Entrepreneurial learning & academic spin-offs – Project report to Nordic Innovation Centre[1]

Göteborg in January, 2005

This study has been conducted with financing from and under the auspices of Nordic Innovation Centre and with additional financial support from InnovationsKapital

[1] We would like to express our gratitude for many constructive comments from our colleagues at Copenhagen business school, Helsinki University, Reykjavik University, and to Thomas Winther och Tor-Jørgen Thoresen for valuable comments and support.

Preface

This project is part of the Nordic Innovation Centre's Forum for Innovation Policies.
The Forum is an initiative to promote more effective policy-making through exchanging information and initiating joint Nordic projects to improve the policy framework and business conditions for Nordic companies. The project specifically addresses entrepreneurial learning among academic entrepreneurs in the Nordic countries, and it has cordially been financed by Nordic Innovation Centre.

The following scholars, together with the academic institutions they represent, are the authors of this report: Sören Sjölander (Project Leader) from Chalmers University of Technology; Annaleena Parhankangas from Helsinki University of Technology; Rögnvaldur J Sæmundsson from Reykjavik University**;** Tomas Hellström from Copenhagen Business School; Mats Magnusson, Stefan Sanz-Velasco and Mattias Johansson from Chalmers University of Technology.

The point of departure has been the dramatically increased international competition combined with raising costs for a larger public sector that have led to low economic growth in Europe and the Nordic countries. Entrepreneurship has been pointed out as a key factor to turn this trend around, and entrepreneurship is here portrayed as activities that bring innovations to substantial economic use. Knowledge about entrepreneurial know-how, others' lack of this know-how, how entrepreneurs achieve this knowledge and apply it, is lacking though. The strict parting of the industrial economy between academy and industry is currently changing, so that a more blurry and flexible interface is emerging, where entrepreneurs play a key role. In this project, we will investigate how entrepreneurial learning is developed in these interfaces, what affects this development, its effect, and how it can be influenced by institutional actors such as academy, state and regional bodies. Our objective is therefore to aid in the development of more effective structures and policy for learning among academic entrepreneurs based on well-grounded understanding of entrepreneurial accumulation of knowledge. Furthermore, we have set out to monitor what influences this knowledge towards increased economic growth through more and better growing ventures. Our focus is Nordic entrepreneurial start-up ventures arising from academy, since these are expected to have an increased importance in the future knowledge-society.

To accomplish our aims we have performed number of case studies in Nordic academic start-up ventures, conducting interviews with the founders, and focusing on the business-related learning. We have also conducted interviews and investigated the existence of, content of and forms of the growing number of academic entrepreneurship education, courses and methods. In combination with this, it has been reviewed what effect current policies at universities and among authorities might have effect on entrepreneurial learning.

We would like to express our sincere gratitude to our financier, Nordic Innovation Centre, for making this project possible. Finally, it should be pointed out that the content of this report is on behalf of the authors and therefore our responsibility.

Table of contents:

Executive summary

Regional policy

Environmental support: A number of learning behaviors were identified that academic entrepreneurs used for improving their ventures. Customer based business model learning being the most important and least exhibited. In more supportive environments (Sweden and Finland), external actors were found to be more involved, whereas in less support rich environments (Denmark, Norway and Iceland), this involvement was scarcely found. Academic entrepreneurs in supportive environments were thus found to have access to a richer set of learning behaviours and perform better. See also below for more regional recommendations.

University management

Increase business competence focus: While much attention has been paid to technology and IPR-issues among universities, attention must be paid to issues such as how to package a technology into an customer offer, how to construct a viable business model and how to grow the company. Teachers with hands-on experience from entrepreneurial ventures are much needed. It was found that very few academic teachers in entrepreneurship have actual experience from developing a real business, and could thus not be considered to be fully prepared to change their way of teaching and learning in their programs. Academically credited industry experience is needed, such as involving more teachers from the business sector. A more stable and continuous involvement of adjunct professors in entrepreneurship and high tech commercialization than today would increase the possibilities for qualified experimental learning based on business development projects. A scheme for such adjunct professors would help accelerate entrepreneurial learning in academic settings.

Manage diversity: Requirements can vary a lot from a software company to a biotech company. Therefore, competence-, and policy-building needs not only be concerned with general requirements of entrepreneurial learning, but foster competence for the specific requirements of various sectors. Universities may need to focus on entrepreneurial learning in their respective core areas of research, focus entrepreneurial activities to what they are good at.

Educational improvements

Unconventional support structures: While the influence of conventional university support services by and large seams to be absent, it is interesting to note the influence of unconventional support measures such as lab integrated entrepreneurship education programs and business plan competitions. These support measures influence the learning behaviours leading to necessary business-related knowledge. Many entrepreneurship programs is about entrepreneurship they do not drive it.

Need for more entrepreneurship programs? Most of the entrepreneurship programs identified in the Nordic countries are primarily focused on small firm management, such as internships in already existing companies, and not on entrepreneurship in its stricter sense. This confusion between SME management and entrepreneurship is a recurring observation, most likely dependent upon the general vagueness of the term entrepreneurship. Policy-makers should thus not be misled to believe that enough has already been made to stimulate the creation of high-growth firms at Nordic universities.

Analysis versus experimenting: There are still several programs with an almost exclusive focus on traditional pedagogical means, and a primary aim at improving students' analytical management knowledge, rather than focusing on experimental learning. It is here argued that this is not sufficient to meet the requirements of the entrepreneurial process.

Dual achievements: It has been found that in a few universities, commercializable research results from the university research groups are used as input to student projects in entrepreneurship education, thereby serving dual objectives. Entrepreneurship education is enhanced and university research commercialised. This was be fare the most productive approach both for learning and for real commercial results..

Entrepreneurship as a complement: While there are several entrepreneurship programs in the field of business administration, there are only a few that build upon basic studies in science, technology and medicine, where the real opportunities for creating new high-growth firms are apparently larger. Consequently, a focus on entrepreneurship programs closely related to science, engineering and medicine should be promoted.

Network management for learning

Venture capital: The absence of influence from venture capital investors and conventional university support services, such as incubator services or technology transfer offices was noted. While these actors are visible in the cases and support the development of the ventures, they are not reported to influence business models development. Not only is there a pressing need to increase the expertise of seed venture capital investors in the Nordic countries, it is also important that venture capitalists can signal their competence to both their own investors and of course to the entrepreneurs. The market is not transparent enough to be effective. The limited size of the Nordic venture capital market suggests a coordinated Nordic action to speeded learning.

Extended executive summary

Introduction

This report focuses a fundamental process in economic development; that of entrepreneurial learning. Entrepreneurial learning is defined as the process by which entrepreneurs acquire the knowledge needed for identifying, creating and exploiting new business opportunities. With entrepreneurs we mean economic actors, working on a market for a profit, developing and exploiting innovations, something new and valuable on the market that was not there before. These innovations typically let the customer or user do what was previously impossible or what was possible before but now at a radically lower cost then before. Innovations can take many forms;

- *new products* such as the first graphic computer chip invented by Jim Clark wile being a university professor at Stanford in 1982, or the first single chip microprocessor, introduced by Intel, the Intel 4004, invented by Intel engineers Federico Faggin, Ted Hoff, and Stan Mazor in late 1971
- or *new services* such as personalized space travel launched in 2004 by Burt Rutan with his tiny flying rocket machine SpaceShipOne winner of the $10 million Ansari X Prize in October 2004
- or *new manufacturing methods* such as the Pilkington float glass process invented by Sir Alastair Pilkington in 1952,
- or *new ways of organizing the firm and its value network* such as Ingvar Kamprad's IKEA, founded in 1943 that gave radically new customer values based on radically different resources combinations, logistics and cost structure in the home and furnishing sector.

In the modern economy, the knowledge economy, innovations based on new knowledge have a special and growing importance and hence the sources of such innovations the "academy" - typically research universities and research institutes- play a fundamentally important role as engines of economic growth in society. The role or the "core business" of the academy has evolved over time since the first university (university of Bologna founded in 1088). Between the 11th and 19th century universities had dissemination of knowledge (teaching) as its dominant role. During the 19th century the creation of new knowledge (research) was incorporated into the role of the so-called Humboldt University. During the 20th and 21st centuries the most innovative universities evolved into the "entrepreneurial university"[2] such as when MIT and Stanford first included also creation and exploitation of new technology, commercialization, into its third integrated role mission with teaching and research. Many of these early attempts evolved into what would become integrated into a formidable strength of some of the modern universities, where the three roles were mutually strengthening each other. The inclusion of commercialization (the industrial and societal realization of technology) as an explicit role of the modern university is a rather new phenomena starting in the US during the 1930s to 1950s and during the 1970s to 1990s among Nordic universities. This new role for universities call for new innovative entrepreneurial university policies that help drive the development of the entrepreneurial role of the university, while strengthening the role and performance in teaching and research rather then weakening it.

Given this background the research reported here is focusing upon entrepreneurial learning in academic settings, research universities and institutes.

[2] Etzkowitz, H. (2002). *MIT and the Rise of Entrepreneurial Science*. London: Routledge.

The Nordic context for policies aiming at increasing the entrepreneurial output from such institutions is one of catching up especially with prominent US research universities. It is a context with relatively less experience compared to some US universities and hence with lower competence in the area but with a strong will from significant actors to experiment with new approaches and policies. The Nordic context is also one of different activity levels for entrepreneurship in general. Referring to Global Entrepreneurship Monitor[3] the situation is different among the Nordic counties. The opportunity based entrepreneurship activity in the Nordic countries vary from low and below average (compared to the OECD average) in Sweden, to somewhat higher in Finland, medium activity in Denmark and higher in Norway, and the highest entrepreneurial activity in Island. One conclusion made from these comparisons is the opportunity based independent entrepreneurial activity is inversely related to the maturity and size of the established industrial sector. This must be seen as an asset for countries such as Island and Norway and to some extent problematic for countries such as Sweden and Finland where large established firms dominate the industry structure and also with a very strong political voice influencing research as well as university policies.

Entrepreneurial learning as a key mechanism for innovation

One means of commercialization in the university, namely that of creation of academic spin-off ventures, has received increased attention. Academic spin-offs are increasingly seen as important means for enhancing local economic development, generating income to universities to support research (and indirectly education), and encouraging successful scientists to become innovators.

The increased interest among universities and scientists with regard to venture creation has also changed the role of scientists in academic spin-offs. From being more likely to have the role of advisors, facilitating the transfer of knowledge to the new venture, they are today more likely to be members of the entrepreneurial team; hence, playing a greater role in identifying and developing the opportunity, acquiring resources, and organizing the venture. However, in order to accomplish their new roles, scientists as well as universities must build new knowledge in a number of areas, for example about industry conditions. Equally important is the ability of scientists and universities to acquire business and managerial competencies, that is to learn how to put their existing knowledge to work in a venture context. Since academics and their students are unlikely to have these abilities in the start-up phase, the new challenge for university-based innovation is that of entrepreneurial learning, that is the process of scientists and their organizations learning how to become creators of commercial value. This is not a simple task.

We believe that to build up the necessary business related knowledge and competence requires an understanding of the modes and mechanisms for learning among academic entrepreneurs. It has been found that the early stage of development in research-based spin-off ventures is characterized by this learning, both through trial and error and through interaction with external actors. It has also been shown that the relative importance of each learning process is dependent on the nature of the environment of the firms. For example, firms without access to external actors with entrepreneurial experience are more likely to rely on learning through trial and error. But what does this mean for academic entrepreneurs? What are the implications for action? This problem is the focus of the present project report.

Because despite the recognition of the importance of learning in academic spin-offs and the role of the environment for the learning processes, we lack systematic knowledge on

[3] Reynolds, P. D., Hay, M., Bygrave, W., D., Camp, S. M., & Autio, E. (2002). *Global Entrepreneurship Monitor 200*

Reynolds, P. D., Bygrave, W., D., Autio, E, Cox L.W. &. Hay, M., (2003). *Global Entrepreneurship Monitor 2003*

how academic entrepreneurs learn different aspects of creating and developing a viable business, and how their learning is influenced by the environment, for example the universities, but also the legal, policy and financial environment. We need to find out

- How do academic entrepreneurs learn when creating and developing a start-up venture?

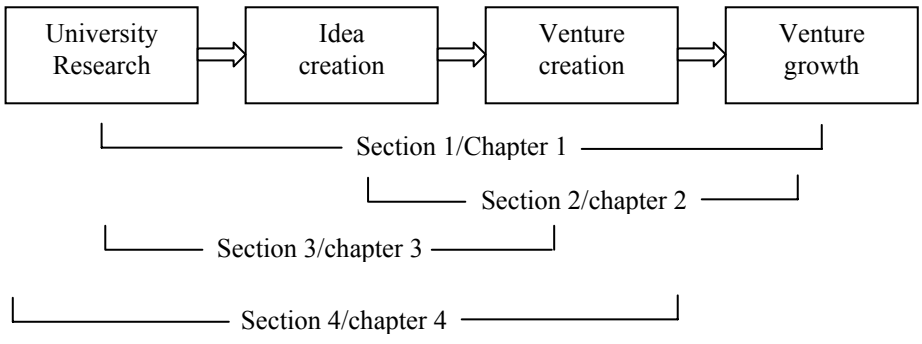
Finally, there are of course different ways of being an entrepreneur in the university. The present report recognizes that there are different means for commercialization of research, but whether it involves academics starting up their own businesses or university licensing activities, entrepreneurial learning is needed in order to guarantee an effective commercialization. This because the worlds of academia and business have traditionally obeyed different logics, and the mind-set or logic of commercialization needs to be incorporated into the universities. That is, entrepreneurial learning is needed.

