category*	*Reference category*	*Reference category*	*Reference category*	*Reference category*	*Reference category*	*Reference category*	*Reference category*
Project founder Students	0.5192 (5.92)***	0.5229 (5.47)***	0.2136 (2.04)**	0.1985 (1.99)**	-0.2631 (-2.13)**	-0.2923 (-2.25)**	-0.0200 (-0.12)	-0.1602 (-1.04)
Project founder University staff & related	0.2635 (2.81)***	0.4869 (4.97)***	0.0991 (0.93)	0.2736 (2.83)***	-0.3427 (-2.57)***	-0.1747 (-1.20)	-0.2238 (-1.37)	-0.1673 (1.02)
Project founder Independent inventors	0.3682 (4.54)***	0.4539 (5.11)***	0.1536 (1.59)	0.1679 (1.84)*	-0.0426 (-0.42)	-0.2233 (-2.03)**	0.0789 (0.58)	-0.0621 (-0.48)
Project-founder Corporate spin-offs	0.3193 (4.12)***	0.4292 (4.97)***	0.2225 (2.43)**	0.2154 (2.46)**	-0.2372 (-2.33)**	-0.4657 (-4.12)***	-0.1482 (-1.05)	-0.2414(-1.82)*
Breadth of admitted projects		-0.1750 (-4.88)***		-0.1336 (-3.54)***		0.1017 (2.46)**		0.0945 (2.17)**
Competition at entry		-0.3226 (-5.14)***		-0.3231 (5.04) ***		-0.2531 (-4.67)***		-0.2579 (-4.45)***
Share of researcher-based projects		0.3709 (2.69)***		0.5230 (3.83)***		-0.1599 (-0.83)		-0.3990 (-1.87)*
Applicants following month		0.3649 (7.06)***		0.2582 (4.69) ***		-0.0241 (-0.42)		-0.0187 (-0.32)
Public funding%		-0.1046 (-0.68)		-0.2648 (-1.69)*		0.3867 (2.18)**		0.4593 (2.33)**
Age of incubator Old <1999		*Reference category*		*Reference category*		*Reference category*		*Reference category*
Age of incubator Middle-aged 1999-2004		0.1263 (1.32)		-0.0824 (-0.83)		0.1461 (0.83)		0.2484 (1.43)
Age of incubator Young >2004		-0.2590 (-2.17)**		-0.2871 (-2.36)**		0.2017 (1.53)		0.2339 (1.51)
Region (incubator)		Yes(20)		Yes(20)		Yes(20)		Yes(20)
Incubator fixed effects			Yes(37)				Yes(37)	
Incubation time (log)			-0.0738 (-1.66)*	-0.0965 (-2.20) **			-0.7665 (-12.17)***	-0.6236 (-10.29)***
Have staff			0.3691 (2.76)***	0.2960 (2.15)**			0.4232 (2.50)**	0.3948 (2.15)**
Have revenues			0.6011 (4.03)***	0.5911 (3.79)***			-0.9511 (-2.62)***	-1.0029 (-2.77)***
Have staff # have revenues			-1.1647 (-6.89)***	-0.9331 (-5.37) ***			0.4224 (1.13)	0.6346 (1.68)*
Industry fixed effects			*Yes* (20)	*Yes* (20)			*Yes* (20)	*Yes* (20)
No. observations	112,781	106,732	105,685	100,394	140,878	133,522	133,782	127,184
No. projects	3,383	3,263	3,044	2,958	3,388	3,277	3,049	2,972
No. failed	1,563 (graduated)	1,469 (graduated)	1,563 (graduated)	1,469 (graduated)	771 (canceled)	722 (canceled)	771 (canceled)	722 (canceled)
No. competing	776 (canceled)	761 (canceled)	776 (canceled)	761 (canceled)	1,573 (graduated)	1,549 (graduated)	1,573 (graduated)	1,549 (graduated)
No. censored	1,044	1,033	705	728	1,044	1,006	705	701
Log pseudolikelihood	-11989.566	-10716.165	-11477.643	-10570.635	-6080.556	-5422.3484	-5632.2855	-5238.7884
Prob>chi2	0.0000	0.0000	0.0000	0.0000	0.0149	0.0000	0.0000	0.0000
Robust standard errors (clustered)	*Yes (project-level)*	*Yes (project-level)*	*Yes (project-level)*	*Yes (project-level)*	*Yes*	*Yes*	*Yes*	*Yes*

*** p<0.01, ** p<0.05, * p<0.10

6.2.2 Cancellation (graduation as competing risk)

The accumulated probability of being canceled increases most strongly in the first two years, suggesting that cancellation decisions are made relatively early. (Remember that successful incubation is observed over a four-year period; see above.) The accumulated probability stays slightly below 25%. That the curve in Figure 6.1 does not go down in the end is due to right censoring and to the fact that there are few projects being canceled after this amount of time, that is, the firms that do fail cannot alter the accumulated probability and thus the curve stays flat.

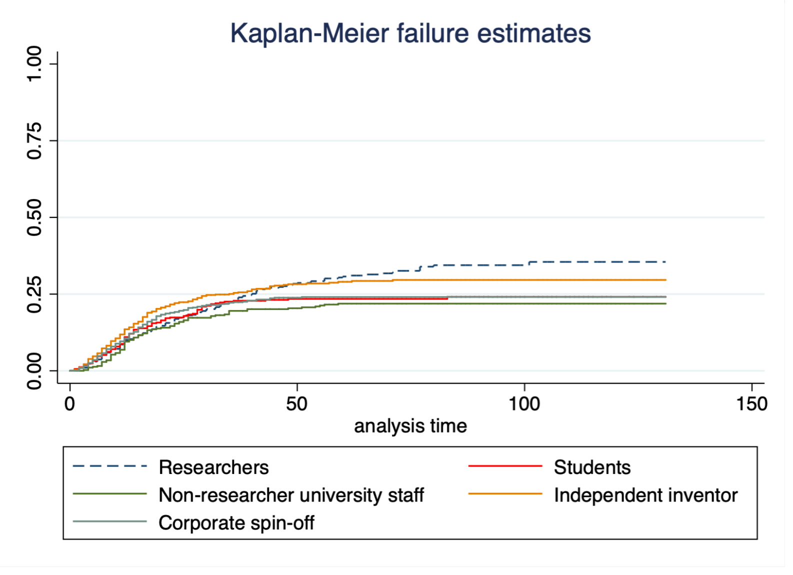


Figure 6.3 Kaplan-Meier failure function by founder type – failed projects

Looking at the hazard of cancellation for different categories of project founders, in the early models (Models 5-6 in Table 6.1 and Figure 6.3), researcher-based projects have the highest hazard. However, after including fixed effects (Models 7 and 8 in Table 6.1), a less clear-cut picture emerges, and the only category with a lower probability of being canceled is corporate spin-offs. Cancellation hazards are lower when larger shares of researcher-based projects are present in the incubator, whereas they increase with the breadth of admitted projects. No significant results are obtained for age, which is my proxy for incubator experience. Finally, competition at entry and the number of applicants in the following month are both associated with lower cancellation hazards, while increasing reliance on public funding comes with higher rates of project cancellation.

6.3 Discussion

At the beginning of the chapter, two hypotheses were elaborated from research question 2:

> To what extent does founder type affect the likelihood of projects completing the incubation process inside a university incubator?

In this section, this question and the elaborated two hypotheses will be answered. As outlined earlier in the chapter, a project can leave the incubator in one of two ways, either by completing incubation, or as it is called in many previous studies, graduating from the incubator, or by being canceled. These two ways of exiting the incubator contain a more nuanced picture with six different exiting events (see Figure 3.3 in Chapter 3 and the following paragraph). If projects do not graduate after four years in the incubator, however, it will likely not happen at all.

Corroborating Hypothesis 6.1, my first main result is that projects founded by researchers have a lower probability of completing incubation and becoming firms than projects with other types of founders, in line with previous findings (Rothaermel & Thursby, 2005). This was true in all models but with differing effect sizes and significance. Even though researchers tend to commercialize in specific sectors (Lissoni et al., 2008), my finding of a lower probability for researcher projects was robust after controlling for the industry. The bleak performance of researcher projects resonates both with prior evidence and practitioners' assessments. Researchers have been found to not be driven by profit motives as much as other founders; they have less incentive to complete incubation, and if they do, they do so much later than others (Siegel et al., 2003). Moreover, in Chapter 5, I found three reasons outlined by incubator managers as to why researchers were slower and less likely to graduate. They were seen as stuck on technical verification, as lacking the ambition to become entrepreneurs, and as having limited time to devote to their projects. Whatever the reasons, Swedish incubator managers appear to be right about their experiences with researchers being slower and less likely to create firms than other types of project founders.

The relatively poor performance of researcher projects might be taken as evidence that the Swedish regulatory environment leads to excessive academic entrepreneurship and to the wasteful support of marginal researcher projects in subsidized university incubators. However, my second main finding suggests that such a negative assessment of researcher-founders in isolation does not do justice to the relevance of their projects. Researcher-founders not only transfer knowledge from universities to society. They also have an important role within incubators where knowledge spillovers from their projects appear to have positive effects on the other types of projects.[5] My results also relate to the findings of Markman et al. (2005), who found researchers to have a positive effect on innovation speed later in the process due to their being involved in the business. Though researcher projects themselves were slower and less likely to complete incubation, their presence is associated with higher speed of other projects. My results thus suggest that positive spillovers on other projects make researchers vital to the incubator. They also point to additional benefits from the professors' privilege environment that was found to be more conducive to entrepreneurship than licensing (Bengtsson, 2017; Damsgaard & Thursby, 2013). If the professors' privilege encourages more researchers to engage in entrepreneurship, more positive spillovers may be the result for other project founders.

Student-based projects was the category that was most likely to succeed in the early models. However, after controlling for incubator or region-fixed effects and project-level controls, less difference between the categories was found, and other university employees came out on top. Could this be due to non-researcher founders having less to lose by starting the firm and exiting their previous positions than researchers do, that is, the employment option? Student founders have been found to be as likely as researchers to commercialize (Åstebro et al., 2016). They also, according to my results, seem as likely to graduate from university incubators.

That the endowments of the mother-firm would affect corporate spin-offs' probability of graduating (becoming KIE firms) from university incubators seems to be questionable. Rather, they might use university incubators as a way to test the potential of spin-offs at a very low premium. This allows them to access public resources to validate spin-off potential. The cost of producing KIE firms will be explored in the next chapter.

Attaching specific importance to independent inventors also seems misplaced as these types of projects do not have a higher probability of graduating than other types of projects and thus have no better ability to contribute to economic growth and potential market-altering effects. Excluding them from the university incubators on the same grounds does not seem prudent either. It might be an unequal distribution that is the cause of this. On the one hand, independent inventors that have been driven to entrepreneurship for lack of better options, and on the other hand, those that over-achieve their peers. My findings here are in line with the findings of Dahlin et al. (2004) and Lettl et al. (2009) inasmuch as there are a lot of independent inventors in Swedish university incubators and they may be of either type: hero or mediocre. Hence, policymakers would want the over-achievers and be wary of the ones driven to entrepreneurship by a lack of employment options.

[5] Margins and marginal effects (unreported) were used to check each category: the effect of an increased share of researcher-initiated projects was the lowest on other researcher-based projects' probability of completing incubation.

Hypothesis 6.2 predicted that the breadth of projects admitted to incubators (in terms of having a large number of different types of project founders) contributes to the likelihood of successful incubation. My results indeed indicate that breadth is relevant, but they are counter to Hypothesis 6.2, that entering into incubation at an incubator with less breadth (or more focus) seems to be advantageous for project graduation. This evidence in favor of incubator focus rather than breadth constitutes my third main finding. As my analysis covers a long time span of 10 years, it seems to contradict Levinthal and March's (1993) prediction that specialization and simplification (in my case, on one or two different types of project founders) may yield short-term success and long-term failure. Peer effects may provide an explanation for my finding. Positive effects on performance can be achieved by likeness. If project founders at the incubator have similar backgrounds, they are more likely to yield these types of effects.

Competition seems to have a dual role in the context of my study, both as a retardant when competing for entry and as an accelerant when the project is already in the incubator. Accordingly, highly demanded incubators may not be as good as less demanded ones when it comes to selecting the right projects. I propose as one possible interpretation that there is so much competition for entry that incubators with many applicants simply cannot systematically select the best applicants. Increasing competition for space may drive incubators to speed up the incubation process and make room for new entrants. Is this necessarily a good thing? This dual role of speed as linked to competition and selection should be studied further, as well as how incubators learn over time and create routines to better evaluate and select successful projects.

Finally, my study suggests that incubator experience is relevant, although with diminishing effects. While being incubated at a young incubator was related to a lower probability of graduation, no systematic difference was obtained between the two categories of more experienced incubators. Above some age threshold, then, incubators seem to have developed sufficient routines in handling, and perhaps more importantly, choosing the right projects.

6.4 Summary

This chapter has established that projects with researchers as founders are less likely to become KIE firms than other types of projects. This is in line with other research and also with what innovation managers at university incubators and innovation offices expressed in Chapter 5, although the managers did highlight the importance of researcher ideas. However, it has also been established that researcher-based projects have another role as well. The share of researcher-based projects affects the probability of other projects' success positively. The importance of researchers in university incubators therefore is threefold: (1) from Chapter 5 we know that they may bring entrepreneurial experience back to their research settings in the university; (2) they start new KIE firms, and after controlling for and explaining more of the unexplained variance, the difference between project types lessened; and (3) they seem to create a spillover effect that has positive effects on other projects in the incubator. On the incubator level, this chapter has established that specialization (in the form of less breadth of project founders accepted) and experience (as measured in age) seem to have positive effects on the survival of projects. In the next chapter, the question of the cost of producing these KIE firms is explored with the incubator as the unit of analysis.

6.4.1 Adding what we have learned to the emerging empirical model

In Figure 6.4 below, I add details from this chapter on how university incubators facilitate the formation of KIE firms.

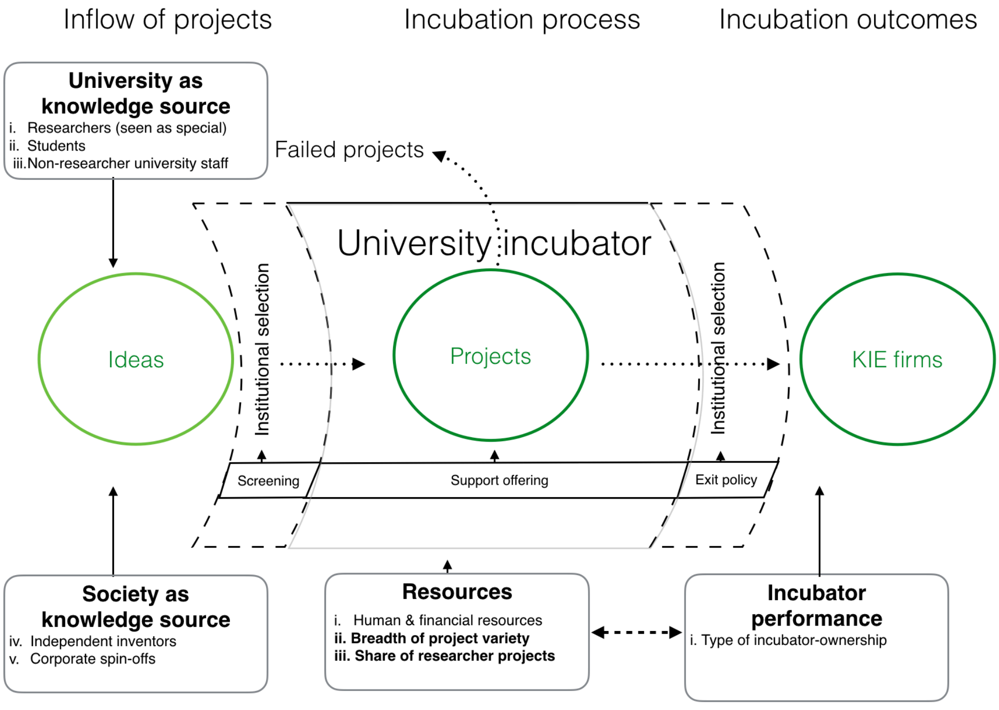


Figure 6.4 Conceptualization of how university incubators facilitate the formation of KIE firms with empirical findings from Chapter 6 added.