Structure of this report

The structure of this report is as follows: This extended executive summary will present the purpose (the present introductory section), also summarizing the methods employed in the study. After that, an outline of the main results from the study will be summarized in the following order:

- a theory of entrepreneurial learning witch provides a *framework for understanding what entrepreneurs need to know, defined by the" business model" to be able to exploit new innovations and how they successfully acquire such knowledge.* This provides a fundamental basis for subsequent parts and for suggesting policy interventions.
- Summary section 2/chapter 2: an analysis of how entrepreneurs in Nordic academic spin-offs learn critical commercialization skills
- Summary section 3/chapter 3: an analysis of entrepreneurship education programs run at Nordic universities
- Summary section 4/chapter 4: an analysis of university policies effecting entrepreneurial learning in the academic context, needs and suggestions for new policies that aim at increasing the entrepreneurial learning and hence entrepreneurial competence in Nordic university contexts.
- The report ends with a summary of the implications found

Each of these sections refer to more full chapters of the main report (chapter 1-4) which can be consulted for additional theory, methodology, data or discussion or results. The whole report follows, and maps, what is now a well-known model of the innovation system:



Outline of the methods employed in the present study

The methodological design of this study has been the following: Several parallel literature studies in areas relevant for entrepreneurial learning were conducted in order to create a map of the field, and find relevant existing case studies to guide further inquiry. The fields covered in this way were theoretical studies relevant to entrepreneurial learning, entrepreneurship education and learning in new firms and policy/university level mechanisms to promote learning. Analysis of this literature and these cases formed the basis for the theoretical study presented in section 1/chapter1. This theoretical study was also used as a way of pulling the team together by creating a common framework.

The empirical study presented in section2/chapter 2, which addresses entrepreneurial learning in academic spin-off firms, utilized a semi-structured interview approach to collect data from eight academic spin-offs in Sweden, Denmark, Finland and Iceland (two from each country). Firms were selected to conform to the criteria of having had their origin at the university (being started by students or faculty), by spreading over a range of technologies (from biotech to IT), and by being fairly young yet having reached a level of business maturity (success cases with the founders still present). This data was then used to draw out the mechanisms for entrepreneurial learning towards creating a successful business model.

The empirical study presented in section 3/chapter 3 focuses on entrepreneurial learning in entrepreneurship education. It is a general survey of the availability, pedagogical strategies and relative merits of these programs in the Nordic countries. The study employs a so-called Internet survey approach, developed in two distinct steps. The first of these was to create an overall description of the state-of-the-art of these programs in Nordic tertiary education. The second step was to generate categories of such programs and compare these against knowledge of entrepreneurship process, in order to generate implications on the university level. Additional information were gathered through interviews of key individuals at the various Nordic universities.

The fourth section of this report deals with the policy framework for successful entrepreneurial learning in terms of how universities can facilitate knowledge growth in this area and thereby become more entrepreneurial. The study builds on policy documentation as well as academic studies in this area. These were selected on the basis of database searches, personal referrals and current discourse and publishing among innovation policy authorities in the Nordic countries as well as outside. These studies were then analyzed from the point of view of how state-of –the-art knowledge in innovation policy can facilitate entrepreneurial learning.

Section 1: What is entrepreneurial learning?

What is it that successful entrepreneurs know and why, and how do they know it? These are some of the most fundamental questions that we must attempt to answer in order to be able to understand the process of innovation and economic growth at the firm level, as well as on higher levels of analysis. The underlying assumption in this project is that *the process of knowledge acquisition by entrepreneurs who exploit business opportunities* is a key process in firm growth. This process we refer to as entrepreneurial learning. It is our firm belief, which has also been substantiated by the present project, that successful innovation policy must rest on a of entrepreneurial learning which draws on the concept of the *business model*, more broadly speaking the script or 'logic of action' that is gradually developed and grow with the company, as a frame for what the entrepreneur needs to know to grow the firm. It is this model in combination with the technology or the offerings of the firm that make up the critical resource which the firm is based upon. It is the way that entrepreneurs acquire the knowledge and skills to develop such a business model, and tie this model to a technology, which we refer are attempting to describe. The logic behind successful learning of this kind

will be a resource for policy formulation on any level – weather it be firm strategy or state policy. In this study, we suggest that two modes of learning are dominant in this process, that these two fill different functions at different times, and that an optimal mix between these two is advisable, albeit a mix which must change over time. The empirical evidence for these conclusions is clear, and can be further explored in chapter 1 of the main report.

Entrepreneurship, as we define it, is intimately connected to innovation (the entrepreneur is seen as the driver of innovation) as well as to learning, the process by which new knowledge is acquired in order to innovate. The latter is a key fundamental process which must be properly understood in order to make sense of entrepreneurship and economic growth at its most basic levels. A robust theory of entrepreneurship, and of entrepreneurial learning, should begin by asking two questions: – what must entrepreneurs know in order to succeed, and how do they acquire this knowledge (learn)? In this summary we will begin by outlining an answer to the first question, namely what needs to be learnt define a venture and to solve the problems involved in creating and exploiting entrepreneurial business opportunities. We will then outline our conclusions relating to the second issue of ways of learning this knowledge.

What do entrepreneurs need to know to be successful?

The base condition for firm growth is at least partly to be found in its ability to acquire, combine, cumulate, and recombine resources, not least technological resources, as well as the ability to rapidly respond to business opportunities and threats. The firm's ability to respond to business opportunities is likely to stems to a significant extent from the development of managerial capabilities, and the strategy, structure and governance and that firm. The firm's business model can be viewed as a footprint of these capacities or at least the intention to realize such capacities. This gives two fundamental dimensions along which the acquisition new knowledge and in turn its effect on firm growth can be understood: The business model (i.e. the commercialization strategy) and the technology (the substantial offering).

Learning component 1: A business model we define as the script, code or logic by which a business generates or intends to generate revenue and profits. This component is at the core of what the entrepreneur needs to know. It is the logical explanation of how a company serves, or will serve, its customers under competition, in order to gain a fair and sustainable profit. We propose that in its totality, such a model involves the understanding of nine dimensions of the business, which comes to guide how the entrepreneur build the business.

- How the new business creates utility and value for its customers - Customer value
- How the new business select, acquires and keeps its customers - Customer segments
- How the new business differentiates its product offerings; - Offerings
- How the product offering of the new business is being defined, developed, and sourced; - Development and sourcing strategy
- How the new business goes to the market; - Promotion and distribution strategy
- How the new business defines the tasks to be performed; - Value chain and value network position;
- How the new business acquires and configures its resources; - Resource acquisition and organization strategies
- How the new business captures a fair and sustainable profit by using mechanisms and methods to share the value created for customers at a level that is greater that the total costs involved; - revenue and cost control model
- …..So that the new business creates enough value for its various stakeholders to be able to keep, develop and accumulate resources and keep cash above zero..

Learning component 2: Secondly firms have to acquire knowledge about the possibilities offered by the technology on which the firm is based, i.e. the technology of the firm. An increasing number of new firms have in one way or another become dependent or as it were 'based upon' technology in exploiting business opportunities, thus giving rise to the notion of New Technology Based Firms (NTBFs) and New Technology Based Businesses (NTBBs). The evolution of science and technology has continually generated business opportunities, particularly in the public-private interfaces of universities and business life. But technology and technological knowledge may also evolve within the firm as entrepreneurs remodel their offering using the same basic technologies or add new technologies to produce a novel combination of capabilities. These two processes, business model and technological learning come together in the innovative firm, and the way entrepreneurs learn to leverage these dimensions will determine the firm's success.

…And what and how do entrepreneurs learn?

The literature from pedagogic, as well as organizational research strongly suggests that the acquisition of these capabilities develop within certain learning modes. The first of these modes is based on 'experimental' learning, where the entrepreneur proceeds mainly through trial and error, and the second one where the entrepreneur works within a 'framework' or 'frame' of assumptions which generate solutions to problems. Next, we will briefly review these two modes of learning.

Experimental and evolutionary models. These modes of learning stretch from what could be called opportunistic learning, without much direction, to more evolutionary learning, where successful patterns are retained. However learning in this mode is a fundamentally experimental, trial-and-error activity, most likely to be present in the early phase start-up of the firm, or appear during crises. The literature has often referred to entrepreneurs as learning while engaged in their practice, a sort of learning by doing, or experimenting. There is also an opportunistic element in this, which is related to opportunities, however, we have chosen to see the opportunistic, experimenting entrepreneur more as a component or relative weight, which is present in most entrepreneurs, but to various degrees. The experimenting, opportunity-driven entrepreneur is also engaged in a form of learning very much akin to Karl Popper's model of scientific growth as a process of 'conjecture and refutation' of hypotheses. Popper suggested the following model for how a discipline or a theory develops which fits well with some forms of entrepreneurial learning:

- $problem_1$ → tentative theory → action / experiment → falsification attempt or error elimination → observation → reasoning/interpretation → refinement of theory (learning) → $problem_2$.

This model suggest that 'learning' starts from the encounter of a problem, in our context this could be an attempt to gain some arbitrage or capitalize a new scientific result. One then constructs a set of hypotheses on how to solve this problem. However, it is our belief that decisions are also taken which cover the whole range of subsequent decisions in the entrepreneurship process, that is, entrepreneurs learn within a frame of reference guided by 'covering' decisions, which may or may not be explicit to them. This is where the frame-based model enters in.

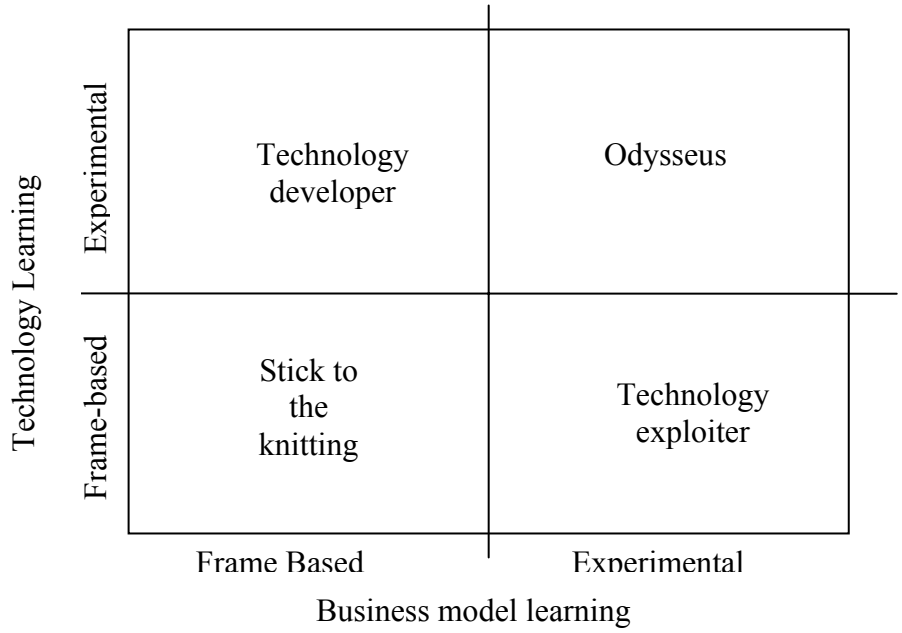
Frame oriented models. Some authors suggest that entrepreneurial learning is essentially about moving from one framework to another. These notions do not put the emphasis on experimentation, but rather on how the entrepreneur refines and deepens a particular form of understanding of the venture process. From this perspective, learners do

not acquire knowledge through trial and error, but are instead involved in a 'way of thinking' or a 'community of practice' which dictates what solutions have to look like.

Just like we were able to utilize Popper to understand the experimental mode of learning, so Thomas Kuhn is useful to further explicating the frame-based view. While Popper would emphasize the 'permanent openness' of knowledge acquisition and rejection, Kuhn, in his now well known book *The Structure of Scientific Revolutions*, took the opposite perspective and argued that scientists worked from within structured frameworks, or paradigms of thought. The schemata for this type of learning mode look like this:

- Early experience and knowledge acquisition → (framework-building ↔ framework application)

These two modes of learning in combination with the 'whats' of learning discussed above, produce four 'learning types' for the entrepreneur (and the firm).



To summarize: In the frame-based learning mode the learner, the entrepreneur, experience:

- Familiarity with the causality of the system context of which he/she and the opportunity or problem is a part of, he/she knows what context to learn from.
- Familiarity with what the opportunity is, what its problems are; he/she knows what needs to be learnt.
- The methods or tools by which the problems are solved, solutions developed (he/she knows the method of learning.

On the other hand in the experimental evolutionary learning mode the learner/entrepreneur experience:

- Unfamiliarity with the causality of the system context of which he/she and the opportunity or problem is a part of and feels a need for questioning the fundamental assumptions of the system context.
- Unfamiliarity with the opportunity and the problems involved, consciously incompetent.

- Unfamiliarity with the methods or tools that can solve the problems and surface the opportunity.

This means among other things that an unconsciously incompetent entrepreneur will tend to stay within his/her frames even when these are not productive for solving the problems involved. His is obviously not a good strategy. Instead it is our belief, based on the observations made in the empirical material (see chapter 1), that the mixed mode of learning, i.e. that represented by either the 'technology developer' or the 'technology exploiter' are most likely to succeed in the long run. This observation which brings us to the last part of this summary, the question of how these modes should be combined to be effective.

Successful entrepreneurial learning: Towards a model

The business model (commercialisation strategy) and the technology (the substantive offer), can reviewed as 'learning domains' in the course of developing a firm. In addition, the mode of learning, as illustrated in the cases above, can be located on a continuum from experimental/opportunist to frame-based. These divisions yield a first basis for categorizing entrepreneurial learning into the four types seen above.

It may be possible to use the knowledge of learning type to 'predict', with a certain degree of informality, how a firm will respond to stimuli to learn, how they will tend to recognize or reject, include or exclude, opportunities for learning in the face of new experience. Entrepreneurs and entrepreneurial team may adopt wholly dysfunctional learning styles (e.g. never questioning a particular framework), or adopt unfavourable combinations of learning styles within the team or towards the technology/business. Examples could include having an experimental learner as CFO or a frame based CEO where instead one would need a visionary. Our case investigations suggest that a mix between frame based and experimental modes will be most successful. This is also intuitively correct, since routine and renewal are both key aspects of successful business growth. However, one must also keep in mind that the balance and exchange between these two learning modes will be likely to shift in terms of their respective functionality through the life cycle of the firm. From a normative perspective a rigid mix between experiment and frame-based learning may be just as bad as being too biased in one direction or the other. This brings us to our next model, or proposition derived from the above reasoning.

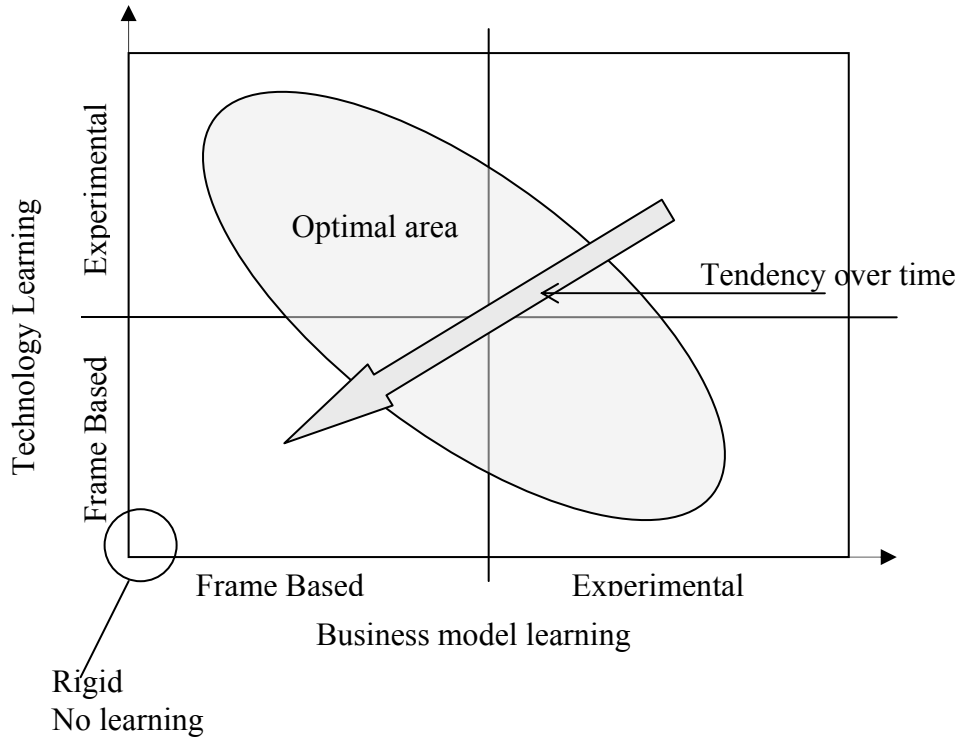


Figure 1: Hypothesized optimal modes of entrepreneurial learning and the dynamic tendency to gravitate towards rigidity

By adding a process dimension to the typology, and recognizing that learning mode will functionally shift through the life cycle of the firm, from more experimental towards a more rigid mode, a number of conclusions may be derived:

Management and policy implications for entrepreneurial learning

1. All ventures in an early stage need to develop according to an experimental learning process. This needs to be taken into account by management teams, boards of directors, investors as well as policy makers. Radical experimentation in both the technology and business model dimensions is unlikely to be productive.

2. Most technology entrepreneurs need to focus experimental business model learning very early on in the process and keep doing so until a first market segment is verified through repeatedly successful sales.

3. The most important "measurement data" in the early experiments are what customers that are willing to pay for what the company offers, as well as information on cost and quality of needed resources. It is important that business models are sought that makes this possible early on in the process so that the learning process is accelerated. Most probably long lead-times to sales, co-varies with failure because of the lack of real, "hard data" market feedback.

4. As the venture matures and the commercial success develops, the drive for increased effectiveness will make frame based learning the dominant mode as opposed to experimental.

This is precisely the cognitive effect behind why older organisations, sometimes also larger ones, tend to fail when entering into times of radical external change where experimental learning again becomes key. If the processes of detecting the inappropriateness of frame based learning is not in place companies may come to gravitate towards treating the environment as predictable and stable in a non-functional way.

In conclusion: - what learning modes are more likely to be growth inducing in the early stages, when the venture is developing, and what are the dynamics involved? We would expect firms that follow the 'Odysseus learning mode' to be less successful. In addition, companies that use a frame-based learning mode relative to the business model as well as to the technology dimension would expect to be successful by accident rather then by rational choice. Instead, we would expect companies that exhibit the learning mode of the technology developer or technology exploiter to be more successful. These firms allow incremental learning to take place in at least one of the two main venture dimensions, for example improving the understanding and mastery of one core technology, while allowing the business model to be experimented with and radically adapted to changing circumstances. However, as a company grows and becomes more successful, we would expect its learning mode to gravitate towards what we have labelled 'stick to the knitting', the impetus to experiment tends to decrease if not challenged. To overcome, there have to be challenges to the way the business is run. Jack Welch is a good illustration of such a force. He is attributed with institutionalizing a management routine with clear effects for business and technology learning. Under Welch, GE had a challenging drive: "Would you rather be in toasters or in CT-scanners" illustrating his strive for higher value added. The Welch-factor also states that in each of the businesses GE should dominate by being number one or two, be strongly on the way of becoming so or withdraw. For those businesses that were number one or two Welch asked : 'How would your business and the market you serve be defined if you redefined it so that you only have 1/3rd of the market share you have today?' Such cognitive challenges aim at fostering learning on how to grow the business by trying to find entrepreneurial growth opportunities in redefining the business model, a counterforce for gravitation into 'stick to the knitting'.

Section 2: Entrepreneurial learning in academic spin-offs – a business model perspective

In this section the results and implications of the case analyses of eight academic spin-offs in four Nordic countries are presented (see methods in chapter 2 for a description of the cases). The purpose of the analysis is to investigate how academic entrepreneurs learn to build a viable business, and how the nature of the environment influences this learning process. This is done through analyzing what learning behaviors may lead to changes in business models and how the environment influences what learning behaviors are available to academic entrepreneurs.

In the analysis an elaboration is used of the concepts of experimental learning and frame-based learning introduced above. Two new dimensions are introduced as a conceptual tool for understanding how academic entrepreneurs, who are likely to have little prior business experience, move from being an inexperienced business learner to becoming a more experienced one. We will focus on the learning behaviors needed to develop a viable business model – or what we call a 'level 2' learning model. This learning is a mix between experimental and frame-based learning, and different from learning within a given business model (level 1 or pure frame-based learning), and learning about one's own learning processes (level 3 learning). In addition a dimension is added to enable us to make a distinction between 'on-the-job' learning through interaction with customers, suppliers,

competitors, and other business partners (experience-based learning) and learning through interaction with other external actors, such as new employees, financiers, consultants, and support agencies (learning through external actors). Such a distinction is important from a policy maker's point of view.

Learning Behaviours Leading to Business Model Changes

All of the case firms have made important changes to their business models during their development. Changes have been made for various reasons within and across firms. Collectively, nine different learning behaviors have been observed as leading to changes in cognitive frameworks, as expressed by the subsequent changes in the business models. These behaviours are listed below in Table 2 and classified as either experienced-based learning or learning through external relations. Below, the characteristics of each of these behaviors are further explained.

Experienced-based learning	**Learning through external relations**
Market scanning	Adding new employees
Virtual market experimentation	Obtaining external expert advice
Interaction with existing customers	Participation in entrepreneurial education programs
Interaction with new customers with new requirements	
Imitation	
Responding to external changes	

Observed learning behaviors classified into two categories

Market scanning

Scanning the market is a behavior that involves information collection regarding potential customers. This information collection may be systematic or ad-hoc, containing varying degrees of personal interaction with potential customers. In the case firms entrepreneurs used scanning to learn who their customers were and what would be a valuable offer to them. The learning is often indirect and incomplete as the learning behavior simply falsifies hypotheses about offering and customers, but does not generate ideas on how to proceed.

Virtual market experimentation

A central element of virtual market experimentation is the demo, or the prototype, which is presented to a potential customer for evaluation or feedback. A demo or prototype provides a more powerful representation of the potential product or service, addressing more senses than written or verbal communication. In the case firms the entrepreneurs used virtual market experimentation to learn who the customers were, and what offer would be valuable for them. The difference from scanning is that virtual experimentation was more likely to help the entrepreneurs to generate ideas, going from one customer segment to the next through new knowledge of possible functions of the product/service:

Interaction with existing customers

After completing a sale to a customer, there is often considerable interaction between the venture and the customer. This is especially common in early phases of venturing when the product or service is in its infancy and needs to be improved through use, which may then lead to considerable changes for the product or service. In the case firms the interaction with existing customers was usually a more direct learning experience, i.e. giving concrete

direction, as compared to interaction with potential customers through market scanning or virtual experimentation.

Interaction with new customers with new requirements
Facing new requirements, especially through the addition of new customers having different preferences from existing ones, is a learning behavior that can fuel changes in the business model. In most cases these changes were related to the ambitions of the entrepreneurs to increase the scope of the ventures' businesses, following the identification of new customer groups. Interacting with new customers with new requirements was also found to change conceptions about distribution.

Obtaining external expert advice
Obtaining external expert advice pertains to learning behavior, not involving customers, but rather the temporary involvement of experts outside the firm, such as consultants, investors, experienced entrepreneurs or other expert networks. Advice can be purchased or simply given for free. In the case firms the entrepreneurs used external advice to help develop the offer and the customer focus, e.g through scientific advisory board. In one case firm investors have advised (or required) the firm to maintain focus on a narrow customer segment until obtaining a proof of principle for the original product idea:

Adding new employees
The adding of new employees brings along the knowledge and experience of those individuals. While the effect may be similar to external advice it is likely to be more influential considering that a new employee is a permanent addition to the organization as is thus likely to have a greater learning influence on the entrepreneurs through continuous interaction. In some cases new employees were found to lead to changes in the offer and in the customers served, e.g. through their knowledge of markets and marketing from previous employment.

Participation in entrepreneurship education programs
Engaging in entrepreneurship education, before or during the development of the venture includes participation in a structured program aiming at coaching entrepreneurs through the creation of a viable business plan. This involves the articulation of the business plan, which may help clarify latent ideas about the business model. Only two of the case ventures were involved in such programs, but they had a broad influence on the business model of those ventures.

Imitation
Imitation pertains to the observation of the behavior of other firms, i.e. competitors or partners, and replicating that behavior, possibly with some minor adjustments. In the case firms, imitation was most often related to revenue models. The entrepreneurs would, for example, gather public information on revenue models of competitors or contract forms.

Responding to external change
This learning behavior is distinct from other learning behaviors mentioned above. Whereas the other learning behaviors seek to learn about the current state of things this one is rather a reaction to information about that the current state has changed. A part of the reaction might be to engage in other learning behaviors. In the case studies, responding to external change could lead to profound changes in the business model, e.g. following the changes in the valuation of Bio-tech firms on the NASDAQ market.

The influence of the environment on learning behaviours

The first step in analyzing the influence of the environment on learning behaviors is to identify the differences in the environment for academic entrepreneurship in the Nordic countries. The table below summarizes the differences in the environment for academic entrepreneurship in the Nordic countries. Please note that the classification is relative, i.e. only describes the relative position of the Nordic countries against each other.

Country	University support system	Seed financing
Denmark	Medium	Medium
Finland	Strong	Strong
Iceland	Weak	Medium
Norway	Medium	Weak
Sweden	Strong	Strong

Summary of relative differences in strength of environmental support for academic entrepreneurship in the Nordic countries. The evaluation is based on Johansson (2005) and Nordic Innovation (2001).

From the table one can infer that the most supportive environment for academic entrepreneurs is found in Finland and Sweden. Academic entrepreneurs in these countries are therefore more likely to complement their experience-based learning with learning through external actors, while entrepreneurs in Denmark, Norway and Iceland are more likely to be limited on their own experience-based learning.

Interestingly, the case studies support this picture. Only in one case outside Sweden and Finland were external actors found to influence changes in business models. Despite being involved in the ventures, e.g. as financiers, and influencing day-to-day learning, external actors were not reported as involved in learning behaviors leading to changes in business models. In contrast, all the spin-off ventures in Finland and Sweden were found to have changed their business model following learning through external relations.

Conclusions and implications

In the study a number of learning behaviors have been identified as leading to changes in business models. Some involve varying degrees of customer interaction, imitation of competitors or responses to external changes in the business environment. Others involve learning through external actors other than customers and suppliers. These behaviors provide different possibilities for academic entrepreneurs to engage in level 2 learning, which eventually support them in arriving at a viable business model.

In addition it has been found that the environment influences the availability of certain learning behaviors. In more supportive environments, such as Sweden and Finland, external actors were found to be involved in learning behaviours leading to changes in business models. In less supportive environments, such as Denmark and Iceland, this involvement was scarcely found. Academic entrepreneurs in supportive environments were thus found to have access to a richer set of learning behaviors leading to needed changes in their business models.

When observing the learning behaviors reported by the entrepreneurs as leading to changes in business models, it is important to note the absence of influence from venture capital investors and conventional university support services, such as incubator services or technology transfer offices. While these actors are visible in the cases and support the development of the ventures, they are not reported to be involved in learning processes

leading to changes in business models. This is an interesting finding considering previous studies on the role of these actors in the development of academic spin-offs (e.g. Bygrave, 1992).