In Figure 6.4, the lower-middle box is added to. Breadth of project variety denotes that the diversity measure of how many types of founder the incubators work with seems to matter for the outcome of projects completing incubation, where admitting fewer types seems advantageous for projects' chances of completing incubation. The share of researcher projects also seems to have positive effects on other project founders' chances to complete incubation.

7. Efficiency analysis of incubator KIE firm formation

This chapter aims at addressing the following research question:

> Research question 3: What is the association between incubator type and resources on incubator performance?

I address the above research question by using descriptive statistics and OLS regression models to explain incubator efficiency, seen as the number of firms they supported or produced each year and the average amount the incubator spent on supporting them to this end. I find that (1) municipality-owned incubators support the creation of KIE firms at less expense than do university-owned incubators. Further, (2) the number of researcher-initiated projects is one of the drivers of this difference in cost as university-owned incubators support more of these types of projects. Moreover, supporting the creation of a greater share of researcher-initiated KIE firms creates different effects in the two types of incubators studied. If the incubator (3) supports the creation of a greater share of researcher-initiated KIE firms, it reduces the cost if the incubator is municipality-owned while increasing it if the incubator is university-owned.

7.1 Describing the study and dependent variable

Peters et al. (2004) argue that the most common way to measure incubator performance is to look at the number of firms being produced. Although they argue that this is also a rather rough proxy, it is the best indicator of incubator performance available. Moreover, Bergek and Norrman (2008) connected incubator goals with performance. They expanded on, among others, the research of Peters et al. (2004) by stating that specific goals might differ between incubators and that it is therefore important to connect the goals of an incubator with the performance outcome being studied. I agree with this more nuanced picture; however, an analysis of my results in Chapters 4 and 5 suggests that policy goals (Chapter 4) and implementation by incubator managers (Chapter 5) align in preferring KIE firms as the outcome of incubation. Thus, as helping to create new firms is the penultimate goal with incubation processes, at least for incubators participating in the national incubator program, I use this as a proxy for performance.

However, so as to not overstate the importance of one or two measurements to proxy incubator performance (which can be interpreted in many ways and with diverse ways of measuring it), I interpret the efficiency side of incubator performance as being the ratio of outputs (firms) over inputs (costs), while recognizing the ability to produce firms that ideally survive and contribute to the economy as effectiveness. My interpretation is based on the notion that organizational effectiveness is related to the external performance of a firm (i.e. doing the right things), while organizational efficiency is related to the performance of internal processes (i.e. doing the things they do as well as possible) (Mosselman, Prince & Kemp, 2004).

In the below Figure 7.1 I expand on my interpretation of incubator performance in relation to the cost-efficiency aspect I intend to analyze.

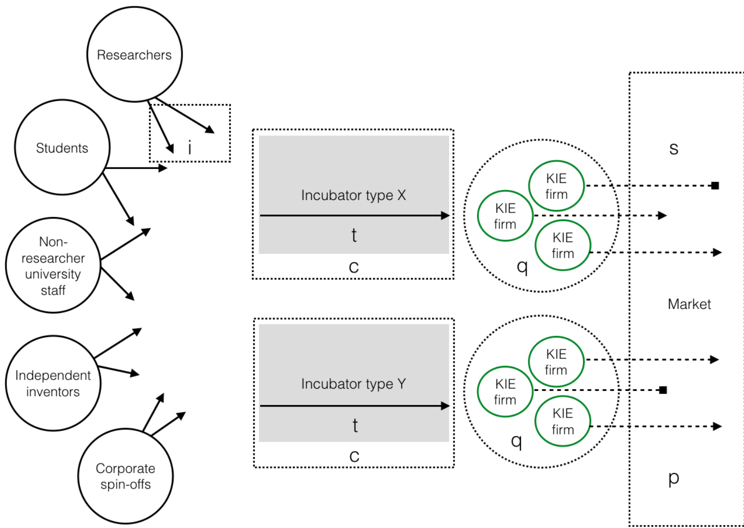


Figure 7.1 Proposed illustration of incubator performance

In the above Figure 7.1, on the left hand side, different types of projects enter incubation and in the middle they can enter two types of university incubators, in my case differentiated by their respective ownership into university-owned and municipality-owned incubators. To the left in the figure, the different potential founder types uncovered in Chapter 4 seek to be admitted into both types of university incubators. Researchers are affected by the institutional regime that governs ownership of their ideas (i). In the center circles of the figure, a number of KIE firms have been created. (t) stands for time, (c) stands for total cost and (q) stands for the quantity produced, (s) stands for the survival of said firms and (p) for firm performance (e.g. growth).

In Figure 7.1, a lot of different options to measure incubator performance is available and incubator performance can be seen as to include both effectiveness measures and efficiency measures. Here, I am interested in measuring cost in relation to incubator output, i.e. the number of firms they help create.

Therefore, this chapter quantitatively investigates incubator cost-efficiency in creating KIE firms. This is done by creating a performance measurement based on the total cost of maintaining the incubator divided by the number of KIE firms they graduate (i.e. the average cost of creating KIE firms, averaged over three-year periods so as not to overstate the importance of yearly deviations). This is followed by using different types of tangible and intangible resources that the incubators have available as an explanation.

While helping to create firms as cheaply and cost-efficiently as possible ought to be of socio-economic importance, it is important to notice this as a limitation of this study. Cheaper does not imply the quality of said firms.

7.2 Municipality-owned and university-owned incubators and performance

I have used the typology of incubators derived in Chapter 4, where two distinct types based on their respective ownership were found within the national incubator program, from which the datasets used in my PhD thesis come. These two types are municipality-owned and university-owned incubators. In earlier research (e.g. Dahlstrand & Politis, 2013) as well as in my previous chapter, these two types have been treated as one category: university incubators. I justify my use of the broader categorization in Chapter 6 by indicating that the focus of that study was on founder types and effects of diversity in founder types inside one broader categorization of university incubator. Additionally, dummies indicating the type of university incubator were unaffected when I added them in the above models.

The previous chapter, thus, assumed the interpretation of VINNOVA – that they support university-close incubators and that all of the incubators included in the VINNOVA data therefore can be included in a larger category of university incubators. However, incubator performance is often studied with different kinds of incubators (Phan et al., 2005; Mas-Verdú et al., 2015).

As this PhD thesis is primarily dealing with the formation of KIE firms at university incubators and as the special focus is on researchers, the broader categorization of university incubator leaves out important details when looking at incubator performance. Hence, in order to further analyze the effects of researcher projects, this time on the performance of incubators, using my subcategorization of university incubators into university-owned and municipality-owned incubators makes sense.

7.3 Incubator performance

A commonality in previous incubator performance research has been availability of different types of resources for the incubated firms (McAdam & Marlow, 2008; M'Chirgui et al., 2018). Drawing on the resource-based view (RBV), firms' resources are seen as distributed heterogeneously across firms. These resources are also assumed to be somewhat stable over time (Barney, 1991). The (assumed heterogeneous) incubator resources listed as important for projects and firms partaking in incubation processes have been identified by previous research as access to networks, reduced rents, support services, and professional business coaching (Peters et al., 2004; Bergek & Norrman, 2008).

There has, however, also been research that points to a mismatch between the needs of the projects and the offerings of the incubators (Van Weele et al., 2017). The same study found incubators to assess that business knowledge is their most important offering, whereas incubated project founders view access to tangible resources such as funding as their most important need.

Bergek and Norrman (2008) identify a number of research gaps that need to be addressed in future research in relation to incubator performance. One of these is directed at the efficiency of incubators:

> …the issue of efficiency in terms of the required resources needs to be investigated further: Do some models require fewer resources to achieve the same level of performance than other models? (Bergek & Norrman, 2008)

As Bergek and Norrman (2008) suggest, aligning the goal of incubators with their outcomes in relation to that goal ought to be the most appropriate way of evaluating incubator performance. While Peters et al. (2004) argue that the most appropriate way, of many, to measure incubator performance is to look at the number of firms graduating or being produced. It is interesting to explore differences in the costs associated with firm formation in different types of incubators, which in this study are municipality-owned and university-owned incubators.

Research suggests that projects in university incubators take longer to incubate (Rosenwein, 2000; Grimaldi & Grandi, 2005; Ratinho et al., 2010; Barbero et al., 2012), which in turn suggests that the time consumption would be higher for university-owned incubators, thus adding extra costs.

Thus, I expect that university-owned incubators with longer incubation periods for their projects would need to pay higher costs to develop those projects into KIE firms and indeed would have slower (average) graduation rates than the other type of incubator. This leads me to make the following hypothesis:

> ***Hypothesis 7.1:*** *Municipality-owned incubators are more efficient than university-owned incubators, as measured in cost of quantity of production.*

However, longer incubation times have also been associated with better post-graduation survival (Rothaermel & Thursby, 2005; Dahlstrand & Politis, 2013). Rothaermel and Thursby (2005) found strong university linkages to increase firm survival but delay graduation. They explained the delayed graduation with reference to the early stage of researcher ideas. Using this logic, a firm that graduates with a researcher founder would take longer to graduate, due to the adolescence of its ideas, and thus would accrue more costs on the incubator supporting it.

Thus, the delayed effect of graduation, as my results from Chapter 6 suggested, would translate when my analysis moves from using projects as the unit of analysis to that of the incubator as organization. Therefore, I would expect that the share of firms with researcher founders that are being created would affect incubator performance negatively. This leads me to make the following hypothesis:

> ***Hypothesis 7.2:*** *The share of researcher-based KIE firms produced affects incubator efficiency negatively, as measured in the cost of quantity of production.*

Using the incubator as the unit of analysis allows for a more rigorous investigation into differences based on the type of incubator. The methods employed in this chapter to address the research question and hypotheses are descriptive statistics and OLS regressions. I use a large national dataset provided by VINNOVA to analyze the differential performance of two types of incubators. This data contains 37 incubators that helped create a total of 1437 KIE firms over a 10-year period (the specific research design and data management for this chapter can be found in Chapter 3, Section 3.3.3).

7.4 Results

The results section is divided into two parts. Part 1 uses descriptive statistics to describe the sample of incubators and Part 2 reports OLS regression results using the dependent variable KIE cost (i.e. cost per created KIE firm/per year).

7.4.1 Descriptive statistics

Table 7.1 below provides a summary of descriptive statistics. The number of incubators included in the national incubator program of Sweden has increased from 15 in 2005 to 37 from 2013 and onward.[6] In total they have produced 1437 KIE firms during a 10-year period.

Table 7.1 Summary statistics (totals)

Year	Number of incubators	Number of projects screened	Number of projects in incubators	Number of produced firms
2005	15	997	210	13
2006	26	1,573	398	37
2007	29	3,054	524	98
2008	30	3,503	594	100
2009	32	3,951	622	147
2010	33	4,095	704	160
2011	36	3,976	746	176
2012	36	4,420	770	191
2013	37	4,140	712	269
2014	37	3,913	717	246
Total	*n/a*	*33,622*	*5,997*	*1,437*

The number of ideas the incubators screen, or evaluate, has grown from an average of around 37 to a somewhat stable level of around 100 ideas per year and incubator by 2007 and forward. Below, Figure 7.2 indicates somewhat of a stagnation in the average number of ideas being screened.

[6] The number of participating incubators was 42 at the end of 2014. Five incubators have been removed from the data as (a) three of them could not be classified as either municipality-owned or university incubators and (b) two were removed due to limited participation of no longer than three years and having a very limited amount of observations (projects/created firms). In Chapter 4, 41 of these incubators were included as the intent of the chapter was to classify incubators into different categories. The 42nd incubator (part of exclusion category (a) was in fact an accelerator that had a preset incubation time of three months and was excluded from all analysis and descriptive statistics.

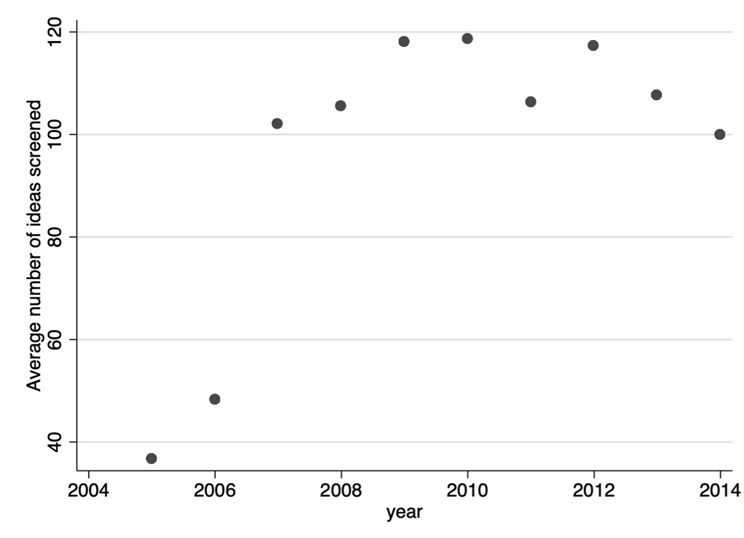


Figure 7.2 Average number of screened ideas per year and incubator

By that I mean that the number of screened ideas differs between the two types of incubators (as can be seen below in Table 7.2).

Table 7.2 Types of incubators and the types of ideas they evaluate

Type of idea screened	**University-owned incubators**					**Municipality-owned incubators**				
	N	mean	sd	min	max	N	mean	sd	min	max
University	183.00	53.69	69.25	0.00	394.00	128.00	29.63	57.01	0.00	413.00
R&D	183.00	24.37	27.54	0.00	141.00	128.00	8.12	12.02	0.00	80.00
Corporate spin-off	183.00	24.75	50.85	0.00	504.00	128.00	29.89	37.68	0.00	157.00
Research institute	183.00	1.25	3.66	0.00	30.00	128.00	1.19	2.76	0.00	15.00
Public sector	183.00	3.18	6.43	0.00	63.00	128.00	2.73	6.12	0.00	35.00
Inventor	183.00	29.49	47.15	0.00	400.00	128.00	38.06	49.78	0.00	236.00
In total	183.00	112.70	115.47	0.00	742	128.00	101.55	90.26	0.00	488

Table 7.2 shows that university-owned incubators, naturally, evaluate more ideas coming from universities but also more R&D ideas. In general, university-owned incubators also screen a larger number of projects each year.

Connecting back to Figure 7.1, if the input side diminishes in quantity, does this automatically affect the output side? Overall, the answer does not seem to indicate that this is the case, as the number of produced firms on average is on a positive trajectory. However, the measuring period might be too short to detect such effects.

In the graph below (Figure 7.3), the average number of KIE firms produced per incubator is outlined.