While the influence of conventional university support services is absent, it is interesting to note the influence of unconventional support measures such as entrepreneurship education programs and business plan competitions. As these support measures are directed towards the development of business opportunities, it might not be surprising that they influence learning behaviours leading to level 2 learning.

The main implication of the study for academic entrepreneurs is the importance of level 2 learning leading to changes in business models and the awareness of the different learning behaviours that are available. The different learning behaviors may be seen as possibilities to learn how to build a viable business. It is also important for academic entrepreneurs to understand the distinction between level 1 and level 2 learning and the complementary roles of experience-based learning and learning through external relations. In this respect it is important for academic entrepreneurs to be able to understand if external actors, such as venture capitalists, consultants or support agencies, are able to contribute to level 2 learning, or if their contribution is limited to level 1 learning. Contributing with level 2 learning, i.e. to helping the academic entrepreneurs to reach a viable business model, is especially important in early stages of venturing in order to provide a viable direction for the venture as quickly as possible. Failure to do so may greatly influence the likelihood of survival.

The main implication for policy makers is the need to provide academic entrepreneurs with opportunities for both level 1 and level 2 learning. When constructing policies and support systems for assisting academic entrepreneurs, it is important to note the distinction between the two levels of learning and to make sure that opportunities for both are provided. More research is needed in order to better understand how these opportunities can be provided, e.g. possible division of labor between different actors in the support system. Is it, for example, viable that venture capital investors and entrepreneurship education support specialize in providing level 2 learning support while actors such as incubator services and technology transfer offices specialize in level 1 support? Could various industry organizations act as information clearing-houses providing industry specific information and expertise needed for level 2 learning? How are the learning capabilities of each actor to be signaled to the entrepreneurs?

There are specific implications for improving the support for academic entrepreneurs in the Nordic countries. There is a need to strengthen the venture capital industry in the Nordic countries. Not only is there a need to increase the expertise of venture capital investors, it is also important that venture capitalists can signal their competence to both their own investors and of course to the entrepreneurs. Investors would be better able to judge the expected performance of venture capital funds and entrepreneurs should be better able to judge the venture capitalists' ability to contribute to level 2 learning. More research is needed on how this could be implanted in a Nordic context and the possibility of Nordic cooperation. For example, the limited size of venture capital markets in each of the Nordic countries suggests that a coordinated Nordic action might be necessary to increase the leverage of available funds and speed up the build-up of expertise needed for contributing to level 2 learning.

Section 3: Nordic entrepreneurship programs

This part of the study includes the mapping of entrepreneurship programs at Nordic tertiary institutions, an investigation of their contents and the pedagogical means used.

Background

Entrepreneurship research has over time gone through substantial changes in terms of its content and volume. A first major change in terms of research focus is a shift from personal- and traits-based theories to an increased interest for the entrepreneurial processes involved in venture creation. Another development trajectory has been a gradual move from a strict focus on analytical approaches to a view of entrepreneurship that also gives ample room to intuition, experience, and non-linearity of processes. The latter has contributed to an on-going debate regarding entrepreneurship education. While there earlier has been a debate whether entrepreneurship can be taught, and even whether entrepreneurship can be learnt, there now seems to be a consensus that the key question is how entrepreneurship should be taught. This should be seen in the light of the suggested particular characteristics of entrepreneurial learning, an activity that does not only consist of analytical, frame-based learning, but also needs to comprise experiential learning triggered by experimentation in practice.

Based on the brief exposition of entrepreneurship theory, two research questions are derived. First of all the study aims at mapping the different entrepreneurship programs that are available today at Nordic tertiary institutions, and to investigate whether these have an explicit focus on venture creation or not. Secondly, it aims at investigating the pedagogical means used in the programs, in order to see to what extent these are action-oriented and thus are likely to contribute to the generation of high-growth firms.

Results and analysis

By using the Internet, all Nordic tertiary institutions have been searched for entrepreneurship programs. While there may be a certain risk that a few entrepreneurship programs may have been overlooked due to the sole reliance upon Internet as a source of information, the possible lack of a few programs would not significantly change the overall results and implications. The data was analyzed in two steps. First, the data from all the different programs was compiled. Based on the program contents and the pedagogical means observed, and received theory, a categorization of entrepreneurship programs was proposed and discussed, followed by a discussion of the implications of this study for policy and university management.

A total of 35 different programs were identified. Out of these, 15 were Swedish, 9 Norwegian, 6 Finnish, and 3 Danish. No entrepreneurship programs were found in Iceland. About half of the programs were Master programs and the rest were with a few exceptions at the Bachelor level. *All programs for which course information was available include some course parts on venture creation*, and almost all programs included more general theory about entrepreneurs and entrepreneurship. More surprising was the observation that *only 12 of the studied programs had a focus on science and technology*, revealing that entrepreneurship is primarily considered to be part of business studies.

At an overall level, *the differences between on the one hand Sweden and Norway, and on the other hand Finland and Denmark, are substantial*. Programs in the latter two countries are mainly composed by traditional academic programs within Business Administration, where entrepreneurship can be chosen as a major. These programs follow the same structures as other academic programs, with the difference that internships of varying lengths may be included. In Sweden and Norway, the variety in terms of program structure and content is

much larger. The Swedish programs are without doubt the most diverse ones. Here we find all kinds of programs ranging from Chalmers School of Entrepreneurship, aiming at generating new high-tech businesses through an extremely action-oriented pedacogical approach, to the Entrepreneurship program at Södertörn University College, where students can combine studies in a range of subjects, e.g. the sociology, history, with a track in entrepreneurship, and the Creative Business Management at Örebro University, focusing specifically on events, the music industry, etc. Yet another observation is the heavy focus on internationalization and extensive collaboration with leading foreign universities that can be seen in several of the Norwegian initiatives.

The differences between countries are interesting as they point to obvious differences in terms of the focus on entrepreneurship programs and their intended functionalities. Apparently, the creation of new entrepreneurship programs has been considered an important component in order to boost entrepreneurship in Norway and Sweden. In the countries that are considered to be higher rated in terms of entrepreneurial activities, the same need is probably not perceived.

When analyzing the programs more closely, it is possible to divide them into three distinct categories, based upon differences in the focus on venture creation or small firm management, and the attention paid to experiential learning, respectively. The three categories proposed are:

1. *Traditional academic programs with emphasis on SME management and/or entrepreneurship,*
2. *Practice-oriented small firm management programs with emphasis on entrepreneurship, and*
3. *Programs combining entrepreneurship training and new business creation.*

The first category refers to the traditional academic programs, primarily in Business Administration, that was mentioned above. These programs primarily consist of lectures, with occasional guest lectures, case studies and study visits. No particular emphasis is put on applying the theories that are learnt in practice. While this category of programs may have been instrumental in order to make entrepreneurship an accepted area of research in the broad field of business and economics, its importance for promoting entrepreneurship is more limited.

More interesting in terms of experiential learning is the second category – practice-oriented small firm management programs with emphasis on entrepreneurship. These programs rely heavily on internships, or other kinds of long-lasting relationships between students and host companies. However, while including components that are clearly practice-focused, these programs do not address the very early phases of firm creation, but instead tend to focus on small firm management. While improved small firm management is an important issue for several Nordic countries, this category of programs still leaves us wanting in terms of providing a potential solution to the creation of new, high-growth firms.

The third and final category is the programs combining entrepreneurship training and business creation. A number of programs belong to this category. The ones that appear to be most interesting are Chalmers School of Entrepreneurship and and the School of Entrepreneurship at Uppsala University, as well as the Master in Innovation and Entrepreneurship at the University of Oslo and the School of Entrepreneurship at the Norwegian University of Science and Technology. All these programs use *student-driven business development projects as the key learning vehicle*. Furthermore, they all utilize *university research as input to the business development projects*, something that constitutes a radical difference between these and a few other programs which share the same overall structure. In the latter, it is often up to the student to generate and refine the business idea,

often leading to the development of businesses that have more limited overall potential and/or are easier to copy.

Without doubt, this type of entrepreneurship program appears to be a promising one. However, it is not without disadvantages. First of all it is *difficult to find a general format for teaching and assignments related to the projects*, as these are all unique and have different requirements. Also, the *resources required to identify suitable projects and to select entrepreneurially-oriented students are substantial*. On top of this, this kind of programs appears to *need additional system components in order to function well, such as e.g. access to seed capital and professional services like accounting and patent expertise*.

Worth noting is that this interesting model seems to become more diffused over time. The core components of the concept developed at Chalmers School of Entrepreneurship already in 1997 can be recognized at both Uppsala University, Skövde University College, and Borås University College, with some local adaptations. Even some of the Norwegian programs started recently reveal that some inspiration has been gathered from Chalmers.

Apparently, there is still a lot of experimentation going on, especially in Norway and Sweden. While it appears to be positive that programs in these countries manage to free themselves of some of the overly academic formats that may hamper the use of pedagogics that are more focused on experiential learning, there may also be negative effects. The extreme diversity of these programs reflects a continued dilution of the concept of entrepreneurship, which may render it more difficult for this subject to become accepted as a legitimate part of academic curriculum. However, to try to fit entrepreneurship into a more traditional frame of research and teaching is not necessarily a fruitful way forward either.

Implications for policy and university management

A number of implications for innovation policy and the design and management of entrepreneurship programs at universities can be derived from the performed study.

<u>Need for more entrepreneurship programs?</u>

- While the number of Nordic entrepreneurship programs appear to be quite high, it is necessary to consider that *most of the programs identify are primarily focused on small firm management, and not on entrepreneurship* in its stricter sense. Policy-makers should thus not be misled to believe that enough has already been made to stimulate the creation of high-growth firms at Nordic universities.

<u>Increased use of advanced student-driven business development projects</u>

- While a large number of the identified programs include at least some component that supports experiential learning, there are *still several programs with an almost exclusive focus on traditional pedagogical means*, and a primary aim at improving students' analytical management knowledge. These means are *not sufficient* to convey a substantial understanding of the situationally dependent, highly complex situations that are encountered in entrepreneurial processes concerning sophisticated products and services.

- *Many entrepreneurship programs put a strong emphasis on internships in already existing companies, sometimes in interesting geographical settings.* However, by undertaking internships in already existing firms, there is a large risk that the activities students will be involved in are more of an administrative character. Accordingly, this *reliance on internships ought to be more suitable for providing SME management skills*. This confusion between SME management and entrepreneurship is a recurring observation, most likely dependent upon the general vagueness of the term entrepreneurship.

- A number of programs include student-driven business development projects. This development is highly promising and a few programs have taken this program component to an advanced level. In a few universities, *commercializable research results from the university research groups are used as input to the student projects, thereby also contributing actively to the commercialization of research*. This is a so far underexploited mechanism for promoting academic entrepreneurship, which could be used more widely.

Entrepreneurship as a complement to other subjects

- In several programs, entrepreneurship is held out as a topic that is to be studied for its own sake, and not as a complement to other studies. This is the case for a number of the degree programmes in Business Administration, as well as a few others. While there are several entrepreneurship programs in the field of business administration, there are only a few that build upon basic studies in science, technology and medicine, where the real opportunities for creating new high-growth firms are apparently larger. *Consequently, a focus on entrepreneurship programs closely related to science, engineering and medicine should be promoted*.

Teachers with hands-on experience from entrepreneurial ventures needed

- In order to be able to contribute in a fruitful manner to students' experiential learning, teachers must have own experiences from the kind of activities, as these skills can hardly be acquired through traditional analytical means. At present, *few academic teachers in entrepreneurship have experience from developing their own businesses*, and could thus not be considered to be fully prepared to change their way of teaching and learning in their programs.

- One way of handling the lack of teacher competence is to involve more teachers from the business sector. To some extent this is done already today, as such persons are invited as guest speakers to the programs, and in some cases even as project coaches. However, a *more stable and continuous involvement of adjunct professors* would increase the possibilities for qualified experiential learning based on business development projects. Over time, also teachers with more limited prior experience of entrepreneurial ventures can acquire the skills required, by participating as coaches to student-driven business development projects year after year. It should not be forgotten that the programs in question are almost all very new ones, and that it takes time for the academics involved to acquire the required skills.

Section 4: Barriers and facilitators to entrepreneurial learning at universities

This section summarizes the results from the study from the point of view promoting entrepreneurial learning from a policy and particularly university policy perspective. The past ten years has seen an unprecedented shift in research policies towards promoting interaction between business and academe, as well as commercialization of the seemingly unrealized potentials residing within public research organizations. There are different means for commercialization of research, but whether it regards academics starting out their own businesses or university licensing activities, entrepreneurial learning is needed in order to guarantee an effective commercialization. This because the world of academia and business obey to different kinds of logic, and with a greater responsibility of the former to account also for the latter, the mind-set of commercialization needs to be incorporated into the universities. That is, entrepreneurial learning is needed.

From a policy point of view, entrepreneurial learning within universities is influenced both by policies specifically directing universities and the commercialization of research, as well as by policies directing entrepreneurship and universities' role in society more generally. The basic logic for stimulating both commercialization of research and entrepreneurship is often one of stimulating funding and knowledge.