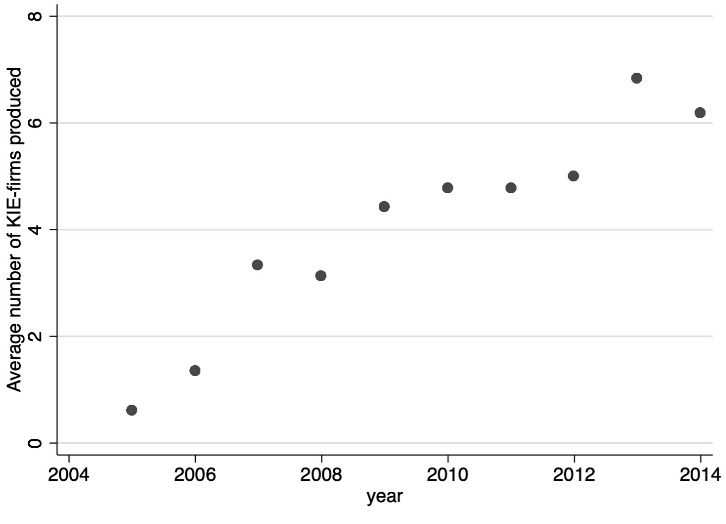


Figure 7.3 Average number of KIE firms produced per year and incubator

Looking at the average number of produced KIE firms by the type of incubator (Figure 7.4), they produce about the same number of firms each year.

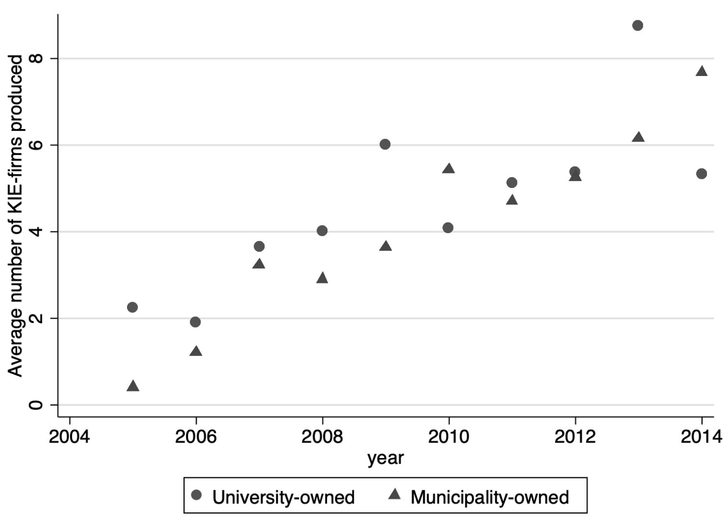


Figure 7.4 Average number of KIE firms produced per incubator type

The cost of producing one KIE firm has varied between years. In Table 7.3 below, there are variations between years as well as a rather large standard error. This implies that there is plenty of variation in the cost of production between incubators but also across time. This is the reason for creating a three-year average cost per KIE firm that is used as the dependent in the OLS models.

Table 7.3 Mean estimation on the cost of producing one KIE firm – all incubators per year

Year	KIE cost	Mean std. err.	[95% conf. interval]	
2005	4,549.137	783.323	3,007.835	6,090.439
2006	5,302.071	926.670	3,478.714	7,125.428
2007	3,616.452	814.757	2,013.298	5,219.606
2008	4,090.674	929.248	2,262.242	5,919.107
2009	3,656.895	832.467	2,018.896	5,294.895
2010	3,207.368	578.822	2,068.451	4,346.284
2011	3,104.168	628.190	1,868.112	4,340.223
2012	3,177.731	702.353	1,795.754	559.712
2013	2,186.633	439.561	1,321.733	3,051.534
2014	2,700.152	642.802	1,435.346	3,964.958
All years	3,419.651	231.243	2,964.647	3,874.655
Number of obs.	311			

Figure 7.5 below illustrates that it takes an average of just above 4 million SEK to produce one KIE firm at a university-owned incubator but less than 2 million at a municipality-owned incubator. However, this measurement does not indicate the quality of those firms. Indeed, there is an obvious difference between incubators under municipality and university management.

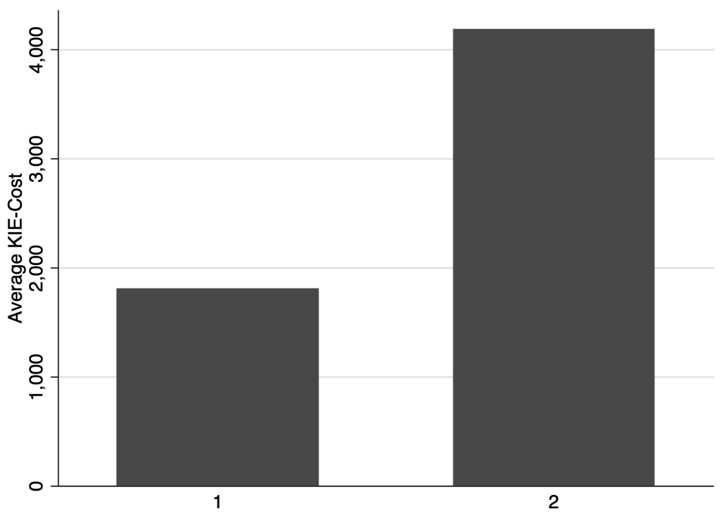


Figure 7.5 The average cost of producing one KIE firm for (1) municipality-owned incubators and (2) university-owned incubators

Below, Figure 7.6 adds the time dimension to the average cost of producing one KIE firm for the two types of incubator studied. The trend seems to persist throughout the years that municipality-owned incubators have lower costs associated with supporting founders to produce KIE firms.

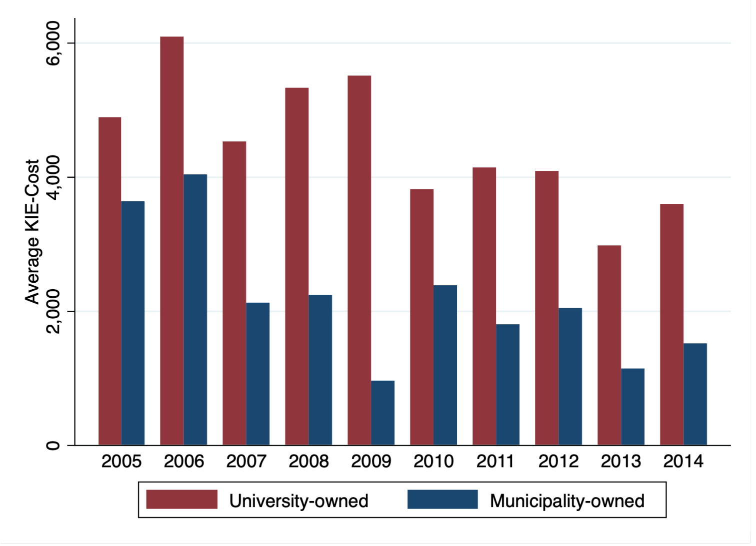


Figure 7.6 The average cost of producing one KIE firm for university-owned and municipality-owned incubators

Looking at the average time incubators spend on successful projects, seen in Figure 7.7 below, there appears to be little difference between the two types of incubators, although, university-owned incubators spend slightly more time supporting successful projects into becoming firms. On average, they both spend around 2.5 years to support successful projects.

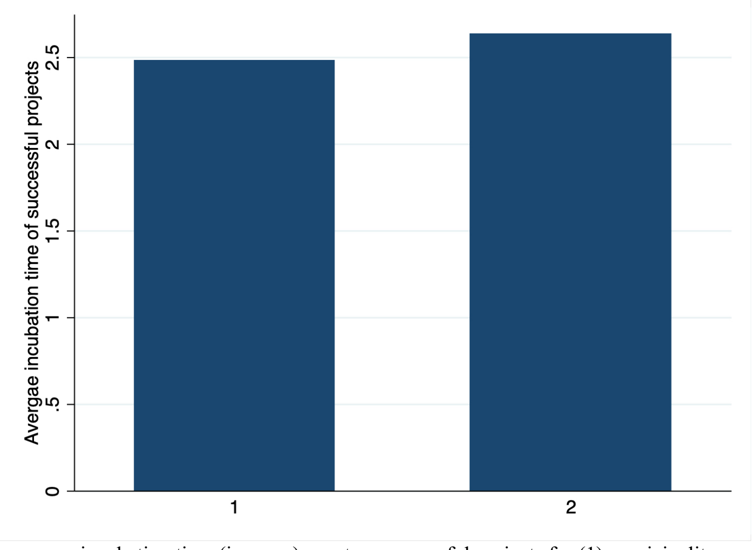


Figure 7.7 The average incubation time (in years) spent on successful projects for (1) municipality-owned incubators and (2) university-owned incubators

In order to dig deeper into the difference between the two types of incubators and efficiency of production in them, we continue with regressions (OLS).

7.4.2 Results from OLS regression

The results section with Table 7.4 uses the cost of producing one KIE firm averaged over a three-year period (abbreviated in tables as KIE Cost) as the dependent variable. See Chapter 3, Section 3.3.3, for a full account of the methods applied and how variables are operationalized. Models 1-3 use robust standard errors clustered on incubator. Models 4-5 use regional fixed effects and (heteroscedasticity-) robust standard errors. In brief, the reason behind the use of two types of heteroscedasticity-robust standard errors is to make sure unbiased estimation of standard errors, with the risk of underestimating standard errors and over-estimating significance.

All regional fixed effects are reported for Models 4 and 5 in Appendix D and are only briefly mentioned in the following sections.

From the results of Table 7.4, Model 1, we can clearly see the difference in the production cost between the two incubator types, where municipality-owned incubators on average help create firms at a discount of nearly 2 million SEK. This difference becomes insignificant in Models 2 and 3, while the variable again becomes significant in Models 4 and 5 with an estimated 2.5 million SEK difference between the two incubator types.

In Model 2, an interaction term is introduced that explains some of this difference. This interaction term is the share of researchers interacted with the type of incubator. The coefficient for the share of researcher-founded firms is insignificant throughout the models, while the interaction term is significant where introduced (Models 2-5).

Table 7.4 Results table 1 (KIE cost as dependent variable))[7]

	Model 1	**Model 2**	**Model 3**	**Model 4** FE Region	**Model 5** FE Region
	b/se	*b/se*	*b/se*	*b/se*	*b/se*
Municipality-owned	-1,973.99 (961.02) **	-993.27 (1176.60)	-1,044.73 (1016.07)	-2,528.47 (893.84)***	-2,457.64 (898.66)***
University-owned	*Reference category*	*Reference category*	*Reference category*	*Reference category*	*Reference category*
Share of researchers	3,145.61 (2482.60)	4,596.97 (2892.63)	4,067.00 (2478.50)	1,636.88 (1428.98)	1,897.52 (1437.51)
Breadth of projects admitted	-323.48 (270.22)	-286.15 (270.93)	-204.30 (214.07)	5.46 (150.49)	28.84 (150.15)
Share of researcher## municipality-owned		-7,563.86 (2,939.13) **	-8,771.52 (3,369.30) **	-8,271.87 (2,621.91)***	-8,335.73 (2,642.93)***
University-owned## Share of researchers		*Reference category*	*Reference category*	*Reference category*	*Reference category*
Old incubator			*Reference category*	*Reference category*	*Reference category*
Middle-aged incubator			-2,923.73 (1,009.74) ***	-4,495.26 (757.53)***	-4,505.64 (759.7935)***
Young incubator			-2,468.06 (924.25) **	-1,631.00 (395.40)***	-1,582.59 (405.68)***
Screened ideas			-3.41 (3.09)	-8.84 (2.12)***	-8.88 (2.13)***
Projects			46.51 (28.30)	45.21 (18.91)**	46.05 (19.25)**
Business coach share			-1,489.71 (1,309.65)	-2,164.97 (867.30)**	-2,109.08 (875.78)**
Regional dummies (incubator)[8]				*Yes (20)*	*Yes (20)*
Share of STEM firms[9]			-353.30 (111.89) ***	-270.33 (87.77)***	-245.65 (87.81)***
Industry development phase II					*Reference category*
Industry development phase III			-		-387.92 (351.86)
Industry development phase IV					-496.62 (358.77)
_cons	4,808.04 (1,264.82) ***	4,279.25 (1,371.12) ***	6,633.01 (1,944.79) ***	10,579.31 (1,111.66)***	10,542.47 (1,113.60)***
R2	0.14	0.17	0.40	0.58	0.59
N	311	311	303	303	303
Standard errors	Robust clustered on (incubator)	Robust clustered on (incubator)	Robust clustered on (incubator)	Robust	Robust

*** p<0.01, ** p<0.05, * p<0.10

[7] Models were also regressed with year-dummies to ensure year-to-year variations did not affect results (they did not).

[8] See Appendix D for results.

[9] Share of produced KIE firms from: clean tech, nanotechnology, space technology, and life science

In Figures 7.8 and 7.9 below, we can see that an increased share of researcher KIE firms being produced lowers the average production cost for municipality-owned incubators, while increasing it for university-owned incubators. The two figures show slightly different confidence intervals, as illustrated by the vertical lines. Both figures are reported in order to point out this slight difference and the cause being differences in what type of robust standard errors are used and, for Figure 7.9, the use of incubator dummies. To err on the side of caution, the reader can assume Figure 7.8 to be a more cautious estimate of the effect.

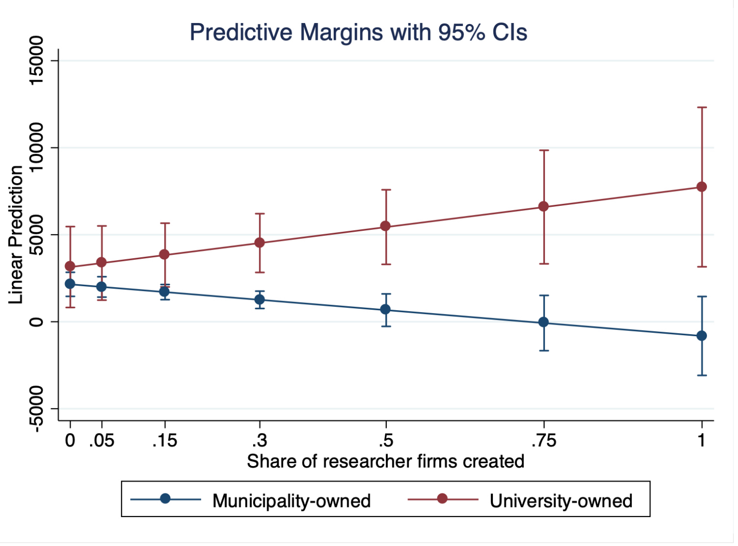


Figure 7.8 Predictive margins on the interaction effect from Table 7.4, Model 3 (with cluster-robust standard errors, clustered on incubator level)

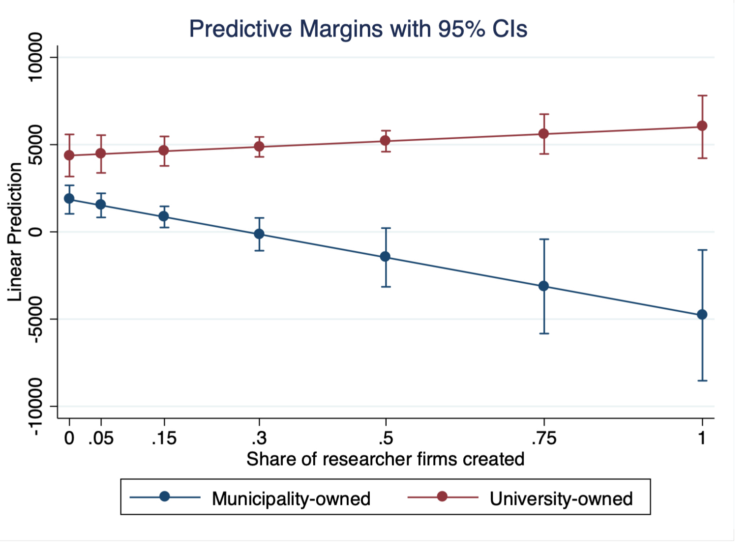


Figure 7.9 Predictive margins on the interaction effect from Table 7.4, Model 4 using heteroscedasticity-robust standard errors and with fixed effects on regional level.