The findings are based on theory and a review of policies in the Nordic countries. The review reveals that many university reforms have been undertaken of late. Most notably is a removal, or changes to, the teachers' exemption clause in all countries but Sweden. The effects of such a removal can, however, be argued (cf. Henreksson, 2002). The Danish experience also gives that a removal in itself is not sufficient, but needs to be complemented by competence and a support structure, as has been the case foremost in Norway. However, it is costly to build such a structure. Commercialization is an avenue that is much more resource-intensive than the traditional channels of diffusion, and many universities in Sweden, for example, are quite cash strapped as it is. Their existing organizational structures are not developed enough to deal with the growing demands from contract research, let alone dealing with IPR and commercialization issues. To the extent that support structures are in place, there are also complaints on the lack of competence on behalf of universities to accommodate for these activities, as shown in Finland. The costs imposed on universities in taking responsibility for the commercialization are moreover not easily compensated. The largest source of external income for most universities in both the EU and the US still comes from grants for specific research projects rather than profits accrued from patents or licenses. Costs are further driven by the time-consuming process that reorganization for commercialization is. While references are often the made to American universities and the Bayh-Dole act in arguing for turning over ownership-rights, it is less often considered that the support structures of some universities had already been developed over decades before the change took place.

There is thus a need for continued financial as well as policy support for the universities to make the organizational changes required in the light of the imposed responsibilities for commercialization. But it is also important to consider the support offered by the existing structures. While all the Nordic countries have made efforts to increase entrepreneurial learning within universities, the Swedish case suggests that a lot of attention has been paid to IPR-related issues, or issues concerning firm formation. Less attention has been paid to the market side, i.e. how to package the technology into a proper offer, or how to create viable business models etc. This is very important for successful commercialization and may call for assistance of industry professionals. Moreover, as universities may not themselves be able to discover and exploit all opportunities, alternative structures for recognition such as bringing in "surrogate" entrepreneurs from outside the universities may be considered. Different scientific areas are also likely to exhibit different requirements, why multiple but separate policies and competences may be needed also within universities. Alternatively universities may have to specialize in entrepreneurial learning in some areas, while providing only more general support to commercialization activities in other scientific areas.

Apart from the support structure and competence within the universities, some additional barriers to entrepreneurial learning were recognized. These include the academic meriting system that still does not seem to have undergone changes making an entrepreneurial path a credible career option, although some experimentation exist in, for example, Iceland. Problems still also seems to pertain to labor mobility in and out of academe, making it difficult to take sabbatical leaves. This may be related to the ability of universities to flexibly and strategically recruit personnel, although the exact extent to which this is the case remains unclear from this review. Moreover, although efforts have been put

into promoting entrepreneurship, the Nordic countries with the exception of Iceland are still behind in international comparison. However, it may still be too early to see the effects of the measures taken. Otherwise, some overarching legislative barriers, such as investments in private firms, have been circumvented but a revision may still be needed in the light of the new policy interest.

As mentioned above, the basic logic for stimulating entrepreneurship and, thus, entrepreneurial learning often resounds around funding and knowledge. On a somewhat more general level, the issue of funding may influence primarily in two ways. Firstly, through the availability of venture capital and support programs and, secondly, through the structure of the public research funding system to the extent that it limits or enables opportunities for commercialization of research.

There has been a significant diversion of financial mechanisms available to SMEs in the Nordic countries, including public and venture capital, as well as soft loans and support programs. There has been a growth of the private venture capital market, but there is still a general consensus of opinion that the current generation of venture capitalists are neither competent nor risk prone enough to meet the demands of the market. The recent downturn in the private venture capital market confirms this. It also suggests that the public venture capital market will continue to play a significant role, especially in the seed funding stages as is evident in, for example, the Finnish case. There is also a range of specialized bonus support programs targeting academic entrepreneurs in general, or in specific academic sectors, such as the FORNY-programs in Norway. Such mechanisms are obviously beneficial as they provide means to engage in, and thus learn from, entrepreneurial activities. What may be lacking, however, is support for very early techno-economic evaluation of research projects, something that would facilitate screening in later stages.

Regarding the public research funding systems, much effort has been devoted to promote collaborative research as a means of bringing university closer to industry needs. The main approach utilized in both Sweden and Finland has been to make collaboration a criterion of eligibility for academic proposals seeking funding. There is an increasing trend towards competitive funding also in Denmark and Norway, while Iceland is still far behind. While this trend is positive in the sense that it may increase the likelihood for knowledge transfer, and thus commercialization, it is not without critics. This partly because industry is concerned in so far as it also leads to a development where universities substitute for the R&D units of private companies. But partly also because it has the effect that university researchers prefer to work with larger firms due to the limited funds of SMEs for commissioning R&D. This may prove a disadvantage for more “entrepreneurial” efforts and also be an obstacle for small firms highly dependent on universities for additional research, such as university spin-offs.

Regarding the infrastructure and general support structure, Sweden and Finland may be regarded as front-runners with respect to innovation policy in general and with respect to policies for commercialization in particular. Denmark, Norway, and Iceland, are somewhat less advanced but ranked quite high seen from a European perspective. Due to extensive benchmarking activities, many infrastructural schemes are similar, including advisory offices, regional development programs, research parks and incubator schemes. While well developed and obviously facilitative of entrepreneurial learning, there are indications that they are not always fine-tuned to the needs of entrepreneurs. In Denmark, the infrastructure might also need a revision in light of the new policy objectives.

Finally, it is also important to consider the extent to which entrepreneurial learning, and an increased focus on commercialization within universities is something of a good. The fact that there in some cases suddenly exists a “customer” for research results may impose risks of, for example, increased secrecy and withholding of research results which could

jeopardize the base for the institution that universities constitute. There are also many potential points of tension between the traditional academic culture and the new environment of managerialism and professional leadership etc., which could make the process even more troublesome. The risk of backlashes has also been recognized in a recent OECD-report further actualizing the question. However, in the end it may not be a question of whether entrepreneurial learning should be promoted or not. There is probably a broad consensus about the potentially positive effects, on a society level as well as on that of the individual researchers and his/her research. The question is rather one of the terms on which commercialization should be conducted, and who should conduct it. Just as all research is not suited for commercialization, all researchers are not potential entrepreneurs. Instead alternative solutions may be needed, including opening up the universities for "surrogate" entrepreneurs to discover and exploit opportunities. This could increase both commercialization and entrepreneurial learning without turning researchers themselves into entrepreneurs.

The review together with theory forms the basis for some conclusions and recommendations. These largely become ones of overcoming barriers toward entrepreneurial learning as they have been identified in the review. Some of the points follow in the line of previous research, which is not surprising since the shift in policy is fairly recent and the processes of change are time-consuming. The points include:

- Provide continued support to organizational development at universities
  While support has been provided, making universities responsible for the commercialization of research is a major shift that is not easily compensated and that takes time to adapt to (cf. the history of the American universities). Thus, there is a need for continued financial and policy support in order to build the competence and management support needed to reorient the university structures towards the new mission.

- Increase focus on business competence
  Much attention has been paid to technology and IPR-issues etc. While this is very important, it is equally important to pay attention to issues such as how to package a technology into an offer, how to construct a viable business model, how to grow etc. Since this is not a traditional area of expertise for universities, industry experience may be needed to support this.

- Create competence and policies able to manage diversity
  Academic entrepreneurship is not a homogeneous activity, but the requirements can vary a lot from a software company to a biotech company. Therefore, competence-, and policy-building needs not only be concerned with the general requirements of entrepreneurial learning but create awareness and competence for the specific requirements of various sectors. Alternatively, universities may need to focus on entrepreneurial learning in their respective core areas of research.

- *Facilitate for researchers to move between the university and business sectors*
  Entrepreneurial learning may be greatly increased by participation in commercialization efforts. This, however, presupposes mobility in and out of academia why remaining obstacles should be revised and removed. This issue is also related to restrictions on the ability to flexibly and strategically recruit personnel within universities, why the structure for this needs to be improved.

- *Create incentives for individual academics to commercialize their knowledge*
  This relates to the preceding point and refers in particular to attuning the academic meriting system to the new mission so that an entrepreneurial path can become a credible career option. A review is may also be needed on how revenue-sharing and university support has been perceived by researchers in the countries where the teacher's exemption clause has been removed.

- *Promote an entrepreneurial culture*
  Entrepreneurial attitudes could be further promoted on a university level, for example by recognize incidents of successful cases, provide explicit formal management support, and to review the perceived concerns of the researchers. This is also a regional problem, for which promotional efforts in terms of entrepreneurship programs, educational programs etc. should be continued.

- *Pay attention to the academic imperatives*
  Commercialization of research is beneficial only in so far as it is compatible with the long-run mission of universities in society, that is, the first and the second mission of the university. Moreover, researchers may not always be best suited to neither discover nor exploit opportunities, why alternative mechanisms such as bringing in "surrogate" entrepreneurs may be used. Such mechanisms may, in addition, by themselves promote entrepreneurial learning among researchers.

These points refer to improvements that can be made within the university structure, and primarily relates to the phases when an idea is conceptualized and a venture about to be founded. In addition to the points presented it may also be mentioned, albeit more briefly, that competence could be further strengthened in areas such as the venture capital industry, and incubator schemes etc. Support could also be provided for techno-economic verification or evaluation already at the closing of research programs or projects in order to facilitate the screening process in later stages. Finally, awareness should also be created of the potential interferences of different policies aimed toward increasing commercialization.

MAIN

REPORT

Chapter 1:

Towards a theory of entrepreneurial learning

Summary

A key process in firm growth is the process of knowledge acquisition by entrepreneurs who exploit business opportunities. Received theories of entrepreneurship and of the growth of the firm, of which there are many, have not particularly connected learning to an account of technology, business models and the management of the early phases in the firms life when a lot of what will later shape the firm is set. Based on theoretical elaborations this study makes an attempt to do this by synthesizing literature from the fields of entrepreneurship, theory of the firm, pedagogy and philosophy of science in combination with illustrative empirical evidence from new technology based firms (NTBFs). This account results in an outline of a theory of entrepreneurial learning – the process by which entrepreneurs acquire what they need to know to be able to develop a new business. This theory draws on the concept of the business model qua script or 'logic of action' that is gradually developed and grow with the company, as a frame for what the entrepreneur needs to know to grow the firm, and introduces technology as the critical resource that the offerings of the firm are based upon. This account suggests an experimental and frame based learning mode as dominant modes of acquiring the knowledge needed for growing the firm and elaborates on the effects on growth of the firm of the respective model. Empirical evidence is provided from the growth processes of four technology based firms. Dynamic effects of the growth of the firm is discussed and key managerial implications pointed out.

1. Introduction

Because of their fundamental importance as key driving forces in innovation processes and hence their importance in creating economic wealth entrepreneurs have been the subject for study for a long time. Their fundamental role in innovation can be seen as that of coordinating resources for creating and realizing opportunities that few understand and even fewer dare to exploit before they are being made obvious by purposeful action. A key issue, very little understood, in this respect is therefore what entrepreneurs know and how they acquire that knowledge. There is a growing interest in the psychological and cognitive dimensions of entrepreneurship; typical examples include opportunity recognition, entrepreneurial business culture and entrepreneurial risk seeking behaviour. While the benefits of applying standard cognitive and social theory to the phenomenon of entrepreneurship are as many as they are important, it is typically forgotten that entrepreneurship is not a 'neutral' type of behaviour, but rather by definition an activity which is directed towards an often bold goal. This goal is to accumulate resources, typically

money, and the vehicle for the fulfilment of this goal is the creation of a venture. Entrepreneurship, as we define it, is intimately connected to innovation (the entrepreneur is seen as the driver of innovation) as well as to learning, the process by which new knowledge is acquired. The latter is a key fundamental process which must be properly understood in order to make sense of entrepreneurship and economic growth at its most basic levels.

A robust theory of entrepreneurship, and of entrepreneurial learning, should in effect combine the normative dimension of entrepreneurial circumstances – what entrepreneurs must do in order to succeed, with an adequate descriptive model of learning that captures what entrepreneurs actually do when they do well. Consequently, instead of trying to make sense of entrepreneurial behavior in terms of received social and cognitive science models, the aim of this chapter is to interrogate the question of what constitutes entrepreneurial learning from a theoretical point of view, but where a significant normative question is put before the analysis. This question is: what do entrepreneurs at least need to learn in order to be successful? The chapter is constructed as follows:

Firstly, we will review a number of models of learning from the field of entrepreneurship studies and condense a few key principles from these models. We will trace the roots of the basic learning metaphors implied in these models to the originating fields of pedagogy and philosophy of science, and we will draw out some implications for practice embedded in these models. Secondly, a tentative normative to the question of what entrepreneurs need to learn to be successful will be attempted. This will be done through an elaboration of a number of learning requirements, which could typically be associated with the notion of a 'business model' in terms of what the basic theoretical literature on entrepreneurship tells us about learning in venture creation. Thirdly, these principles with then be confronted with the requirements on learning posed by the entrepreneurial context of action, as well as with previous results on entrepreneurial learning. This is done through a presentation of a few illustrative case studies of what we take to be successful entrepreneurial learning. Finally a model will be presented, which integrates the most promising principles of a theory of learning, with the 'demands' of entrepreneurial development, and summarizes these in a two dimensional model, whose dimensions are illustrated with examples from practice. Aside from this we aspire to make a contribution to the ongoing discourse on entrepreneurial opportunity (c.f. Sarasvathy et.al. 2003, Shane 2003) we see entrepreneurial opportunities as something that do exist in an objective meaning before they are exploited but can only be acted upon when discovered, understood and internalized by the entrepreneur and the entrepreneurial team. The process by which this is done we call learning and learning can

be done according to different learning styles or habits depending on who is learning what and in what context, what we label as learning modes.

To summarize, in this chapter we will focus on modes of learning in the context of what needs to be learnt and from what sources information stems that define and solve the problems involved in creating and exploiting entrepreneurial business opportunities.