While keeping the slightly different results in mind, both figures indicate that helping to create a greater share of KIE firms with researchers as founders seems to have the opposite effect in the two types of incubators. This difference increases when controlling for additional factors and holds significance throughout the models. The share of produced researcher KIE firms thus seems to be a key driver of cost, with the cost increasing with the relative share of researcher KIE firms produced, but only for university-owned incubators.

Breadth of projects admitted, an important finding in the previous chapter, seems to have no effect and small coefficients when looking into the cost of producing KIE firms.

The experience of the incubator, measured by its relative age, provides an interesting result. The most experienced, oldest incubators produce at a higher relative cost than younger incubators, with middle-aged incubators having the lowest average cost of production.

An increase in the number of screened ideas, that is, higher demand, reduces the cost of production in Models 4 and 5, while it is insignificant in Model 3. However, the number of incubated projects has a significant effect on the cost of production in Models 4 and 5. In those models, an increase of one project, all else being equal, increases the cost of producing a KIE firm by 42 thousand to 46 thousand SEK. An increase in the share of business coaches, however, resulted in a substantially reduced cost, with significant effects in Models 4 and 5.

Considering the regional dummies, incubators located in the capital region of Stockholm have the highest cost of producing KIE firms (see Appendix D for the full table). The control variable STEM, controlling for share of produced KIE firms that is STEM, decreases costs by a substantial amount and is highly significant throughout the models. The experimental variable of industry development phase, discussed in Chapter 4, shows no significant results.

7.5 Discussion

Below, I outline and briefly address the stated hypotheses that were made in order to be able to answer the research question (research question 3) guiding this chapter:

> ***H7.1:*** *Municipality-owned incubators are more efficient than university-owned incubators, as measured in the cost of quantity of production.*

The short answer to the hypothesis is yes, if looking at the cost of production. In line with much other research, I used the type of incubator to compare incubator performance (Phan et al., 2005; Mas-Verdú et al., 2015). However, I connected performance with the main outcome of Swedish incubators (using the definition set by Bergek and Norrman, 2008). I identified this main outcome in earlier chapters as created KIE firms. As the findings of the previous chapter suggested, the share of firms with researcher founders and the breadth of projects admitted mattered for projects to graduate, I controlled for these factors. An analysis of my results suggests the cost of production to be significantly higher in university-owned incubators.

Moreover, corroborating my second hypothesis:

> ***H7.2:*** *The share of researcher-based KIE firms produced affects incubator efficiency negatively, as measured in the cost of quantity of production.*

One of the main drivers of the cost seems to be the share of researcher KIE firms, but this factor had differing effects in the two types of incubators. The knowledge-intensity component thus seems to add financial costs as well as what the incubator management in Chapter 5 described as other difficulties in dealing with researchers, such as their never being truly finished with a potential innovation. The findings of Rothaermel and Thursby (2005) as well as the previous chapter, which suggested slower progress and less likelihood of completing incubation for researcher-based firms, affect the costs of production for incubators differently. Similarly, Barbero et al. (2012) studied differences between incubator types and found differences in the type of innovations that researchers and other founders developed. They suggested that the differences were due to the early stage of researcher ideas in university incubators as compared to projects incubated in other types of incubators, an argument building on the research of Jensen and Thursby (2001).

However, this effect did have opposite effects in the two (sub-) types of (university) incubator studied. In university-owned incubators, the above reasoning on the cause of cost increase to help create KIE firms seems reasonable. In municipality-owned incubators (see Figures 7.8 and 7.9), we can see that an increased share of researcher KIE firms produced lowers the average production cost for municipality-owned incubators while having the opposite effect in university-owned incubators. This result relates to the one found in the previous chapter, where the share of researcher-based projects found in the incubator affected the hazard of completing incubation for other types of projects. Here, instead, the share of produced KIE firms with researchers as founders affects the costs incubators accrue while helping to create new KIE firms differently depending on the type of incubator.

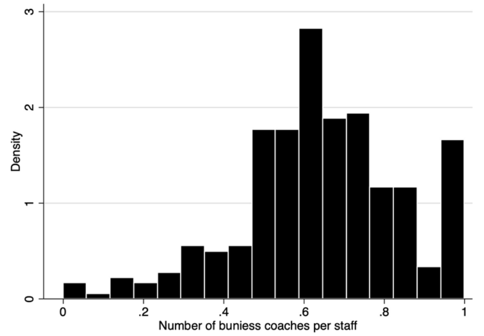
However, it is important to notice that this increase in cost does not indicate the quality of the resulting firms. On the contrary, findings from a recent study from Gifford et al. (2020) indicate that academic experience has a positive impact on KIE firms in the top-quantile of growth. This, they argue, could be due to making it easier for the KIE firm to maintain ties to the university and academic experience could also be of use in building firm capabilities. They conclude that only a few of the KIE firms surveyed grew, but the firms that did had high growth rates in employees and turnover. This would confirm the assumption of KIE firms, founded by researchers, as instrumental to economic growth. It would also justify the societal costs of operating university-owned incubators.

Moreover, the results from incubator experience are twofold. Incubator age, or experience, affects the costs of supporting one KIE firm to completion negatively. Incubator experience is negative on the cost of production, which might be explained by an accumulation of costs in the incubators, for example, cost of human capital, properties, and equipment. These costs would accrue over time, leaving newer incubators with a cost advantage.

The industry development phases construct did not show any signs of significance. As this measurement is very aggregated and has limited accuracy, the non-result has to be taken with a grain of salt. Further studies into the effect of professional training for business coaches would be necessary to really uncover the true effects of this program. However, professional training and industry networking are held up in the routines literature as a deliberate way to gain organizational routines – the organizational ability to repeat (successful) behavior (Nelson & Winter, 1982). Hence, the effects of this professionalizing program ought to have had other consequences, if not on the efficiency side of incubator performance, then on the effectiveness side. Also, having a higher relative share of business coaches, those that underwent training in the VINNOVA program, had cost-reducing effects on incubator efficiency.

An increased share of business coaches seems to have, on average, a positive effect on the cost of production measurement. It decreases the cost related to producing KIE firms by quite a lot. This might explain the high number of business coaches at Swedish incubators.[10]

[10] Histogram of business coaches per employees



However, the approach I used in this study, using the measurement of cost of the number of new firms created, comes with some limitations. Two such limitations are that the approach does not provide information on (1) the quality of the produced firm and (2) the survival of that firm after entry into the market.

These aspects are important but fall outside the scope of my PhD thesis (for further discussion on limitations, see Chapter 3, Section 3.5). There are, however, some indications from previous research suggesting that university startups survive to a larger degree than non-university startups after graduating from an incubator (Rothaermel & Thursby, 2005). Due to these firms being knowledge-intensive, there is also a presumption of quality (Malerba & McKelvey, 2020).

The screening practices at Swedish incubators indicate highly selective incubators (see Chapter 4). Hence, if we think that the incubators made good choices when selecting their projects, the subsequent admitted projects would be of a high quality and the subsequent firms (which are fewer than the admitted projects and their hazard of completing incubation is explored in the previous Chapter 6) would be even better.

7.6 Summary

This chapter has established that municipality-owned incubators produce firms at lower costs than university-owned incubators. It has also established that university-owned incubators have a higher production cost per created KIE firm partly because they produce a larger share of researcher KIE firms. However, producing a larger share of researcher KIE firms affects municipality-owned and university-owned incubators differently. In the first category, it lowers the average production costs, while in the second, it increases costs. Lastly, the experience of incubators had negative effects on the cost of production. This might be explained by the accrued costs that come with time.

7.6.1 Adding what we have learned to the emerging empirical model

In Figure 7.10 below, how university incubators facilitate the formation of KIE firms is added to with details from this chapter.

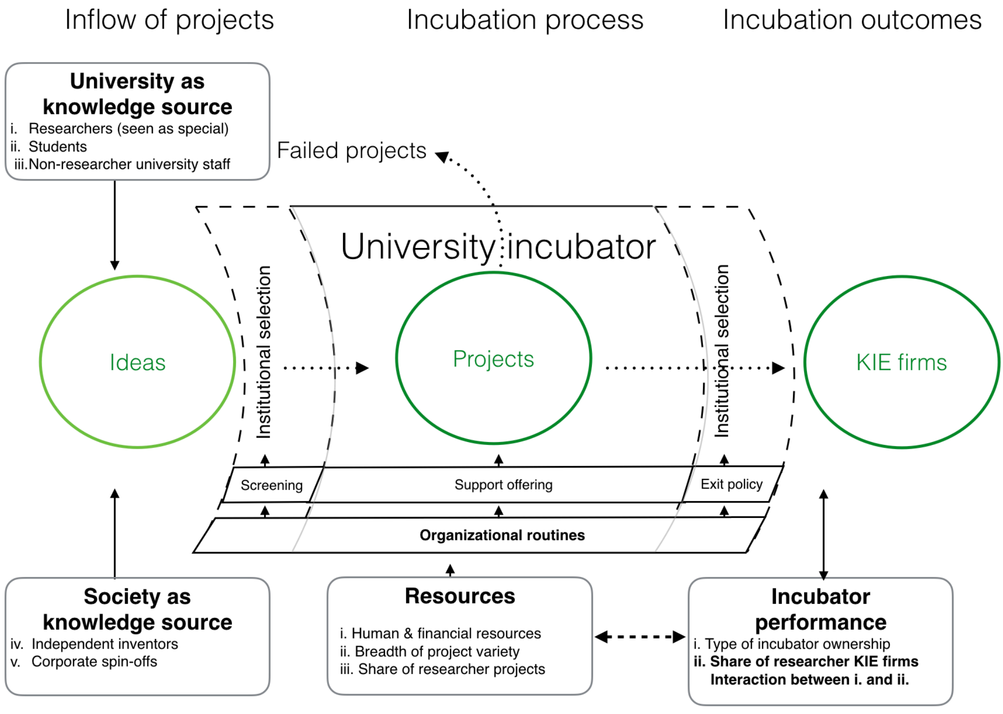


Figure 7.10 Conceptualization on how university incubators facilitate the formation of KIE firms with empirical findings from Chapter 7 added.

In Figure 7.10, my results suggest that the share of researcher KIE firms is a contributing factor in the cost difference between university-owned and municipality-owned incubators. Having a larger share of these firms seem to have opposite effect on the two subsets of university incubator: creating cost-reduction in municipality-owned incubators and an increase in the cost of helping to create one KIE firm at university-owned incubators. Based on the results of this chapter, one could argue that underpinning some of the observable differences between incubator types, perhaps, but more likely between individual incubators, there is a difference in how well developed their respective organizational routines are. According to Nelson and Winter (1982; 1977), a routinization process starts with doing a certain task and thereby learning the task. With time, this task is routinized and becomes part of the organizational routines that govern how well a firm does what it does.

8. Discussion and Conclusion

My PhD thesis has investigated how university incubators impact the formation of knowledge-intensive entrepreneurial (KIE) firms in Sweden, which is interesting due to Sweden's unusual institutional regime for commercializing research results. "Commercialization done differently" refers to university incubators in the context of the institutional regime of Sweden, which differs in that individual researchers own their own commercial research results and have complete agency over what to do with them instead of the university owning them. Under this institutional regime, previous research has suggested that university incubators may favor the creation of KIE firms, and I set out to find out how they do so.

A mixed-methods approach has been used, utilizing explorative case study, survival analysis, and OLS regression. The study thus triangulates and uses qualitative interviews, policy documents, and secondary data sources as well as a large longitudinal national database provided by the Swedish Innovation Agency (VINNOVA).

My research leads to three findings, of relevance for understanding how universities interact with society. The first finding relates to how interviewed incubator managers view researchers. Although researchers are perceived as being slow, less eager to start a business, and stuck on technical improvements, their ideas are also viewed as high-impact and as the most important ones. To deal with researchers as founders, incubator managers have developed a number of options, all of which aim at either starting a firm anyway or selling the idea.

My quantitative findings substantiate the above mentioned managers' view of researchers as founders but further indicate that having more researchers facilitates a speedier and more successful process for other project founders. By differentiating by ownership of university incubators, I examine performance. University-owned incubators seem to have higher costs per supported firm, in part because they have more founders that are researchers. However, if the incubator is municipality-owned, having more researchers instead seems to reduce costs. Thus, even though university-owned incubators help facilitate the formation of KIE firms at a higher cost, a likely interpretation is that the potential in the type of firm they help create is greater. I synthesize my findings and conceptualization by also proposing a process model of how university incubators facilitate the formation of KIE firms under the institutional regime for commercializing research in Sweden.

The structure of this chapter explains my research results in terms of my purpose, e.g. to investigate how university incubators impact the formation of knowledge-intensive entrepreneurial firms in Sweden. To do so, I synthesize and explains, how my research results provide new insights to the literature, in relation to my three research objectives. Each chapter addresses a specific research question.

In Section 8.1, I provide the answer to the first research objective, on literature synthesis, model, and results. I do so by providing an overview of my main results, as well as the updated process model of the three stages of inflow of projects, incubation process, and incubation outcomes. The specific results for each research question are presented, as well as an updated model that builds upon the literature review in Chapter 2 as well as my empirical findings.

In Section 8.2, I update and discuss the key concepts and definitions used throughout this PhD thesis. The definitions discussed are: university incubator, the incubation process, incubator performance and KIE firms.

In Section 8.3, I discuss my results relative to the second research objective, on national policy under inventor ownership regime in Sweden, while in Section 8.4, I do so in relation to the third research objective, on differential outcomes and performance. For both sections, I provide a short synopsis of each relevant chapter, and return to reflect upon my findings relative to existing literature.

In Section 8.5, I reflect upon future research topics. I do so by elaborating upon three interesting research questions for the future. These topics are new ones, which arise from my results.

In section 8.6, I propose three implications for public policy. This section provides interesting reading both from a policy and practitioners perspective.

8.1 Research objective 1: Literature synthesis leading to a process model of commercialization done differently

My first research objective is to synthesize relevant literature in order to propose and revise a process model of how university incubators, under an institutional regime of inventor ownership, affect the formation of knowledge-intensive entrepreneurial firms.

I address this objective by first providing an overview of my research questions and main results, which forms the answers to the stated research questions. I then present a final process model that builds on the initial model presented in Chapter 2, Section 2.5, and in doing so, integrates my empirical findings in relation to the model. This process model is based on my three phases of university knowledge-intensive entrepreneurial (KIE) firm commercialization: inflow of projects, incubation process, and incubation outcomes.

Table 8.1 below provides an overview of my main results.

Table 8.1 Chapter overview with research questions (RQs), method used to address each RQ, and summarized results

Chapter	Main RQ	Methodology	Main results
4	NA/Empirical context chapter	Explorative case study/descriptive statistics	Since Sweden have an inventor ownership institutional regime (a) the individual researcher becomes important in transferring university knowledge, therefore (b) university incubators provide services to develop an idea into a firm to researchers and students, as expected. However they also provide these services to (c) people unrelated to the university. I identify a variety across university incubators in terms of founder types and expected industry of their projects.
5	How do incubator managers describe and work with researchers as compared to other founders and the incubation process in an inventor ownership environment?	Explorative case study	The incubation process (a) is the main way university incubators support potential founders and is described as (b) beginning with screening and ending in one of two ways: completing incubation or failing. Further, researchers are seen as more difficult to support in this process but also as having projects with great potential. University incubators have (c) adopted or tried a number of ways of dealing with this perceived issue, and students are often used in aiding researcher projects.
6	To what extent does founder type affect the likelihood of projects completing the incubation process inside a university incubator?	Competing risks (survival analysis)	As expected, researcher projects (a) fail more often and are slower than other types, however, they have (b) a positive effect on other projects' probabilities of successfully completing incubation. While (c), if the incubator has less breadth and (d), is more experienced, the likelihood of projects' successfully completing incubation increases.
7	What is the association between incubator type and resources on incubator performance?	Descriptive statistics and OLS based partly on risk data	Municipality-owned incubators have (a) a lower cost per successfully exited KIE firm as compared to university-owned incubators, as expected, however, if they (b) successfully exit more researcher KIE firms, the cost per successfully exited firm goes down substantially; this effect instead increases the cost in university-owned incubators.

In the above table, I also specify which methodology I have used to be able to answer the outlined research questions. In Figure 8.1 below, I outline a model of university incubation processes under inventor ownership, building on the theoretical foundation set in Chapter 2 and my empirical findings.

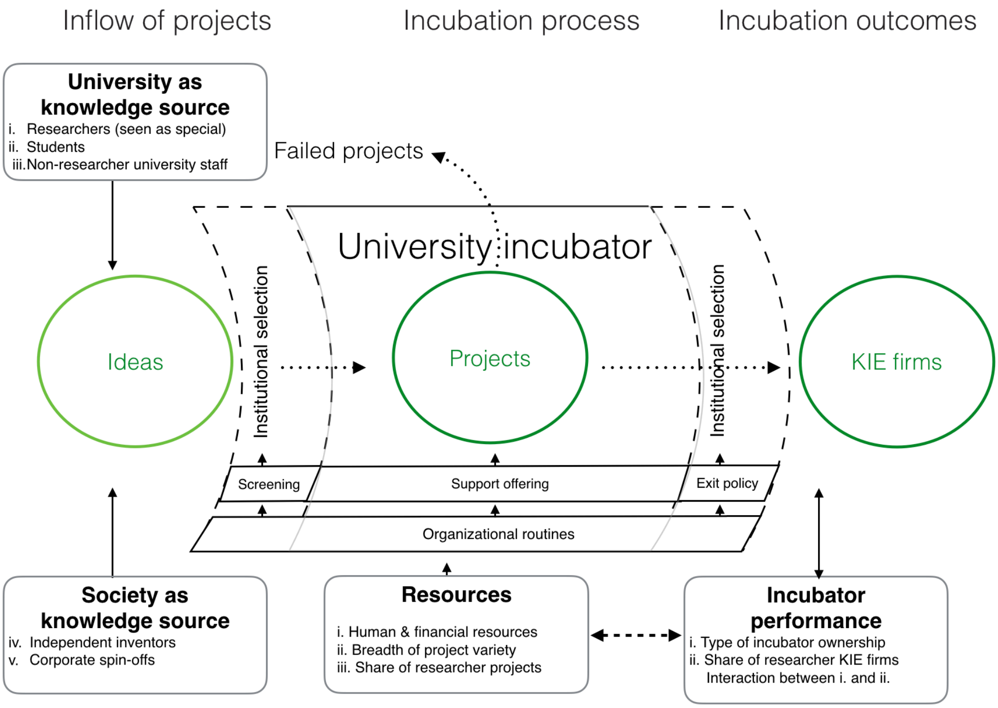


Figure 8.1 Elaborated process model: how university incubators facilitate the formation of KIE firms

In Figure 8.1, on the far left, the two boxes on top and bottom, two knowledge sources are identified as important: knowledge internal to the university (i. Researcher, ii. Students, and iii. Non-researcher university staff) and external to the university; I call it society for lack of a better word. As described previously, universities produce knowledge by doing research. They also educate students, and in so doing, they spread this knowledge. The third mission revolves around spreading knowledge in other ways by interacting with society (Smith, 2007).

Ideas, represented by the left-most green circle, come to the incubator from these two knowledge sources by would-be entrepreneurs.

Ideas are then selected by the incubator, represented by the institutional selection dotted box. Those ideas that are admitted (middle green circle) evolve into innovation projects. The reason for using the term "institutional selection" was discussed in Chapter 2, but in short, it is to differentiate this type of selection from the type that firms are subject to in a marketplace. Hence, I follow Nelson and

Winter's (1982; 1977) definition of selection, which makes a distinction between market selection and non-market selection. Market selection, they argue, involves customers, retailers, and producers making a selection based on firms' fitness to survive in a market economy. Non-market selection, they argue, refers instead to selection done by universities, commercialization-infrastructure, norms, and customs. This PhD thesis is not about market selection as the study ends when KIE firms leave university incubators, ideally entering the market. Rather, I see incubators as one type of mechanism for selection of KIE firms.

Incubator performance, represented in Figure 8.1 as the box on the lower right, has been explored in much previous research and is tightly coupled with the resources of the incubator (Peters et al. 2004).

Projects can either fail or be selected as fit for the market by the incubator. Those selected as fit emerge on the marketplace to compete, represented by the right-hand side green circle. The model ends at this stage, as this PhD thesis concerns how university incubators create KIE firms and not what happens to these once they exit the incubator. The following three subsections add my empirical results related to the process model.

8.1.1 Empirical findings in relation to the phase: Inflow of projects

The box in the lower left corner of the elaborated process model above (Figure 8.1) shows knowledge external to the university. I include external sources of knowledge in this figure due to the empirical context of Sweden, where university incubators receive a mix of funding from universities, municipalities, regions, and governmental agencies. Therefore, it is possible to do a more fine-grained analysis of not only researchers, students, and non-researcher university employees but also other types of founders active in university incubators. These other types of founders do not have previous ties to the university but can still be supported, and they are represented in the above model (Figure 8.1) by the society as knowledge source box.

However, this knowledge source is closely related to the other one (internal knowledge of the university) as it is dependent on skilled workers, basic research laying the ground, and skills acquired through education. The types of project founders I categorized here are (iv) independent inventors and (v) corporate spin-off projects. As found in Chapter 4, Section 4.3.3, these founder types make up a large proportion of applicants trying to get their ideas accepted by the university incubators in the studied time period of 2005-01-01 until 2014-31-12 (see Chapter 6, Sections 6.3 and 6.4 for results related to the probabilities of these project-founders to complete incubation).

8.1.2 Empirical findings in relation to the phase: Incubation process

Resources can be seen as all parts that form the sum of the organization (Penrose, 1959). They may be internal or external to the firm. In this figure I have identified four types of resources as important for the support of projects into KIE firms. These elements are: human capital, as in incubator employees and experience of the incubator; financial resources, as in financing and the size of the incubator; the breadth of project types accepted at the incubator; and the share of researcher-projects at the incubator. Human capital is important as qualified staff is needed to operate and manage the organization and to apply the experience that develops with time and practice; but also, the staff is needed to carry out the main function of this particular type of organization: to support innovation projects into becoming knowledge-intensive entrepreneurial firms. The second resource available to the incubator is its financial resources and relative size. As Penrose (1959) suggests, everything changes with size – such as scale advantages. The third form of resource is the relative breadth of project variation. A more specialized organization that only deals with a few types of founders seems to be advantageous for the individual project's probability of completing incubation. The fourth type of resource – the share of researcher-based projects in the incubator – seems have a positive spillover effect on the other project types' chances of completing incubation (see Chapter 6, Sections 6.3 and 6.4).

In the above process model (Figure 8.1), organizational routines can be seen as inside the body of the university incubator. I have added routines to the model, as I recognize the ways incubator managers try to deliberately deal with how to handle projects without an entrepreneurial founder, as a first attempt to deliberately create routines (in Chapter 5). In Chapter 7, organizational routines could also provide an explanation for, for example, the trend observable in Figures 7.3 and 7.4, both in Chapter 7. These figures show an increasing pattern of more KIE firms being produced with time. According to Nelson and Winter (1982; 1977), a routinization process starts with doing a certain task and thereby learning the task. With time, this task is routinized and becomes part of the organizational routines that govern how well a firm does what it does. Also, Howard-Grenville et al. (2016) add the aspect of deliberate actions taken to achieve routinization of tasks, hence I see my finding of these ways incubator managers try to deal with what they recognize as a major concern as related to organizational routines.

In Figure 8.1, the organizational routines box in the body of the university incubator also indicates that it affects institutional selection. I relate this to what I named a competition effect in Chapter 6. Here, my results suggested that higher competition at entry for a project was a retardant for the projects' probability to complete incubation. Moreover, competition in the following month, affected projects as an accelerant for completing incubation. Highly demanded incubators can therefore have trouble selecting the right projects due to the sheer number of projects applying, while the competition also increasing the speed of incubation for projects already in the incubator. If speed is always better, more research is needed to look into how incubators learn over time and become better at selecting and evaluating the best projects.

On the question of which resources are important for the success of projects, I add to Bergek and Norrman's (2008) and Peters et al.'s (2004) list of important resources (human capital and financial resources) with both the breadth of incubators, as measured in the number of different founder types they admit, and the effect of having more researchers in the incubator (see Chapter 6 for results on how breadth of incubators is related to projects' probabilities to complete incubation).

The incubator's ability to develop routines on selecting fit projects and help develop these into functioning firms should be highly affected by the resources available to the it. Further research is needed on the exact nature of the effect of having more researchers in the incubator.

8.1.3 Empirical findings in relation to the phase: Incubation outcomes

Incubator performance can be seen as the definition made later, in this chapter, to encompass both aspects of effectiveness and efficiency, that is, doing the right things and doing those things as well as possible (Mosselman et al., 2004). Empirically, I have analyzed whether the cost per created KIE firm differs between municipality-owned and university-owned incubators. As the above discussion about the definition of university incubators has revealed, I have scoped down and investigated effects between two subgroups of university incubators differentiated by their respective ownership and funding structures. These two subgroups are university-owned and municipality-owned incubators (see Chapter 7 for results related to how cost-efficiency differs between the two sub-types of university incubator).

The very end result of these knowledge flows going from ideas into innovation projects is the knowledge-intensive entrepreneurial firms. Knowledge-intensive implies that they are able to learn as organizations, and are thereby able to innovate and adapt to external changes in their environment better than other types of firms. The knowledge is seen as a product of founder and employee education in many cases (Malerba & McKelvey, 2019). Entrepreneurial in this context implies a very distinct type of entrepreneur, namely the Schumpeterian, an entrepreneur that combines existing knowledge into something new (Malerba & McKelvey, 2019). They thereby create opportunities that other entrepreneurs can act on and create products or services that could lead to changes to the economy at large, in many cases leading to economic growth. This type of firm is therefore of particular interest, theoretically, but also in a (regional, national, or even international) policy perspective. The particular KIE firm created with the assistance of university incubators has been suggested by previous research to have a great economic impact

(O'Shea et al., 2005; Barbero et al., 2012). This economic impact is often attributed to the high-tech nature of university spin-offs (Shane & Stuart, 2002).

8.2 Revising definitions

In my reading of and engagement with the literature, I have developed the process model and concepts throughout this PhD thesis. In order to address my two last research objectives, I have used, and sometimes reformulated, the following definitions: university incubator, the incubation process, incubator performance and KIE firms. In the following sub-sections I discuss how I have revised these definitions.

8.2.1 Revised definition of university incubator

Initially I used McKelvey and Lassen's (2013) definition of incubator types, which includes four types of incubators: business innovation centers (BICs), university business incubators (UBIs), independent private incubators (IPIs), and corporate private incubators (CPIs). They define business innovation centers (BICs) as incubators of a type that are publicly owned and operated and that aim at promoting local, regional, or national growth by creating firms that positively affect employment rates and technological development (McKelvey and Lassen, 2013). They define UBIs as university owned and operated incubators that allow projects to have access to university resources and infrastructure. See Chapter 2, Section 2.2, for definitions of the last two types as these were not used in this PhD thesis.

However, the Swedish context does not have clear boundaries between the private and the public, and between the university and non-university, when it comes to its incubators. Therefore, I have modified the definition. The reasons behind this discrepancy are due to Swedish incubators being owned by a mixture of actors and receiving funding from yet more government and non-government actors. However, all incubators participating in the national incubator program, hosted by VINNOVA, are highly associated with different Swedish universities. This is a prerequisite to be eligible for funding from the national incubator program (VINNOVA Report A). In Chapter 4, I classified all the incubators participating in the program using these four classifications. However, only two types of incubators could, after tracing their ownership structure (through their respective home pages and the business register – allabolag.se) be used. These two types were UBIs and BICs. Nonetheless, the apparent prerequisite by VINNOVA, that they needed to be closely affiliated with a university in order to gain access to funding, precludes the use of BICs. As a result of my research, I propose an updated definitions as follows:

> University incubators are organizations that are closely affiliated with a university and that provide services in the form of an incubation process to founders in order to help develop their ideas into projects and projects into KIE firms, which are then able to compete in the market.

My definition is broader than that of McKelvey and Lassen (2013), in that it allows for more incubators to be included without their having to have access to university facilities and infrastructure as implied in the other definition. However, there are still important differences to be explored. I therefore made subdivisions of the definition of university incubators based on their ownership structure. Hence, I used the terms "university-owned" and "municipality-owned" incubators to define the closeness to university resources. More on the differences found between these two subtypes of university incubators will be uncovered later in this chapter.

8.2.2 Revised definition of incubator performance

I started off using the definition of incubator performance that Bergek and Norrman (2008) put forth, as: "…the extent to which incubator outcomes correspond to incubator goals." However, as the authors also point out, their definition adheres to the effectiveness side of performance (the right things are done) and not the efficiency side (things done are done properly) (Mosselman et al., 2004 in Bergek and Norrman, 2008). When I have looked at performance in this PhD thesis an aspect of the latter, cost-efficiency, has been analyzed. This makes the definition set by Bergek and Norrman (2008) less useful inasmuch as this definition depends on the incubators' own goals, which can vary extensively and not always be publicly available. I propose an updated definition of:

> Incubator performance as containing both aspects of efficiency, broadly related to the input and output side, and effectiveness, broadly related to the quality of output.

Where:

- Input side refers to: money and time
- Output side refers to: new KIE firms
- Quality of output refers to: firm survival and firm performance

This definition should thus enable a distinction, and discussion of both effectiveness as well efficiency sides of incubator performance. In Chapter 7, I analyzed one aspect of incubator performance, cost-efficiency. There is a need for future research into other measurements of incubator performance.

The definition of KIE firms that I have used throughout this PhD thesis is the one provided by Malerba and McKelvey (2020:6), who define them as: "…new learning organizations that use and transform existing knowledge and generate new knowledge in order to innovate within innovation systems."

This definition of KIE firms is used throughout this PhD thesis, where I have conceptualized all firms coming out of university incubators as KIE firms. The above broad and inclusive definition allows for the inclusion of all the potential firm types supported at university incubators. A prerequisite to receiving funding from VINNOVA, through the national incubator program, is for university incubators to support the creation of what they determine to be knowledge-intensive firms. I do not use the term "university spin-off" (see Chapter 2 for a comparison including university spin-offs with other related types of KIE firms such as NTBFs), a term used by much prior incubator research (e.g. Bercovitz & Feldman, 2008; Bathelt et al., 2010). The reason given is that the term "university spin-offs" lacks a clear-cut definition due to the inherent heterogeneity of how they are created, in which industries they operate, etc. (Bathelt et al., 2010). Therefore, it makes sense to use the term and definition of KIE firms, which is more precise and allows for researchers to be explored in relation to other (KIE) founder types, and not under the presumption that all firms emerging from university incubators are initiated by researchers or created to realize researcher intellectual property.

8.3 Research objective 2: National policy under inventor ownership regime in Sweden

My second research objective is to explore how university incubators interpret national policy goals and work with researchers in ways that affect the formation of knowledge-intensive entrepreneurial firms.

I address this objective by first providing synopses of the two chapters that address this objective (Chapters 4 and 5). Then I discuss and reflect on the objective based on the main results in more detail, ending with a concluding answer to the objective.