2. Modes of entrepreneurial learning and their roots: A selective review

2.1. Experimental and evolutionary models

These modes of learning stretch from what could be called opportunistic, weakly directed learning, to more evolutionary forms, where successful patterns are retained, however within a fundamentally experimental, trial-and-error framework. Aldrich and Martinez (2003) for example have pointed out that many entrepreneurs begin their journey by imitating what already exists, without any deeper understanding other than the intention to, for example, 'construct an organization'. They are learning while engaged in their practice, a sort of learning by doing, or experimenting. Smith (1967) saw 'the opportunistic entrepreneur' as standing in opposition to the 'craftman-entrepreneur' in that the former was more prone to take a leadership role and expand his/her business. The opportunistic element is of course related to an opportunity driven approach, while the craft element is related to the utilization of already existing intellectual and physical resources. Aldrich (1999) makes a similar point, when he describes how, in the early phases, an entrepreneur must build a knowledge base through experimentation. Cooper (2000) specifically refers to opportunistic entrepreneurs as those with little technical skill, who have spotted a gap in the market, and then enter into relatively unknown territory. However, we have chosen to see the opportunistic, experimenting entrepreneur more as a component or relative weight, which is present in most entrepreneurs, but to various degrees.

Such a view may be connected to the learning theories of Lewin and Kolb, who emphasizes the distinctly experimental quality of learning, where, quite realistically, emerging theories or hypotheses play a role in the development of knowledge. Kolb (1984) and Kolb and Fry (1975) devised, on the basis of among others Kurt Lewin's and John Dewey's pragmatist theories of learning, a scheme comprising four sequential steps, which 'spirals' the learner towards higher levels of understanding. In the model some concrete experience gives rise to further observation and reflection, which in turn leads the learner to form some more abstract concepts around the experience. These concepts are then tested in a new situation. Kolb and Fry (1975) point out that this process could presumably begin at any

of the four stages, but that it typically is initiated by a person carrying out an act, and observing its consequences - therefore this can be said to represent an experimental model of learning. The learner would, by acting in the world and observing some effect, come to formulate tentatively a principle governing this cause and effect relationship. However, as pointed out by Coleman (1976), this understanding may be of a very simply nature, and not easily put into words. The formation of abstract concepts should not be taken to imply that these are in any way complex, in fact Kolb pointed to the use of concrete, 'here-and-now' experiences to test fairly simple ideas; and use of feedback to change practices and theories (Kolb 1984). This could also be connected to the single/double-loop learning theory of Argyris (1993), where learning essentially involves the detection and correction of error, albeit on different levels of abstraction.

It is tempting, and perhaps fruitful, to connect this family of learning to Karl Popper's theory of science. This has been done for example by Harper (1999). The Popperian scientist an by extension entrepreneur, never takes his/her 'theory' to be 'true' – these are always of a speculative nature, like guesses or hypotheses, which may be overthrown in the light of opposing evidence or corroborated, i.e. be temporarily accepted (Popper, 1959). Revisions are the key activity for people operating within such a tradition, and not unlike the Kolb learning model, Popper suggested the following model for how a discipline or a theory develops and to summarize the evolutionary, experimental mode of learning can be stylized as an evolutionary Popperian process:

- $problem_1$ → tentative theory → action / experiment → falsification attempt or error elimination → observation → reasoning/interpretation → refinement of theory (learning) → $problem_2$.

This model suggest that 'learning' starts from the encounter of a problem, in our context this could be an attempt to gain some arbitrage or capitalize a new scientific result. One then constructs a set of hypotheses on how to solve this problem. The entrepreneur actually trying out a business model, testing ideas on presumptive customers etc, tests puts these hypotheses to the test in the entrepreneurial situation. What is left after these 'tests' have been conducted is a new version of the problem, or an altogether new theoretical framework, should the original ideas not have panned out at all. Harper (1999) in his elaboration of the popperian model, takes the entrepreneurial decisions to be sequential, quite in line with what Popper would have prescribed for science. However, it is our belief that decisions are also taken

which cover the whole range of subsequent decisions in the entrepreneurship process, that is, entrepreneurs learn within a frame of reference guided by 'covering' decisions, which may or may not be explicit to them. This is where the frame-based model enters in.

2.2. *Frame oriented models*

O'Driscoll and Rizzo (1985) working from within the tradition of Austrian economics, suggested that entrepreneurial learning is essentially about moving from one interpretative framework to another. While O'Driscoll and Rizzo could not explicate exactly how entrepreneurs move from one frame of reference to another, they did suggest that learning within a frame was neither determinate nor random, and that each subsequent frame has a 'loose dependency' on its predecessor (p. 38) (c.f "path dependency" Teece 1980, 1982 and 1997) . The notion of learning within frameworks, was part of the authors' typical Austrian notion that entrepreneurship was about coping with uncertainty and surprise. The idea that the entrepreneur starts out from within a frame**,** basically what he/she knows, believe to be true and are familiar with**,** which may be gradually refined and changed, but which essentially retains significant influence over how the entrepreneur refines and develops knowledge of the business process, is connected two the role of 'scripts' and 'prior knowledge' in the venture process. The former notion has been elaborated by among others Mitchell and Chesteen (1995), who discuss how expert scripts or heuristics are developed and then employed to identify for example opportunities in an area. The notion of 'prior knowledge' has been elaborated by Shane (2000) to depict how entrepreneurs perceive future opportunities on the basis of earlier training and other experiences.

These notions do not put the emphasis on experimentation, but rather on how the entrepreneur refines and deepens a particular form of understanding of the venture process. The corollary for this type of learning may be found in the works of Vygotsky (1978) and Lave (1988). In the 'social learning theory' of Vygotsky and the 'situated learning theory' of Lave, learning is tied to a context of application and mediated by culture and technology. Lave's position is that that learning is always situated within a particular activity, context and culture. From this perspective, learners do not acquire and utilize 'abstract' knowledge through trial and error, but are instead becoming embedded in a context of knowing or a 'community of practice'. Situated learning is seldom intentional, but rather takes on the form of gradual enculturation into a paradigm of thought. The 'cognitive dissonance theory' of learning may help to point out some of the shortcoming of utilizing such frameworks. According to Festinger (1957) there is a propensity for people to seek consistency among

their beliefs and opinions, and if an inconsistency between attitudes or behaviors occur (dissonance), something has to change to eliminate the dissonance. If for example, there is an inconsistency between attitudes towards something and already existing or learnt behavior, it is more likely that the attitude will change to accommodate the behavior then the other way around. Connecting the cognitive dissonance theory of Festinger to Lave's situated learning theory, we arrive at social learning perspective on entrepreneurship suggested in the writings of among others Bandura (1986) and Deci (1992) that once an entrepreneur has arrived at certain standard preferences and behaviors, they will select to work on problems and with individuals who share these behaviors and preferences, and as a result continue to reinforce existing biases, and of course strengths (Delmár, 2000).

Just like we were able to utilize Popper to understand the experimental mode of learning, so Thomas Kuhn will be useful to further explicating the frame-based view. While Popper would emphasize the 'permanent openness' of knowledge acquisition and rejection, Kuhn, in his now well known book *The Structure of Scientific Revolutions* (1962/1969), took the opposite perspective and argued that scientists worked from within structured frameworks, or paradigms of thought. In a broad sense, the Kuhnian paradigm refers to a 'disciplinary matrix' of beliefs, values and techniques shared by a research collective, to which its members often unreflexively subscribe. In the more narrow sense a paradigm is an 'exemplar', or an influential presentation of a scientific theory. In our context, it is important to note that Kuhn points us to one way of building knowledge, namely by 'following through' on a number of pre-established commitments as to worldview, methods to be employed, social relations to uphold and vocabulary. The schemata for this type of learning mode, following the general Kuhnian conception would look something like this:

- Early experience and knowledge acquisition → (framework-building ↔ framework application)

This conception is complementary and established a broader theoretical context for notions such as 'prior knowledge' where creativity and learning is in fact about assembling prior knowledge in more or less new ways, i.e. what is already in the system of thought, thereby restricting potential variation of new concepts. To summarize: In the frame based learning mode the learner, the entrepreneur, experience:

- Familiarity with the causality of the system context of witch he and the opportunity or problem is a part of, he/she knows what context to learn from.
- Familiarity with what the opportunity is, what its problems are; he/she knows what needs to be learnt.
- The methods or tools by witch the problems are solved, solutions developed (he she knows the method of learning

On the other hand in the experimental evolutionary learning mode the learner/entrepreneur experience:

- Unfamiliarity with the causality of the system context of witch he and the opportunity or problem is a part of and feels a need for questioning the fundamental assumptions of the system context
- Unfamiliar with the opportunity and the problems involved, consciously incompetence
- Unfamiliar with the methods or tools that can solve the problems and surface the opportunity

This means among other things that a unconsciously incompetent entrepreneur will tend to stay within his/her frames even when these are not productive for solving the problems involved.

3. What entrepreneurs need to know and do to be successful

The base condition for firm growth is at least partly to be found in its ability to acquire, combine, cumulate, and recombine resources, not least technological resources, as well as the ability to rapidly respond to business opportunities and threats (Granstrand & Sjölander, 1990). The firm's ability to respond to business opportunities is likely to stems to a significant extent from the development of managerial capabilities, and the strategy, structure and governance and that firm. The firm's business model can be viewed as a footprint of these capacities or at least the intention to realize such capacities. This gives two fundamental dimensions along which the acquisition new knowledge and in turn its effect on firm growth can be understood.

3.1 First dimension: the content of business models

This section draws on the work of Andrén et al., 2003 and Chesbrough and Rosenbloom, (2002) in order to propose a descriptive-normative model of the content of a successful

business plan. We believe that such a 'lightly' normative stance in relation to the way the creation of a new business is conducted is important in understanding entrepreneurial learning, if the goal with research is to make concrete suggestions, and ours is. We also believe that this is in recognition of the fact that entrepreneurship is not a 'neutral behaviour', but a thoroughly normative stance to the world, where intentions vis-à-vis certain values are already given in the act of entrepreneurship. This insight must be reflected in a theory of entrepreneurial learning.

What is it that successful entrepreneurs come to know and why, and how do they come to know it? These are some of the most fundamental questions that we must attempt to answer in order to be able to understand the process of innovation and economic growth at the firm level, as well as on more general levels of analysis. In what follows, we intend to contribute one piece to such understanding by proposing an empirically as well as theoretically derived descriptive (rather that inherently prescriptive) model for what it is that entrepreneurs 'need to know'. We take the entrepreneur to be that person(s) who introduces something new to the market, he/she can be seen as the 'driver of innovation' (Schumpeter, 1911). In this chapter we focus for-profit entrepreneurs; actors who have the intension to extract profit from that market. We take 'a business' to be a commercial activity, and specifically a means of livelihood and/or profit, or an entity which engages in such activities. A business model we define as the script, code or logic by which a business generates or intends to generate revenue and profits. This last component is at the core of what the entrepreneur needs to know. It is the logical explanation of how a company serves, or will serve, its customers under competition, in order to gain a fair and sustainable profit. We propose that in its totality, such a model involves the understanding of nine core dimensions of the business, which comes to guide how the entrepreneur build the business, aka 'the business model': This following should be regard a script, which clarifies the understandings necessary for such a model, and in the context of this chapter, the learning goals of a successful entrepreneur.

- How the new business creates utility and value for its customers - Customer value
- How the new business select, acquires and keeps its customers - Customer segments
- How the new business differentiates its product offerings; - Offerings
- How the product offering of the new business is being defined, developed, and sourced; - Development and sourcing strategy

- How the new business goes to the market; - Promotion and distribution strategy
- How the new business defines the tasks to be performed; - Value chain and value network position;
- How the new business acquires and configures its resources; - Resource acquisition and organization strategies
- How the new business captures a fair and sustainable profit by using mechanisms and methods to share the value created for customers at a level that is greater that the total costs involved; - revenue and cost control model
- …..So that the new business creates enough value for its various stakeholders to be able to keep, develop and accumulate resources and keep cash above zero..

(c.f. Andrén, Magnusson & Sjölander 2003 and Chesbrough & Rosenbloom, 2002)

Some aspects of the model are very intuitive. To have a value proposition for the customer is of course key if the aim is to be able to sell something to the customer. This means that the entrepreneur needs to clarify what should be offered to whom, and why they should buy what he/she is offering. Different customers value different attributes of the offering. Therefore it is important to understand what customer segments meaningfully exist for this product, which ones to serve and how to serve them. Customer value is an economic concept as opposed to product performance (often mistaken as a value), is important because it puts limits as to what can be charged as a price. Creating customer value for specific customers in specific ways is a necessary but not sufficient precondition for an entrepreneur to create profit. The entrepreneur have also to figure out in what specific value chain to participate, largely defined by the offering, and what position to acquire in that value chain to be able to appropriate enough value for his or here business to cover the cost of resources used.

3.2. Second dimension: Technology

As argued above, the growth of the firm partly originates in its ability to acquire, combine, cumulate, and recombine resources, as well as the ability to rapidly respond to business opportunities and threats. One such key resource is the technology on which the firm is based, i.e. the technology of the firm. An increasing number of new firms has in one way or another become dependent or as it were ‘based upon’ technology in exploiting business opportunities, thus giving rise to the notion of New Technology Based Firms (NTBFs) and New

Technology Based Businesses (NTBBs) if it is developed intra firm or as a JV between firms. The ability to grow then partly stems from the evolution of science and technology, including the 'scientific method' of systematic experimentation as incipiated and refined since the time of the Renaissance. The evolution of science and technology has continually generated business opportunities, particularly in the public-private interfaces of universities and business life. However, it is important to be clear on the fact that the concept of technology is here understood in the narrow sense of natural science and engineering or technical knowledge, thereby sticking to an old tradition recently re-emphasized by Cantwell (1994). More specifically, we define technology as the body of knowledge of techniques that, in principle, constitutes patentable knowledge (c.f. *Granstrand, 1998).*

Henderson and Clark (1990) introduced the notion of incremental, modular, architectural or radical innovation. These were defined respectively as innovations that change only the core design concepts of a technology (modular innovation), innovation that change the relationship between these concepts (architectural innovation), innovations that leave core concepts and components as well as their relation unchanged (incremental innovations), and finally radical innovation, which was defined as involving the change of core concepts and components and the overturn of prior dominant design concepts. This means that radical as well as architectural innovation involves the acquisition of knowledge outside what has previously been referred to as 'prior knowledge' (Shane, 2000), outside the dominant paradigm of the established technology. For the present purposes, we take the acquisition of such knowledge to be based in 'experimental' learning, as apposed to the 'frame-based' learning that is prevalent for incremental and modular innovation. Paul David (1975, 1985, 1988) introduced the concept of 'path dependency' to describe and explain how past experience tend to create a trajectory that guides future learning. This notion comes very close to the view that some learning takes place within certain already internalized technological frames.