8.3.1 Synopsis of chapters addressing the objective

In Chapter 4, (1) using extant research, I establish that, and explain how, this institutional regime in Sweden differs from other national contexts and why it may matter to university incubators. (2) Using different empirical sources, I set the empirical context. I provide an overview of a subset of the Swedish innovation system related to commercialization of research, the relationship between university incubator and policy, organization, etc. (3) Using VINNOVA's national incubator program database, I set the empirical context and demonstrate that there is much activity and many ideas in university incubators in Sweden. I also find diversity of incubator types, and diversity of founder types inside university incubators. Further, I define the five founder types found in Swedish university incubators: researchers, students, non-researcher university employees, corporate spin-offs, and independent inventors.

In Chapter 5, I (1) describe the incubation process with the use of interviews I did with managers at university incubators and innovation offices, as beginning with screening ideas and ending these projects (called exit) either as a firm that leaves the incubator or with the project failing during the process. (2) During the incubation process, incubators provide coaching with the aim of giving the potential founder entrepreneurial skills. They also help them with market validation, subsidizing their rents and occasionally subsidizing patenting. (3) Researchers are seen as especially difficult to encourage to start firms. These three reasons are given: lack of time, stuck on technical verification, and unwilling to become entrepreneurs. However, incubator managers also value researchers' ideas and assess them as being the ideas with the highest potential impact if successful. (4) To deal with researchers, university incubators have two main strategies: to start a firm or attempt to transfer the IP/idea to industry in order to take these special ideas to the market with or without the active participation of the researcher who owns it. Involving students in the projects is often part of the strategy to deal with researchers.

8.3.2 Addressing the objective

With Sweden having an institutional regime of inventor ownership, where researchers retain the rights to any and all commercial outcomes of their research, the likely outcome of university commercialization is new KIE firms. That this is the case in inventor ownership regimes has been indicated by a number of previous studies (Bengtsson, 2017, Damsgaard & Thursby, 2013). The primary goal of creating KIE firms is financed by Swedish governmental policy. Public funding, the policy instrument used by the government, aimed at university incubators specifies that KIE firms are the preferred outcome of such activities. The Swedish government and university system have developed innovation offices and university incubators to support the transfer of knowledge from university (researchers, students, and non-researcher employees) to society (see Figure 5.3 in Chapter 5 for an overview of the process). An analysis of my descriptive results shows that almost 40,000 project ideas had been screened at Swedish incubators, 3400 were accepted and 1540 graduated during the studied period of 2005-2014. This suggests that there is a huge number of ideas being generated by diverse founder types at Swedish universities and society that apply to university incubators to gain access to their incubation process.

I also found that there are several different KIE founder types, apart from researchers, that are admitted to Swedish university incubators. Four additional main types were identified: students, non-researcher university employees, independent inventors, and corporate spin-offs. This finding suggests that the set-up of institutional regulation and entrepreneurial support structures (innovation offices and university incubators) promotes diversity of project types, a finding contrasting with the stated policy of TTOs operating in the US that prioritizes patentable ideas in specific industries (Jensen & Thursby, 2001; Jensen et al., 2003). I find this interesting as it may suggest that university incubators and innovation offices that act in this institutional regime accommodate a larger variety of "customers" because they do not have the explicit focus, nor responsibility, to commercialize IP themselves. To clarify the diversity found in project founder types, an avenue of further research could be to clarify how this matches policy objectives.

Innovation offices and university incubators in Sweden have a stated goal of mainly producing KIE firms, which aligns with national policy in Sweden. This finding aligns with previous research that suggests that the set-up of institutional regimes (Damsgaard & Thursby, 2013) and entrepreneurial support structures (Bengtsson, 2017) prioritizes different outcomes of commercialization through TTOs, a name denoting both innovation offices and incubators in many contexts. Other research has found that inventor ownership regimes seem to be more conducive to academic entrepreneurship than university ownership regimes (Åstebro et al., 2019).

Moreover, I found that university innovation offices and incubators are dealing with issues related to what the management perceives as researchers having a lack of entrepreneurial drive. The reasons for this can be summed up into three themes. The first is that the researcher might be stuck on technical verification because of technical complications, always striving for improvements, or that the distance from idea to product is seen as too great. The second theme is that researchers may not want to become entrepreneurs or engage in entrepreneurial activities. The third theme is that researchers in general are busy people with demanding jobs and they have limited time. In my study, the managers talked about how they tried to be present in the university where the research took place in order to be able to identify and support viable ideas with commercial potential that would otherwise be, in their view, lost. This echoes the concerns of managers in Jensen's (2003) study, where TTO managers viewed the biggest threat to their commercialization mission to be researchers neglecting to report inventions. However, my finding adds the issue of what to do with ideas disclosed by researchers who do not want to commercialize themselves, when the university is not the owner.

In order to handle the outlined problem with researchers who lack the drive to commercialize for themselves, innovation offices and incubators seem to have developed two possible routines (which were called strategies in Chapter 5): buy their IP and start a KIE firm or sell/give away IP to an external party. I call these possible routines as no actual observations of incubators or innovation offices using these have been collected; rather, they are mentioned by managers as possible remedies to counter what they perceive as researchers having great ideas but no drive or will to realize them. They initially seem to emulate the behavior of TTOs acting where the university owns the IP (Jensen et al., 2003). Perhaps having two additional routes in order to exploit ideas coming from research is not a bad idea. Rather, it could be a possible additional avenue of university commercialization in an inventor ownership regime. However, the answer to whether innovation offices and university incubators should engage in this costly process altogether remains. After all, this study did not cover researchers that for whatever reason choose to commercialize without the support of the university, and there is little evidence suggesting that this is neglected.

Rather, innovation managers from one university argue that many of the ideas coming from researchers are what are left from university-industry collaborations. If this is true, it signifies the importance of university-industry collaborations and contract research as more potent ways of transferring technology/knowledge to society in Sweden than the two commercialization routes of academic entrepreneurship and IP/licensing.

To conclude, I have explored how university incubators interpret national policy goals and work with researchers in ways that affect the formation of KIE firms. Using descriptive statistics from the national incubator program on participating incubators and their projects and firms, my results suggest that there is much activity and many ideas turned into projects, and eventually firms, at the involved incubators. There are diverse incubator types where previous research has deemed all university-close incubators to be university incubators. I have instead differentiated by ownership and found two subtypes: university-owned and municipality-owned incubators. There are also diverse founder types, where both university- and non-university-related founder types are supported inside university incubators in Sweden. University incubation processes involve different types of university organizations that provide coaching aimed at giving the potential founders entrepreneurial skills, helping them with market validation, subsidizing their rents, and occasionally also subsidizing patenting of their ideas. Because researchers who found companies are busy with many other activities, university innovation offices and incubators act to overcome the perceived lack of entrepreneurial drive and help researchers commercialize their research results by either starting a firm in their place or trying to sell/give away their IP. Further, I have identified multiple ways that students can participate in incubators, a finding that aligns with previous research in other national contexts: students as staff (Mian, 1996) and students as project owners and as project staff for researcher-founders (Culkin, 2013). The findings of Culkin (2013), in particular, align with my results. My results, however, suggest that students are engaged in researchers' projects because of the perceived inability of researchers to be entrepreneurs themselves and, crucially, they are being used for this purpose in order to overcome this conception. Culkin's (2013) research, in contrast, was done in the UK, where the university owns the right to IP that originated in research. The alignment of results between his and my study suggests that TTOs and incubators act similarly and engage students in a similar manner in both the university ownership context of his study and the inventor ownership context of mine.

8.4 Research objective 3: Differential outcomes and performance

My third research objective is to investigate the early formation of KIE firms by analyzing the differential outcomes of projects and incubators within the national incubator program.

I address this objective by first providing synopses of the two chapters that address it (Chapters 6 and 7). Then I discuss and reflect on the objective based on the main results in more detail, ending with a concluding answer to the objective.

8.4.1 Synopsis of chapters addressing the objective

In Chapter 6, I quantitatively analyze the competing risks of projects either failing or successfully completing incubation at Swedish university incubators. This chapter explores how the diverse backgrounds of different types of founders (researchers, students, other university employees, independent inventors, and corporate spin-offs) may affect their likelihood of completing incubation and becoming KIE firms. As expected, (1) researcher-based projects have a lower probability of completing incubation in a timely manner than all other types of projects. However, (2) having research-initiated projects in an incubator seems to create spillover effects on all other projects, increasing their likelihood of completing incubation. Moreover, (3) the probability of projects successfully completing incubation increases if the university incubator has less breadth, as measured in admitting fewer types of project founders, and (4) if the incubator has more experience, as measured in age.

In Chapter 7, I use descriptive statistics and (heteroscedastic robust) OLS regression models to explain incubator efficiency, seen as the number of firms they supported or produced each year and the average amount the incubator spent on supporting them. I find that (1) municipality-owned incubators support the creation of KIE firms at less expense than do university-owned incubators, while descriptive statistics reveal the average incubation time to be about the same for both. Further, (2) the number of researcher-initiated projects is one of the drivers of this difference in cost as university-owned incubators support more of these types of projects. However, the effect for incubators in helping to create a larger share of firms with researchers as founders differs for the two types of incubators studied. If the incubator supports the creation of a greater share of researcher-initiated KIE firms it reduces the cost if the incubator is municipality-owned while increasing it if the incubator is university-owned. (3) The experience of the incubator, as measured in age, seems to make the process costlier.

8.4.2 Addressing the objective

Using survival analysis on the competing risks of projects to either complete incubation or fail, an analysis of my results shows that projects founded by researchers have a lower probability of becoming KIE firms and completing incubation than projects with other types of founders, in line with previous findings (Rothaermel & Thursby, 2005; Barbero et al., 2012). Barbero et al. (2012) found differences in the types of innovations coming from researchers (proxied in their study by being incubated at university incubators) where university incubators were seen as particularly weak in producing organizational innovations while comparatively strong in producing product and technical innovations as compared to the other types. The explanation given as to why university incubators are different in these ways was linked to the early stage of the ideas of researchers (also noted by Jensen & Thursby, 2001). Rothaermel and Thursby (2005) found that strong university linkages reduced the probability of firm failure and also delayed graduation. By university linkages they mean a license obtained from the university and a link to university faculty. Adding to this research, an analysis of my results suggests that within the broad category of university incubators there is a lot of heterogeneity between project types, although my results do not preclude projects having different degrees of maturity when entering incubation. Maturity of ideas coming in is a compelling argument for the differences in probabilities of completing incubation and indeed in incubation time between projects with different types of founders.

Even though researchers tend to commercialize in certain sectors according to a patent study by Lissoni et al. (2008), my result of a lower probability for projects founded by researchers was still robust after controlling for the industry in which the project developed their business. Researchers have been said to not be driven by profit motives as much as business people (Siegel et al., 2003), thus they might have less incentive to complete incubation, and if they do complete it, they are likely to do so much later than others.

Nonetheless, my results also suggest that the share of researcher-based projects in the incubator is associated with a higher probability of all other types of projects succeeding. The professors' privilege environment that was simulated as more conducive to entrepreneurship than licensing in Damsgaard and Thursby's (2013) study seems to encourage more researchers to engage in this type of commercialization activity (Åstebro et al., 2019), and in so doing, they seemingly create spillover effects on other project founders. This result relates to the findings of Markman (2005), who found researchers to have a positive effect on innovation speed later in the process due to their being involved in the business. Though it seems that the research-based projects themselves were slower and less likely to complete incubation, they had a positive effect on the speed of other projects.

Entering into incubation at an incubator with less breadth, as measured through the number of types of projects admitted, seems to be the advantageous option for prospective projects to ensure completing incubation. An explanation as to why this is the case can potentially be found in peer effects. These types of positive effects on performance can be achieved by likeness. If the project founders at the incubator thus have similar backgrounds (e.g. working together at the university), they are more likely to yield these types of effects. Thus, admitting fewer types would increase this effect.

This evidence in favor of incubator focus rather than breadth constitutes one of my main findings. As my analysis covers a long time span of 10 years, it seems to contradict Levinthal and March's (1993) prediction that specialization and simplification (in my case, on one or two different types of project founders) may yield short-term success and long-time failure. Peer effects may provide an explanation for my finding. Positive effects on performance can be achieved by likeness. If project founders at the incubator have similar backgrounds, they are more likely to yield these types of effects.

This leads to the question: Why do university incubators operating in an inventor ownership environment bother with projects founded by researchers? They are after all less likely to complete incubation and also more time-consuming for the incubator. One possible explanation is the evidence of the high value impact of university spin-offs. According to one calculation by the Bank of Boston's Economics Department, MIT spin-offs generated, in 1997, sales of a staggering 232 billion dollars (O'Shea et al., 2005). The value impact is often attributed to the high-tech nature of university spin-offs (Shane & Stuart, 2002). Another compelling reason is the effect that having more researchers in the incubator has on other types of project founders. What exactly they do to create spillover effects could be an interesting question to explore further.

The importance of having researcher-based projects in incubators is a significant finding. Not only do they indeed create a lot of KIE firms, which previous research has shown to have a great propensity to innovate, thereby affecting the greater economy, but they also seem to create beneficial effects on other incubated projects. The specifics of this finding, I think, are worth exploring further. For example, how researchers affect other founders, whether it is by giving them advice or if they have a more general influence as people with deep scientific knowledge, is an interesting question. If we can find out the specifics of this interaction, we can try to replicate it. If incubators can create organizational routines that facilitate the spillover effect of more researchers in university incubators, it would benefit the economy.

Throughout this PhD thesis I have systematically analyzed and tested whether the two identified subsets of university incubator, university-owned and municipality-owned incubators, had any association with the probabilities of project founders completing incubation and creating KIE firms and incubator performance. Previous studies of Swedish incubators have categorized all incubators part of the national incubator program as university incubators (e.g. Dahlstrand & Politis, 2013, who used data from the program to analyze differences between male and female academic project founders). Even though they are all university-close, when looking at the performance measure (cost per created KIE firm) I found that it is important to differentiate between university-owned and municipality-owned incubators. Descriptive results from the quantitative study in Chapter 7 suggest that university incubators have a higher average cost per supported/created KIE firm than municipality-owned incubators. They also suggest that the average incubation time of successful firms did not differ much between the two types of incubators (approx. 2.5 years in average for both of the incubator types, see Figure 7.7). This descriptive result compares to the average incubation time of the (Georgia Tech) incubator firms Rothaermel and Thursby (2005) studied, which had an average incubation time of 2.4 years. However, as suggested by my findings in the earlier competing risks econometric models, there is heterogeneity in incubation times between projects with different founder types. This indicates that there are differences in incubation times within incubators but not between different types of incubators. This also sheds light on the importance of further studies of project composition and the effects of within-group variation in incubators.

The fact that my analysis revealed no significant difference in incubation times between the two types of incubators contradicts the findings of Peters et al. (2004) and Rosenwein (2000), which indicated that public incubators (akin to municipality-owned incubators) are faster in creating new firms. By running OLS regression models with the average cost of creating one KIE firm as the dependent variable, I found these results to corroborate my descriptive results. The increased cost of producing KIE firms that an analysis of my results shows at university-owned incubators, I argue, is partly due to the comparatively higher knowledge-intensity of the KIE firms sprung from research, and the fact that there are more of these types in university-owned incubators than in municipality-owned ones. Further, Barbero et al. (2012), studying differences between incubator types, found differences in the type of innovations that researchers developed. These differences, they argued, were due to the early stage of researcher ideas in university incubators as compared to projects incubated in other types of incubators. Their argument seems to resonate with the findings of Jensen and Thursby (2001), who found that TTO directors and licensing officers in the US regarded researcher ideas as embryonic and because of this they needed to be commercialized, with the researcher's cooperation, through an established company.