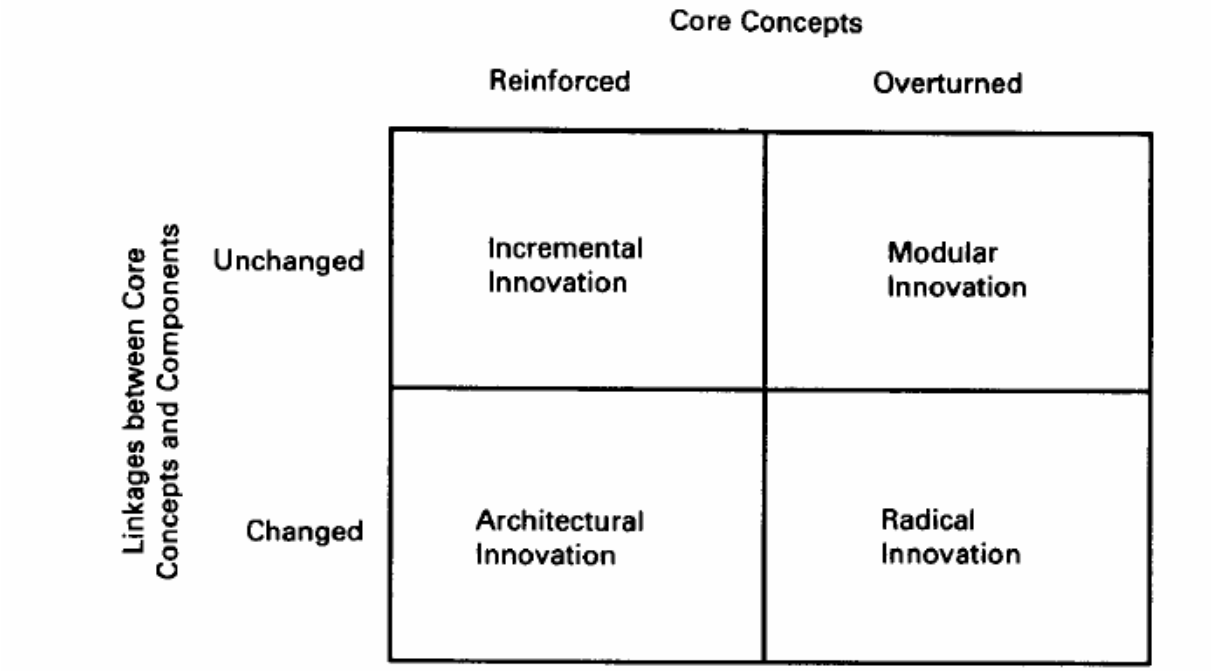


Figure 2: *The Henderson and Clark framework for defining innovation*

In what follows, we will elaborate four cases illustrative of how entrepreneurs may vary in terms of these forms of learning, by focussing on business model and technological learning respectively, within the experimental and frame-based modes elaborated above.

4. Four cases of entrepreneurial learning

What is it that entrepreneurs need to know and do to be able to develop a new business, and how do they acquire and develop that knowledge and the associated skills – that is, how do they learn? This question will be explored through a consideration of four empirical cases, where the notions of a (1) a frame-based and (2) an experimental approach to learning can be discerned. These approaches will be shown to hold for business model adaptation and technology development respectively, thus creating four ideal types of entrepreneurial learning. It is important to recognize, and the cases makes this clear, that these four types can not be said to be homogenous with regard the respective learning forms. Rather they describe a 'trend' in the material, or an inclination towards a particular form of business development (see figure 2 and 3). In the end of these case presentations, a summary and comparison of the cases across the more important dimensions of learning found in respective case will be provided.

4.1 Experimental business model and frame-based technology learning: Icomera[4]

Icomera was founded by a party of four. Kristian Axelsson, a former masters student of engineering physics had just left the Chalmers School of Entrepreneurship. With him into the company he had the fresh experience of a failed biotech venture. In late 1998, Kristian, and his next-door dormitory neighbour Mats Karlsson, both decided that they wanted to run their own business. They started tossing around several ideas from within the technology and market domain they had some understanding of: engineering physics, radio communications, computer science and business development. Using VentureCup, a business plan competition initiative, as a vehicle for developing their business plan, their first tentative concept was to launch a service involving taking digital photos/video streams with a digital camera onboard a remotely controlled, Un-manned Air Vehicle (UAV, e.g. small helicopter), and transmitting this information down to ground, real time, via three parallel and synchronized GSM-cards (basically the mother boards of three mobile phones). Their primary value proposition was the radically lower cost compared to similar services provided by the traditional aviation firms. They envisioned customers such as (1) local, regional and national road authorities, the value proposition being monitoring traffic at a low cost and (2) power companies, monitoring the need for tree cuts along power lines at a substantially lower cost compared to the current manual or helicopter based method. Icomera was to develop and own proprietary rights to the software used in managing the communication links, and to outsource all the hardware, but run the monitoring service. However, when approaching the market, and penetrating the business plan issues, the team realized that this idea suffered from poor market potential and the regulatory process was a huge hurdle to cross. The idea was abandoned in a matter of months.

But the team was determined not to quit the business plan competition. Since the UAV was the problem, the team started to investigate how the communication technology intended for the UAV could be used in other applications. A value proposition towards mobile professionals was formulated. The idea was to use the multiple communication routes in order to increase the bandwidth and quality of service for the mobile professional, when using his/her laptop or PDA. Several mobile (GSM) links in parallel would result in increased bandwidth and reliability. Icomera planned to develop a communication unit including three GSM modules and reselling mobile capacity from the different mobile operators to mobile professionals. The knowledge in the team of mobile communication was not deep, so former

[4] www.icomera.com

Ericsson Mobile employee Martin Bergek was invited to join the team. This idea was good enough to be the basis of a company. In May 1999, the idea was patented, attracted start-up funds from a small group of local business angels, and a first software prototype for the communication link was developed. But after studies and intensive collection of data on costs of current services, estimates on development cost based on in depth interviews with potential key partners, and dialog with the legislative body, they began to understand that the cost to develop a new hardware unit was too high and the legislation would never change to force the mobile network operators to sell to service providers such as us as we originally had planned.

After this somewhat disappointing revelation late 1999, Axelsson, Karlsson and Bergek realized they needed to formulate a value proposition based on current available hardware technology and with a clear customer/channel - the mobile network operator such as Telia, Comviq and Europolitan (later Vodafone). This was in fact very easy. No change was needed on the software side and the relevant hardware existed. During 2000, top level meetings were achieved with all relevant executives at the mobile network operators. Discussions and negotiations took place. Even though they attracted much attention, the meetings never resulted in any real commitment. They started to realize we were aiming to fix a problem that no one really experienced as a problem. Their solution would only bring marginal savings on a market that still was not booming in the Nordic countries.

So in 2001, the Icomera team decided to shift business model again and instead try to become a specialized mobile communication software player. They would sell software licenses for clients and servers to Intel and Microsoft, who in turn would supply software and hardware to players up stream in the value chain. After learning about all new available network technologies they realized that there was a value in being always connected using the best available communication technology - "seamless connectivity". The software solution, managing multiple links, was more or less the same, but the value proposition was totally different. This proposition gained real interest from the mobile operators. But apart from a few test systems sold, no major commitment was gained from the mobile operators. The seamless connectivity did not only attract the attention of mobile operators, but also of potential partners such as Compaq, Intel and Microsoft. Partnership agreements were signed, several fairs were visited jointly, celebrations were had, but as no cash was transferred the Icomera team and their investors remained unsure of the real commercial value of these agreements. Finally, Icomera realized that their particular solution to the problem was only one out of many options, and even though it was the best one at the time, the market was perhaps not yet ready to develop. As it would turn out, this application has not yet bloomed.

(v) In late 2001, as the initially great hopes of lucrative contracts with some of the big players increasingly seemed futile, and after many desperate glances at an increasingly empty cash account, the team and the board of directors, mainly business angels, decided to inject some additional capital to try a fifth, and as it was said last, radical change to the business model of Icomera. In this fifth model, Icomera was to supply high speed trains with mobile internet solutions for their passengers. In 2001 Mats Karlsson had come up with the idea of how to solve a known and frustrating problem of lap-top user on trains, namely that of being 'off-line' for the duration of the journey. Previously passengers had used phones or GSM-cards to communicate with internet and their companies. These links were irritatingly slow and unreliable and this problem could 'easily' be solved through the technology that Icomera had already developed. Based on past experience it was decided that Icomera should supply a complete system, hardware, software, installation and training, to specifically chosen 'hungry' train operators, presenting to them, not only a complete working solution, but a reliable business case with a clearly spelled out value proposition. Linx AB, a new entrant on the Scandinavian train market with a intended position as a high quality, fast and reliable business class train service between Oslo, Gothenburg (home town to Icomera) and Copenhagen, as well as between Stockholm to Copenhagen. Linx AB was targeted among five similar European train operators who were considered as possible early adaptors in the attractive customers segment where Icomera technology would be especially valuable. Trials, which were paid for by Linx, proved successful. Very satisfied end customers as well as operators, quickly fell in love with the service. As a 'side effect' of the technology, operators could monitor all their trains in real time, seeing where they were, at what speed they were moving, and with a simple complementing technology could also conduct real-time monitoring of machinery, onboard computers and restaurant equipments, etc. The first order came from Linx in April 2003 and was worth 25 MSEK (7,5 Milllion USD). In April 2004 orders worth many times the Linx contract were received from GNER, a leading UK train operator and in December 2004, SJ, Sweden's major train operator, decided to equip their whole Swedish fleet of high speed trains with Internet, the order sum now being significantly bigger then the GNER deal. As this is being written, all major European train operators are lined up for trials. The first working business model of Icomera was finally passing its first test if not finally proven.

4.2. Experimental technology and frame-based business mode learningl: Permanova

Permanova is a research and manufacturing company that has been in existence since 1985. The company employed about 50 people before it was split into two separate companies in the spring of 2002. Their turnaround in 2001 was ca 8 million US$. Before the split, Permanova was active in two areas: laser technology, where they provide whole laser systems, and fiber optics, where they provide components for high-effect lasers. Both areas are high-technology knowledge intensive, especially the area of fiber optics where their products are based on patented knowledge. The market consists mainly of big Swedish companies for the laser systems part, and big laser systems manufacturers in Germany for the fiber optics part. Permanova offer laser-fiber-robot based production equipment to the automotive and manufacturing industries, directly to end customers or through partner channels, and this business model has been relatively fixed throughout the company's life span.

The company was originally spun off in the late 1970's from a government financed research project at one of Sweden's two largest technical universities. Halfway through the project, the Principal Investigator decided to start a company based on new ideas generated in the project and the potential yield from consulting services that these new concepts could generate. In the beginning, the company came to focus on laser measurement techniques and laser systems, but in 1984 the laser systems part was spun off and formed Permanova together with another company from a Swedish consortium, which contributed with the funds for the establishment. The technical base of the company was very much dependent on input from the university and consisted of the ideas developed in the research program which had formed the original basis for the company, but also on academic contacts with former colleagues at the university. In the spring of 2002 it was decided that the two areas of activity within Permanova, laser working systems and fiber optics components, were better off as two separate businesses. The reason was that since the two areas of activity are rather separate in terms of markets, chances for obtaining new investors for a coming expansion would increase if they were separated into two businesses.

It is recognized that the technology of the fibre optics field has now developed so that within a couple of years there will be new, fundamental problems concerning materials physics etc. that will need to be solved, and that technological knowledge will have to be radically renewed and replaced. This radical technological dynamism, with impending technological shifts lurking has a great impact on the company's strategy. Even with heavy investments in R&D, Permanova cannot afford to build this type of knowledge on their own. They therefore have to rely on basic research conducted elsewhere. So far the exchange with

the university has been conducted through informal seminars, research collaboration and supervision of PhD students and master theses. The university and the relevant research conducted there is accessible to employees. Permanova' dependence on basic research conducted at the "home" university means that it is beginning to become concerned that declining funding for the research group on which it is dependent may affect the company's future adversely. Other university links, albeit not very strong, have been forged through participation in EU-projects. Permanova has participated in several such projects over the years, however, not jointly with any Swedish departments or institutes, but rather with German and French actors who contacted them and proposed collaboration. Within these projects the foreign partners deal with administrative matters. This is a requirement for Permanova, since they do not perceive themselves to have the time to engage in the cumbersome bureaucracy of the EU-projects.