Moreover, indications from recent research by Gifford et al. (2020) suggest that KIE firms with very high growth are associated with founders with academic experience or a previous record as firm founders. That founder academic experience, as in having worked at a university, can be tied to very high growth, they argue, could be because the academic experience makes it easier for KIE firms to maintain ties to the university. Academic experience would also be of use for founders in building critical firm capabilities. They conclude that only a few of the surveyed KIE firms grew, but the firms that actually did had high growth rates in terms of employees and turnover. That academic experience of the founders mattered in the high-growth KIE firms on their performance indicates that the assumption made by, among others, Malerba and McKelvey (2019), that KIE firms with researcher founders or employees would be important for economic growth, could be somewhat substantiated. Moreover, their findings also emphasize the importance of founders on later firm growth. The potential highlighted in their study would most likely justify some of the societal costs of operating university incubators as well as adding another reason why both municipality-owned and university-owned incubators should be welcoming to this particular founder type.

However, my results also suggest that if incubators help create more KIE firms initiated by researchers, it affects their respective average cost of creating firms differently by incubator type. In university-owned incubators it increases the average costs, which can be expected as these types of founders typically operate in certain industries (Lissoni et al., 2008) and can be assumed to be more early-stage than those from other incubator types (Barbero et al., 2012). However, helping to create more firms founded by researchers were associated with a decrease in the average costs for municipality-owned incubators. This association remained even after controlling for the share of firms produced that would count as STEM industry firms. Having more researchers in incubators, thus, seem to have advantages.

To conclude, I have explored the early formation of KIE firms by incubators within the national incubator program and analyzed the differential performance of projects with different types of founders as well as two types of incubators. In line with previous research, my findings suggest that projects initiated by researchers have a lower probability to complete incubation than other projects (Rothaermel & Thursby, 2005). However, these researcher-founders also seem to create spillover effects that have positive effects on the probability of projects with other types of founders, present in the incubators during the same time, completing incubation. This finding relates to Markman's (2005) findings of an increased commercialization speed if the researchers are involved in the whole process. Moreover, the breadth of the incubator, as measured by the number of types of founders of projects they admit, matters. It seems that less breadth of project types is beneficial for a project's probability of completing incubation. This finding contradicts the reasoning of Levinthal and March (1993), who predicted diversity to be beneficial to long-term success. Instead, for the success of projects, it seems important that incubators focus on a select few founder types. Instead, peer effects may provide an explanation for my finding. Positive effects on performance can be achieved by likeness. If project founders at the incubator have similar backgrounds, they are more likely to yield these types of effects.

Systematic analysis of university-close incubators in the Swedish setting reveals that, when looking at performance measures at least, it is important to differentiate between two main types: university-owned and municipality-owned incubators. University-owned incubators have a costlier incubation process leading up to KIE firms than municipality-owned incubators have. This is a probable consequence of the relatively higher knowledge-intensity of researcher-initiated firms and the demands that follow on supporting these firms and the experience of the incubator, measured in age, due to the accumulation of costs over time. Barbero et al. (2012) argue that differences in the types of innovations generated at university incubators and other types of incubators are due to the early stage of researcher projects. Maturity of the ideas from different founders therefore seems to play a role (following the logic of Thursby et al., 2001 and Barbero et al., 2012). It might partly explain differences in the cost of bringing them to the market. However, if municipality-owned incubators help create more KIE firms initiated by researchers, they reduce the average cost of creating firms altogether. University-owned incubators doing the same, however, yields higher average costs. Having researchers in incubators seems to create diverse and beneficial effects on other projects, and decreasing costs for municipality-owned incubators.

8.5 Proposals for future research

This PhD thesis has dealt with how university incubators, under inventor ownership, select projects and help founders create KIE firms. I have shown that researchers are less likely than other types of founders to graduate from university incubators, aligning with previous research, but also that they add something else to other types of project founders that improves their respective probabilities of completing the incubation process and emerging as KIE firms. However, my investigation ends at that point, in the emergence of new firms. I do not address how these newly formed KIE firms fare after "graduating." Nor can I address if incubation indeed had any effects on these projects as compared to non-incubated ones, which relates to the quality of these firms.

Therefore, a first proposed area of future research should address the important question of effectiveness of processes within the incubator leading up to KIE firms as well as their later impact on the economy. Previous incubator research is divided and, I think, unfulfilling as it does not address the heterogeneity of project types explored in this PhD thesis. This heterogeneity is outlined in the introduction and explored in Chapter 6, where there is a research gap on the performance of different types of firms, having been incubated in university incubators (and subsets of university incubators: Chapter 7). Would the type of project founder and potential endowments gained from participating in an incubation process at municipality-owned and university-owned incubators cause different results in the firm's subsequent survival or growth post-incubation? Further, are researcher KIE firms incubated at university-owned incubators better adapted to survive in the marketplace than those fostered at municipality-owned incubators?

A second future study could look into how KIE firms contribute to society by using quantile regression to emulate and build on a study by Gifford et al. (2020). In their study they found that only a few of the KIE firms surveyed grew, but the firms that did had high growth rates in terms of employees and turnover. Could a similar approach be used on the KIE firms that completed incubation from one of the incubators in the national incubator program of Sweden? A study of post-graduation growth rates would be interesting from a policy perspective but also to build on the knowledge about KIE firms. If the firms completing incubation from these incubators, as compared to matched non-incubated firms, grow and provide opportunities for employment, among other things, at higher rates (at least in the last quantile), then these types of firms truly have an impact on society, and the incubators supporting them have an impact on the larger economy.

A third future study could be initially explorative, followed by quantitative research. Interviews could be used to further explore my finding regarding the unexpected effect researchers seem to have on founders with other backgrounds, helping them complete the incubation process. How do researchers affect these other founders? Is it by giving them advice, or do they have a more general influence as people who have deep scientific knowledge? If one can find out the specifics of this interaction, one can try to replicate it. Moreover, cross-national studies could see whether this effect is across different empirical contexts or an anomaly. In order to explore this third option further, I suggest connecting the future study to an understanding about organizational routines that underpin how organizations learn. According to Nelson and Winter (1982:97) a "routine" "…may refer to a repetitive pattern of activity in an entire organization, to an individual skill, or, as an adjective, to the smooth uneventful effectiveness of such an organizational or individual performance." Organizational routines are seen as a consequence of a learning process that has been described as a process that is unintentional or implicit rather than deliberate.

Many interesting questions arise, if one is to further develop the idea of organizational routines in this context. Two such questions could be if the incubator develops routines to facilitate firm creation and perhaps also in the process "instills" value creation routines to the incubated projects. The development of routines in organizations can be the product of a deliberate process (Zollo & Winter, 2002) and/or the product of learning by doing (Argote, 1999). Routines are often complex and deeply embedded within an organization (Howard-Grenville, 2016). This makes it hard to copy or transfer successful routines both within and between organizations. Becker (2003) suggests looking at routines as "recurrent patterns of interaction." Routines are, by nature, repetitive, and this repeatability renders stability. Thus in order to capture the particular learning process involving researchers and other types of founders, one potential route is by viewing their interaction as a recurrent pattern.

Because if routines are stable, they can be predicted (Nelson & Winter, 1982), and if they can be predicted, they can be copied. For example, if some incubators have a stronger researcher spillover effect than others, one can study the particular make-up of the organizational routines created that facilitates this interaction at these incubators. If there are commonalities between these incubators, that can facilitate a strong interaction between researchers and other founders, then these commonalities would be highly interesting to explore further.

An approach to studying these interactions would be to first quantitatively identify the incubators in which researchers have the strongest effect on other project founders, and then do interviews with researchers and other founders to map their interactions and also do some observational studies to uncover additional unintentional interactions. This research could potentially result in concrete best practices or ideal types of set-ups that facilitate strong researcher spillover effects. If incubators would be able to facilitate the spillover effect of having more researchers as project founders in university incubators, which I found, it would increase the likelihood of other types of projects becoming firms and completing incubation. Thereby it would add to the variation of new firms that the market can select from, potentially allowing for such economic changes that would not have occurred if the spillover effect had not been reproduced.

8.6 Implications for public policy

In this section, I present three policy implications based on the findings of this PhD thesis.

8.6.1 Multiple roles and potential in students

> Because researchers and universities have core missions of research and teaching – in addition to commercialization – public policy should consider alternative paths. I propose that further involving entrepreneurship students to commercialize research knowledge should occur close to the university context.

Students are a potent resource for incubators in that they provide their own ideas and develop KIE firms but also because they can be of service in other ways. One of these ways, as outlined in this PhD thesis, has similarities with what Lundqvist (2014) called surrogate entrepreneurship, that is, students taking on a project for a limited period or for a longer stretch to realize it.

As discussed in Chapter 5, researchers were described by incubator managers having reasons to not start a firm by themselves. Therefore, the incubators had developed a number of ways of achieving commercialization anyway. One of these ways was to engage students to become, like Lundqvist (2014) would have called surrogate entrepreneurs. The incubator could engage the student to either develop a certain part of a project with a researcher as founder or to completely take over the role of entrepreneur for the project.

Clearly students are engaged in many ways to act as entrepreneurial agents in these incubators. As most Swedish universities have some type of entrepreneurship education, ranging from single courses to full master's programs (Zaring, Gifford and McKelvey, 2019), I see great potential in engaging more entrepreneurship students. These students bring with them important knowledge related to entrepreneurship and business development that can be valuable in order to realize projects into KIE firms.

University education in entrepreneurship consists of both purely theoretical courses and more applied courses and master's programs (Zaring, Gifford and McKelvey, 2019). This theoretical and applied knowledge may prove important to translate latent researcher ideas into KIE firms. If we assume that the fear of innovation office and university incubator managers (see Chapter 5) is that great researcher ideas are killed off because of inactive and unwilling founders, entrepreneurship students could be part of the solution to this concern.

8.6.2 On the pros and cons of having an inventor ownership legislation

> Although I do not study or compare institutional regimes in different countries per se, my results suggest that the Swedish focus upon the creation of KIE firms may be a more prudent way of transferring knowledge to society than by universities engaging in activities aimed at licensing researcher IP to external parties.

Based on my literature review and some indications from my study, I would like to argue for, if politicians and policy makers reconsiders the inventor ownership legislation in Sweden, that there are more factors to consider before they change the current status quo.

The inventor ownership legislation dates back to 1949 and allots the rights to any and all commercially viable research results to the individual or team that did the research. However, in the wider international context, universities themselves are often the ones that own, administer, and potentially profit from commercially viable research results (Audretch & Göktepe-Hultén, 2015). Sweden's neighboring countries Norway and Finland have, for example, in recent years changed their legislation from inventor ownership to university ownership. The effects of these changes have been studied. In Norway, the effects have been a 50% reduction in the number of academic patents as well as in the number of firms created at Norwegian universities (Hvide & Jones, 2018). A similar decline (46%) in Finland has been identified in research by Ejermo and Toivanen (2018). However, these changes in legislation and policy took place rather recently, and therefore long-term effects of the changes may be different. Future studies might be able to capture longer-term effects.

On top of the (short-term) output reductions due to institutional regime changes, there is a need for plurality of regimes, for research purposes as well as policy-informing, for example, evaluating strengths and weaknesses of the different regimes. There are many indications that the inventor ownership regime affects what the output would be, with more firms than license agreements in inventor ownership regimes and the opposite in university ownership regimes (Damsgaard and Thursby 2013; Bengtsson 2017; Åstebro et al., 2019).

Furthermore, an analysis of my results suggests that KIE firms are the desired end goal of both policy and incubator managers. My findings thus highlight new firms as the most desired outcome of this type of commercialization activity in Sweden. This aligns with findings of Bengtsson (2017), Damsgaard and Thursby (2013), and Åstebro et al. (2019), who found new firms to be the likely product of commercialization rather than license agreements with established industry or other startups. Perhaps new KIE firms founded by researchers is a more efficient way of transferring university knowledge to society than by selling researcher IP via license agreement. Knowledge is often tacit in nature, which means it is not easily written down, or communicated to other parties (Thursby & Thursby, 2004). There is for example research suggesting researchers' involvement in firm creation and later development as important for transforming their idea into something that would be commercially viable and technically possible (Murray, 2004). However, until we have strong indications in either direction, it is important to keep the knowledge about how to support researchers in creating KIE firms.

Hence, the Swedish innovation policy has prioritized one type of commercialization at innovation offices and university incubators, and this type of commercialization primarily creates a large variety of KIE firms. These firms range from those initiated by researchers to corporate spin-offs and inventor-based firms, and they operate in diverse industries. My findings have potentially shed more light on the processes leading to new KIE firms under inventor ownership, which I believe have not previously been sufficiently considered when debating the pros and cons of keeping inventor ownership.

To conclude, I do not find enough reasons to change the institutional regime of Sweden, and there are plenty of indications that there are advantageous ways to transfer university knowledge in the current system, not least through KIE firms.

8.6.3 Researchers as key in incubators

> Policymakers should emphasize the possibility of including researchers in their project funding offerings. Hence, project applicants such as university incubators and innovation offices would think on how to include researchers or to interact more with researchers to strengthen entrepreneurial ideas, teams, projects and firms.

Researchers as KIE founders in university incubators seem to, besides starting KIE firms themselves, have a beneficial effect on other project founders. This twofold contribution of researchers to universities' commercialization efforts needs to be highlighted. Researchers, as pointed out by incubator managers, do not just contribute great ideas that are better left to others to commercialize. Therefore, I believe incubator management and policymakers ought to recognize that researchers have their own agency and commitment to transferring knowledge to society in a direct and commercial manner.

More generally, time is intimately coupled with cost, as alternative costs of project founders or the actual costs of incubators supporting them, matter. An analysis of my results suggests that (1) if a project is developed into a firm, it is likely to happen within a 2.5 year incubation process, while (2) the project is likely to fail up to four years into the incubation process.

Therefore, incubator management should avoid having projects that linger too long in the incubator (other than STEM projects, which have long development times[11]) and would benefit by instead making room for new, more promising projects. After all, public resources, responsible for on average 82% of the funding for Swedish incubators, ought to be allocated where they will have the most impact.

Further, an analysis of my results suggests that university incubators that are not owned by the universities' holding companies have even more to gain by attracting and admitting researchers as project founders, as they may create additional benefits for their fellow project founders, making the incubation process less costly for the incubator.

A possible way of attracting and retaining more researchers in incubator milieus would be to specify their being located where there is consultancy funding. University incubators tend to have an array of offerings related to consultants taking on their project's, or alumni firm's, needs such as marketing surveys, technical proofing, and standards adherence, often undertaken by researchers or consultants

[11] STEM or science, technology, engineering and mathematics.

with a research background. These offerings commonly provide consultancy funding in a 50%-50% set-up, where incubators or the state provide half of the necessary funding, and the firm provides the other half.

9. References

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Appendix A – Structured Literature Review, Step by Step

In order to grasp the research fields that could be associated with university commercialization, university incubators, and knowledge-intensive entrepreneurial firms, a systematic literature review was conducted, which, according to Tranfield, Denyer, and Smart, is "…a key tool in developing the evidence base" (2003:209). The systematic literature review was conducted concurrent with, primarily, the first part of the PhD thesis, that is, the grounded-theory-like part. The literature review was revisited several times and new parts were either added or discarded depending on the findings in the explorative study. This review was constructed based on five steps:

1. Inclusion / exclusion criteria
2. Search words
3. Where to find relevant articles and books
4. The search (itself)
5. Selection

The steps are based upon a number of the steps undertaken by McKelvey and Lassen (2013) in their structured literature review. Inspiration was also obtained from Rothaermel, Agung and Jiang, (2007) compacted literature review process. This process included two additional checking procedures that were applied to this review process as well. The first additional check-technique in this study was to relax my search terms when it came to certain journals, including *Research Policy*, *Journal of Technology Transfer*, and *Technovation*. In essence, I did a more open search where general search words such as "university" were used. The second check-technique was to ask senior researchers about key reference papers (paper/s covering the theory that was searched for) and first read them before going through the reference list of the papers to familiarize myself with the research field at hand. These two techniques rendered additional papers that would otherwise have been overlooked had I used only the five-fold process outlined below.

Reflection

Although a literature review can be arduous on the practitioner intent on finding all relevant papers and results, it can become easier by using a clear process. To complement a clear process, I pinpointed many relevant articles by looking at the reference lists of papers that were highly cited in the field and by following suggestions from colleagues at the institute.

Step 1: Inclusion/Exclusion Criteria[12]

Table A.1 Inclusion criteria

Inclusion criteria	Reason
1980-2020	To be able to trace the development of the field. The national innovation system-theory, for example, although present in other forms, came to fruition in Lundvall's 1992 book.
Theoretical papers	To capture the development of the field as well as different related fields.
Quantitative and qualitative papers	For insights into how a study can be conducted and results.
Book chapters	An additional source of research. Much work done in the NIS, RIS and commercialization fields has been done in a book format and policy work usually is presented in book- or report format.

Table A.2 Exclusion criteria

Exclusion criteria	Reason
Everything before 1980	According to McKelvey & Lassen (2013) "entrepreneurship as a field of research has mainly developed since the 1980s (with the exception of a number of seminal macroeconomic studies)."
Non-English language papers	To avoid bias from regional language journals (McKelvey & Lassen 2013).
Non-university settings on applied papers	Not relevant for this study. (Leeway has been given to firm survival/firm hazard rate in order to get insights into the workings of this specific field.)

Step 2: Search words

After establishing the ground rules for the intended search, the next step was to identify relevant search words. The search words are based on the learning objectives, research area, and suggestions from my supervisor and colleagues.

Search words (not in a hierarchical order):

- Commercialization
- Third Mission (only in conjunction with other search words)
- University (only in conjunction with other search words)
- University Entrepreneurship

[12] Not applicable on secondary sources.

- University Incubator
- University Spin-off
- Knowledge Intensive Entrepreneurship
- Knowledge Intensive Entrepreneurial Firms
- Knowledge Intensive Innovative Entrepreneurial Firms
- University Innovation
- National Innovation System
- Innovation System
- Innovation Support Structure
- Knowledge Transfer
- Technology Transfer
- Hazard Rate AND (University, spin-off, startup & firm)
- (academic) Firm/spin-off AND survival
- Academic Entrepreneurship

Step 3: Where to Find Relevant Articles and Books

Web of Science is one of the most used search engines for scholars, so this engine was an evident candidate. But to feel confident that I did not miss relevant papers, I also checked my results with Scopus and Google Scholar. This became important in order to get access to books and book chapters as well. I also used the university library's search system of books (libris) for the sake of not overlooking any relevant Swedish-language literature as well as books not previewed in Google Scholar.

Additional sources and data, used in this PhD thesis but not included in the literature review, come from:

- Governmental reports
- Council and local government reports
- Propositions
- Laws
- Organizations' home pages

Step 4: The Search

Different search engines require different search algorithms. For Web of Science, the topic search criteria were chosen and the time span was selected as 1980-2020 and the language as English. The same was done in Scopus and the closest equivalent of "TS" in Scopus is "TITLE-ABS-KEY," where you search in the title, abstract, and keywords. The different search terms were shortened to, for example, univer*, "academic entrepre*, etc. to be able to get different endings to each word.

Step 5: Selection

During this step the search results were ranked based upon the number of citations. The top five of each were selected as a starting point and read thoroughly, and the ones with more than 30 citations, depending on the total number of papers, were selected. So as to not overlook important new articles, the results were filtered by date as well, prioritizing the most recent, as these could not possibly have the quality stamp of being well cited. This rendered additional articles of interest.

The following result table provides an example of how this type of table could clarify and give the reader an overview of the field as well as being a good summary tool for the researcher. Table A.3 below shows results for knowledge transfers from universities, collected through Web of Science (WOS) in 2017.

Table A.3 Top 10 university knowledge transfer search results in Web of Science (851) in total

Author (year)	Title	Journal	Citations (WOS)	Dependent variable (type of study)	Primary finding
Bozeman (2000)	Tech Transfer and Public Policy: A Review of Research and Theory	Research Policy	386	N/A (literature review)	Effectiveness of systems – other types of effectiveness considered, such as capacity building and political effectiveness.
Agrawal & Henderson (2002)	Putting Patents in Context: Exploring Knowledge Transfer from MIT	Management Science	356	Activity type	Patents only account for 10% of knowledge transferred at MIT.
D'Este & Patel (2007)	University–Industry Linkages in UK: What Are the Factors Underlying the Variety of Interaction?	Research Policy	303	Channels (to interact with industry)	Not only patenting and spin-offs matter: there should be a broader view of tech transfer.
Perkmann & Walsh (2007)	University–Industry Relationship and Open Innovation: Towards a Research Agenda	International Journal of Management Reviews	256	N/A (literature review)	Organizational dynamics of other types of interactions than commercialization understudied.
Perkmann et al. (2013)	Academic Engagement and Commercialization: A Review of the Literature on University-Industry Relations	Research Policy	183	N/A (literature review)	Academic engagement different from commercialization and more widely practiced.

Bruneel et al. (2010)	Investigating the Factors That Diminish the Barriers to University-Industry Collaboration	Research Policy	167	Barriers	Prior experience of collaborative research lowers barriers, and greater level of trust lowers the two outlined barriers.
Bekkers & Bodas Freitas (2008)	Analysing Knowledge Transfer Channels between Universities and Industry: To What Degree Do Sectors Also Matter?	Research Policy	157	Channels (perceived importance of)	Variety in researcher preferences of channel are explained by disciplinary origin, characteristics of underlying knowledge, individual and institutional characteristics.
Santoro & Chakrabarti (2002)	Firm Size and Technology Certainty in University-Industry Interactions	Research Policy	155	Firm Size	Larger firms use knowledge transfer from universities to build competences but smaller firms use it as a way to solve key problems – champions at firms play a key role in these relations.
Agrawal (2001)	University-to-Industry Knowledge Transfer: Literature Review and Unanswered Questions	International Journal of Management Reviews	144	N/A (literature review)	Literature can be divided into: firm characteristics, university characteristics, Geography in terms of local spillover and channels.
Geuna & Muscio (2009)	The Governance of University Knowledge Transfer: A Critical Review of the Literature	Minerva	115	N/A (literature review)	Knowledge transfer is a strategic issue: funding for research and a policy tool.

In order to make further sense of the research stream (in this case technology transfer from universities), sub-research fields were identified by going through the above papers, in particular the literature reviews. From these, five subfields were identified as important and frequently used: reasons, channels, barriers, measurements, and spillover.

Appendix B – Interview questions

The entrepreneurs

1. What types of people approach your organization with ideas? Do you classify them into different groups?
2. What types of ideas do you get?
3. How many apply and how many get approved to your organization?
4. How long do they usually stay?
5. How many of the admitted projects succeed, and how do you define when a project has succeeded?
6. What factor is the most important in order for your cases to succeed?

The process

7. What does your process for handling ideas look like? How do you screen ideas? Do you have screening criteria, and if so, do you use different screening criteria for researchers, students, or unaffiliated people, and what do these processes look like?
8. Are the roles of the incubator and technology transfer office different, and if so, why?
9. How would you describe your daily work routine?
10. Do you admit and work with social enterprise / social entrepreneurship ideas? If yes, how/why; if not, why not?

The support structure

11. What would you say are the benefits of being admitted to your incubator/TTO?
12. How do you support your projects? If monetary, how much on average? If coaching, how much time on average? Is there a difference in time or money spent on researchers, students, and unaffiliated people?
13. What is the role of business coaches (operative personnel)?
14. What support structures exist for the coaches?

Organizational structure

15. What does the overall organizational structure look like? (For example, is the incubator/TTO wholly owned by the university's holding company?)
16. How would you describe your organization's current situation and outlook?
17. How is your operation funded?

18. Can you describe one way of working that other incubators/TTOs do that you think is particularly interesting and positive and one that you are skeptical about in terms of whether it will work at all?

Data

19. What kinds of data do you collect regarding the different cases?
20. How do you work with this data?
21. Is there a possibility for me to access that data? If so, what kinds of data can I get access to and under what conditions?

Network

22. What other actors do you cooperate with? What does this cooperation look like?
23. What effects can you see from this cooperation?

Appendix C – The analysis and coding process

Initial coding

In coding data material (interviews), I followed a process similar to Eisenhardt's (1989) more general process and Charmaz's (2006; 2014) very detailed process. The first step was to do initial coding where large amounts of descriptive data were reduced to codes, which could be: themes, topics, ideas, concepts, terms, phrases, and keywords, among others (Charmaz 2014). All coding was done using Nvivo software to make sure that continuous documentation was made and thus reduce the risk of losing important thoughts and notes that would otherwise be written by hand. Another compelling reason to use computer software in the coding process is that it is hard, maybe impossible, for the individual researcher to keep hundreds of pages of transcripts and coding in mind when doing the coding, etc. I started coding all interviews (2) from University A (the CEO and a middle manager). The first interview generated 203 codes and 304 uses of these codes. The second interview generated an additional 135 new codes and 350 uses of old and new codes.

Examples of codes

- Conflicting agendas – "…if they [the university] see that we are stealing competent researchers, it is certain that it would create a certain conflict."[13] (*Person A at University B*)
- Driving the process – "And it is us that drives the process."[14] (*Person B at University B*)
- Feeling secure and comfortable in a particular setting – "…you feel secure and comfortable in that situation."[15] (*Person A at University B*)

Focused coding

According to Charmaz (2006), focused coding is what follows open coding and entails a need to explain large swaths of data. Thus it is important to use the most important codes from the first coding step in order to select the ones that can be categorized as important in the next step. It is necessary to take a closer look at the

[13] Translated text: "…om de ser att vi knycker duktiga forskare så är det klart att det blir en slags konflikt i detta här då"

[14] Translated text: "Och så är det vi som driver processen."

[15] Translated text: "…du känner dig trygg och bekväm i den situationen"

codes generated from both interviews to do this. The code *working with the university* seemed to be central, and a lot of the other codes could be organized together or under its heading. At a closer look at the text coded using this code, one can sense that something is going on here: two references coded, Reference 1: " …many times we get such an interest that we can create a relationship between an external part, a company, and the researcher and in that way maybe also gains new funding for the researcher. And this is something we did not expect."[16]
Reference 2 :"Strategic questions with the university."[17]

Conflicting agendas also fits well with this code:
Reference 1: "If they can see that we are stealing good researchers, of course this becomes a conflict."[18]

Stealing good researchers from the university seems interesting in the *conflicting agendas* subtext: one reference coded, Reference 1: "If they notice that we take accomplished researchers, clearly a conflict arises."

The code *Cooperating with the university* also fits:
Reference 1: "I think that this is a good way to safeguard the university. …the challenge is that if we are to succeed at the university, the unit heads, prefects, and departmental heads need to approve and even think it's a good thing that we come by…"

Being part of the university also seemed related:
Two references coded: Reference 1: "Before, everything was administered by the university and that did not work out so well."
Reference 2: "There was no order and no… well, no it did not work out great, it was a bad arrangement."

Helping the university could also be related: one reference coded, Reference 1: "we are part of the decision making and administer and manage this in order to make this arrangement as good as possible for the university."

Cooperating with the university, however, seemed very close to the first code, *working with the university* and I therefore kept the first code and scrapped this code. But at a re-examination of the text that the code entails, I could see a closer resemblance with the code *Conflicting agendas* and I therefore added the text to this code instead.

[16] Translated text:"får vi ju många gånger ett sånt intresse att vi kan liksom skapa en relation mellan en extern part, ett företag, och den forskaren och på det sättet kanske också få in nya forskningsmedel till forskaren. Och det förväntade vi oss inte."
[17] Translated text:"…strategiska frågor med universitetet."
[18] Translated text:"om de ser att vi knycker duktiga forskare så är det klart att det blir en slags konflikt i detta här då."

Memo example for this part of focus coding

There certainly seems to be something interesting in the apparent clash between the interests of the university and the interest of the innovation office (IO). There seems to be somewhat of a theme that there is more going on in the collaboration with the university and being (and not being) a part of it than meets the eye. This warrants further investigation.

Next step

However, I could deduce that a theme might be formed from one of the codes with the following codes linked to it:

- Being part of the university
- Working with the university
- Conflicting agendas
  - Stealing good researchers from the university
- Helping the university

The real strength with qualitative methods that use a more structured approach, according to Charmaz (2006), is that the investigating researcher becomes active and is not passively going through the data. This is something I recognized in my own process, especially during focused coding where codes from both interviews and memos were reviewed with the goal of being able to do the next step, that is, to form categories.

Memo Writing

As I coded the interviews and also during the focused coding, I wrote memos. Charmaz (2006) describes memo writing as an essential tool for analyzing the collected data as well as the codes early in the process. I made use of writing memos during open coding as exemplified below, and also later on during focused coding. According to Bryant and Charmaz (2007), memos help the researcher remember links in the data, and this became evident as time passed between the initial coding of, for example, interview 1 and interview 2.

Example of memo during open coding

Person A at University A mentions the changed direction and learning from mistakes a lot. This would suggest that the organization also values learning as a key tool. Check with the next interview with Person B (at the same university).

Amendment to said memo

Person B at University A also reflects on this subject and mentions past mistakes using a common method. He adds to Person A's thoughts by introducing different types of learning that they have experienced during their long history (over 30 years).

Turning the table

After coding and categorizing my transcripts, I printed all transcripts and started going over them again with a highlighting pen and highlighted the parts that fitted the themes I had constructed using Nvivo software. This yielded some additional parts and aspects that otherwise would have been lost if I had done the coding just once. I ended up with the following themes:

1. **University - incubator - innovation office relation**
2. **Firms as focus**
3. Knowledge flow back to the university
4. How to talk about the process as education
5. Entrepreneurial thinking
6. Financing
7. State funding
8. **Types of projects**
9. Leftovers from university-industry collaboration
10. Circumventing inventor ownership

In Chapter 4, themes 1, 2, and 8 are explored (in bold font). In Chapter 5, the rest of the themes are explored (to different degrees).

Appendix D – Regional results from Chapter 7

Table D.1 Results per region (Stockholm as region of reference)

Results by region	Model 4 b/se	Model 5 b/se
Stockholm	*Reference category*	*Reference category*
Uppsala	-2093.03 (870.30)**	-2256.43 (898.134)**
Östergötland	-933.11 (1222.20)	-970.72 (1196.86)
Jönköping	-969.45 (986.84)	-837.71 (995.28)
Kronoberg	-6563.74 (878.40)***	-6551.96 (896.39)***
Kalmar	-4362.06 (961.91)***	-4266.47 (978.17)***
Gotland	-6777.27 (884.42)***	-6714.59 (894.07)***
Blekinge	-6049.87 (929.45)***	-6063.70 (928.04)***
Skåne	-1878.77 (940.68)**	-1821.57 (938.19)*
Halland	-7489.29 (1033.38)***	-7419.28 (1029.82)***
Västra Götaland	-2267.24 (886.78)**	-2245.19 (885.20)**
Värmland	-6125.91 (978.73)***	-6098.99 (971.04)***
Örebro	-5075.12 (943.73)***	-5076.08 (935.58)***
Västmanland	-25.69 (1128.09)	-113.11 (1085.81)
Dalarna	-2947.12 (787.88)***	-2981.46 (787.01)***
Gävleborg	-2874.93 (1044.06)***	-2684.12 (1052.57)**
Västernorrland	-4433.61 (840.40)***	-4449.54 (859.84)***
Jämtland	-2994.61 (1033.62)***	-3046.68 (1042.90)***
Västerbotten	-2075.38 (1324.40)	-2057.73 (1341.93)
Norrbotten	-3926.51 (897.07)***	-3939.87 (898.45)***
_cons	10579.31 (1111.66)***	10542.47 (1113.60)***
R2	0.58	0.59
N	303	303

*** p<0.01, ** p<0.05, * p<0.10