4.3. Frame-based technology and frame-based Business Model learning: SoftWareControl A/S

In 1986 Ulrik Nielsen and Dieter Tostrup won a prestigious Danish National price for innovators at Universities, with their new product SeQure. They both specialized in software engineering and had won their PhD degrees four years before. The year after, 1983, they started their company SoftWareControl and devoted half their time to the company and the development of their first product SeQure. SeQure was a counter-calling device that should connect between the modem and the phone line and when the computer operator calls the databank a special tone is provided, wile the operator keys in his phone number from where he was calling. If that number was on a predetermined list of authorized users the device called up that number and provided the modem communication. Hackers would not be able to go through such a barrier, and therefore it provided security. The team decided that SeQure is something that accountants at accounting firms and lawyers would love to have because of the need to maintain the integrity of their databases. Several test installations with happy users gave them the proof the thought they needed. Ulrik and Dieter however had decided that they wanted to stick with what they were good at producing smart code and building small electronic boxes in small series so they wanted to stick to their original business model of selling hardware at a fixed list price to those that wanted to buy is. The company strived for several years with devises of better and better performance but sales got stuck in the chasm, and never were able to cross it. They were able to sell to technically advanced buyers that could set up the hardware, following printed, thorough technical instructions in a manual

that was packed together with the device. Not very many users of modems however were competent enough to get it to work. In 2004 the company was still 5 people working with software based specialized solutions for data communication with a turnover of a modest 2,1 MDK. Reflecting upon his 21 year journey Ulrik Nielsen says: "If we would have understood early on that people don't want to buy hardware for computer communication security, they just want communication security, we could have incorporate installation service and tech support we would probably had been several hundred people in the company. When we finally understood this, something that most probably is obvious to any commercially competent person it was too late. We never were able to regain our competitive edge. The timing was perfect our technical competence was top of the line but we lacked customer empathy."

4.4. Experimental business model and experimental technology learning: InSynk Inc.

InSynk was started by one electrical engineer and one newly graduated MBA student, who had set out to build a welding bench for the automotive industry. In the early 1982 they formed a company, and borrowed up money from two banks and a few relatives and friends who were willing to invest in the idea. The bench was developed during the course of the first year, and they had one customer lined up, who had tentatively agreed to place an order for 100 welding benches as soon as these were ready for delivery. One year later there was a change in the national safety standards governing industrial welding, and it was clear that the bench would have to be thoroughly redesigned. At this stage a considerable amount of work and money had already been sunk into the project. Instead of investing further in redesigning the bench, InSynk decided that it was time to bail out of what they perceived to be an uncertain market, and a technology too dependent on external changes, e.g. on standards.

The engineer had at this time left the firm and with him the main link to the automotive industry. The MBA considered the options available, and decided that the company would use some of its remaining capital to invest in power tools for renting out to artisans and independent construction workers, who would find such investments in tools heavy to take in the start-up phase of their own business. He had gotten the impression, in the course of working with independent contractors for their own bench development, that there existed such a need. The early mid-1980s saw an increase in the number of independent contractors in the construction industry, and the new concept of InSynk proved a success. The firm expanded its number of employees from two to 10, and updated its machine park regularly to keep abreast with innovation in the industry. However, soon the market became fiercely

competitive, and as available investment capital increased towards the second half of the 1980s, more and more contractors could invest directly in their own tools upon entering the business. InSynk had to look for alternative channels for income, and for a period even acted as construction contractors themselves in order to stay afloat financially. However, they did not possesses the customer network or trust, and definitely not the competence in construction work, a fact which increasingly started to give InSynk a bad name in a market where they were not even 'supposed to be'.

The MBA/co-founder was still in the firm however, and was now starting to speculate about what the next source of income for the firm should be. In connection with building the tool-renting business, he had gradually constructed an electronic system to manage the company's economic processes, especially invoicing and inventory. After talking to a friend from the business consultancy industry, he realized that there was a market for a cheap software package for managing a company's business processes. He built out his own program, and complemented it with a few functions which were already on the market, such as book-keeping functions and added a 'customer information database' for storing miscellaneous information about the customer, such as problems encountered or product ideas. This feature would make InSynk's product unique. In the early 1990s, InSynk started marketing the package under the name of Ecosolv, to be sold through the many small computer shops that had grown up as a result of the introduction of the personal computer. A few of these shops bought the package, however at the same time as the package appeared in the stores, a large Swedish computer firm launched their own business solutions package. This package lacked some of the functionalities of Ecosolv, but was on the other hand connected to a very popular 'How-to' book for the small business owner, which was sold through a subsidiary to the large Swedish computer firm. This in combination with the fact that Ecosolv, had a few early incidents of crashing the systems on which it was installed, made the home computer market drop this product completely within the first six months of its introduction. InSynk declared for bankruptcy soon afterwards.

4.5 Case summary and comparison

In the light of the above reasoning, we would like to propose a framework of four main forms of entrepreneurial learning, out of which the Icomera case represents one. This framework integrates the dimension of mode of learning (experimental vs. frame-based) with content of learning (overall coherence in the content of the business model). As we could see in the Icomera case, the content aspect of the business model was considered fairly or very flexible,

while at the same time the company did not abandon the essential technological frame around which they grew their knowledge. They were then able to build incrementally a better and better understanding of their core technology (frame-based learning), while experimenting with their business model, i.e. how to exploit this technology on the market. Their subsequent success was very likely dependent on this dual mode of learning. Icomera experimented with basically all of the components of a business model (the content) referred to above, while sticking to their essential technological knowledge and framework, learning increasingly more about the form of data transfer on which their business ultimately depended.

In comparison to Icomera, we can see how Permanova has kept their business model relatively intact, serving large industrial end-customers, mainly automotive and manufacturing companies, with laser-fiber-robot based production equipment through partner channels. This contrasts with Icomera's model, which is reverse to that of Permanova' in that they have kept the business model in an experimental mode, while focusing on one core technology. In this case, we instead see some experimentation with the technology, which at one point led to a radical restructuring and break-up of the firm, and in addition an anticipated technology shift in the horizon, which in turn affects the basic sourcing strategy of Permanova. All in all though, this has been a successful strategy for Permanova as it has enabled learning around (at least) two forms of technology, but more importantly, it has been a source of stability in terms of customer focus and forms of cooperation. This can be contrasted with a third form of entrepreneurial learning, in which both technology and business model are kept stable, or display a frame-based mode of learning.

SoftWare Control had a clear idea of what their technology was going to do, how it would look and who to sell it to and how to sell it. Their biggest problem was that they did not change this conception when it was clear that either the technology of the business model was in need of adjustment or even radical change. Towards the end of the company's life, it became apparent to them that they had not used the response of their customers as a source of information for adjusting their technology, and in fact they had not clearly questioned their own choice of customer for the product. These decisions had been set at an early stage in the formation of the company, and then been kept intact for the duration of the firm's life.

InSynk, represents a counterpoint to SoftWare Control in the sense that this company experimented with business model as well as with the technology offered throughout its lifetime. In many ways it managed to overcome important hurdles by listening to the market and by using some of its existing capabilities, however, it seemed that they never listed 'enough' at the market or used 'the right' capabilities, so that their technology and their

commercialisation strategy always seemed to float a little to freely. Unlike, Icomera and Permanova, InSynk did not 'stick to the knitting' on either their business model or their technology, but radically altered either one of these, and always at the same time. This is likely to account for their recurrent failure, since they did not really allow any learning to take place on either count, only the simple observation that 'this didn't work'. InSynk did not bring very much of anything from one 'venture' to the next, save for the enthusiasm of its co-founder. However, from a learning perspective, this may not have been enough to secure survival.

5. Discussion

The examples described above can be summarized across the two dimensions of learning discussed above, namely *business model* (commercialisation strategy) and *technology* (the substantive offer), both of which can viewed as 'learning domains' in the course of developing a firm. In addition, the mode of learning, as illustrated in the cases above, can be located on a continuum from experimental/opportunist to frame-based. These divisions yield a first basis for categorizing entrepreneurial learning into four types (see figure 3).

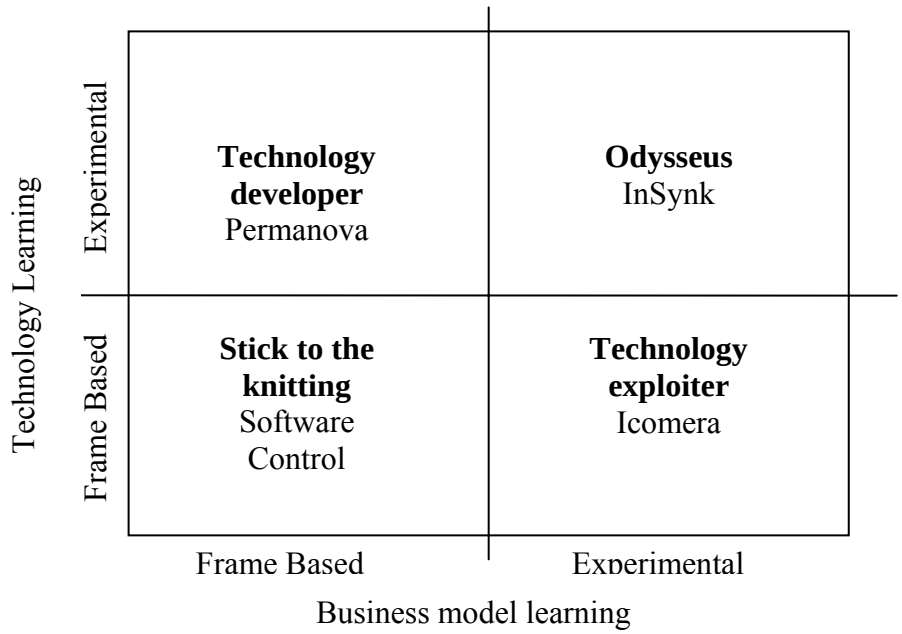


Figure 3: *Modes of entrepreneurial learning in four illustrative cases.*

It should be clear that these are ideal types which do no account for learning mode in the respective firm in any complete way. Instead one should view the types as describing an 'inclination' towards one learning mode or the other. This being said however, it may be possible to use the knowledge of learning type to 'predict', with a certain degree of informality, how a firm will respond to stimuli to learn, how they will tend to recognize or reject, include or exclude, and opportunities for learning in the face of new experience. It is also important to recognize that this typology is not completely 'descriptive', i.e. in that it would set out to merely describe a number of learning styles and assume that these are somehow 'functionally' connected to the business at hand. The review of learning modes above clearly connected learning style to personality traits and cognitive predispositions, and these would of course precede the rational structuring of a business to a certain extent. This means that entrepreneurs and entrepreneurial team may adopt wholly dysfunctional learning styles (e.g. never questioning a particular framework), or adopt unfavourable combinations of learning styles within the team or towards the technology/business. Examples could include having an experimental learner as CFO or a frame based CEO where instead one would need a visionary. Empirically one may find that the learning style of a firm is not be functionally connected to the business or to the organizational demands, and this suggests that the model presented above is also normative to a certain extent. Our cases suggest that a mix between frame based and experimental modes will be most successful. This is also intuitively correct, since routine and renewal are both key aspects of successful business growth (ref.). However, one must also keep in mind that the balance and exchange between these two learning modes will be likely to shift in terms of their respective functionality through the life cycle of the firm. From a normative perspective a rigid mix between experiment and frame-based learning may be just as bad as being too biased in one direction or the other. This brings us to our next model, or proposition derived from the above reasoning.

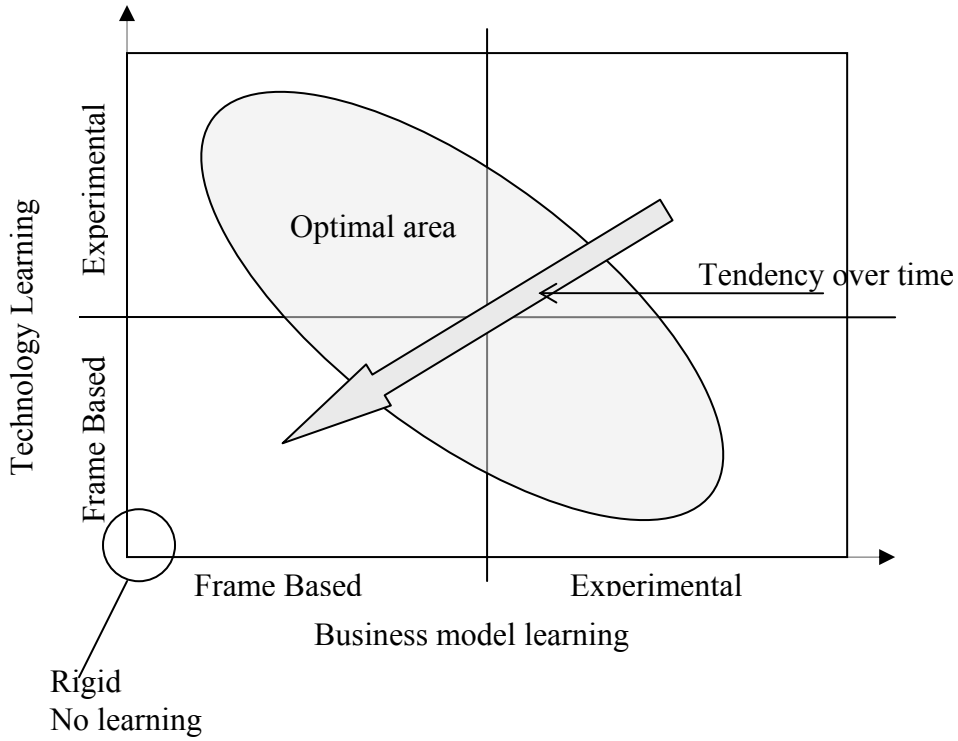


Figure 4: *Hypothesized optimal modes of entrepreneurial learning and the dynamic tendency to gravitate towards rigidity*

By adding a process dimension (figure 4) to the typology, and recognizing that learning mode will shift functionally through the life cycle of the firm, from more experimental towards a more rigid mode, an additional number of reflections may be derived:

1. All ventures in an early stage need to develop according to an experimental learning process. This needs to be taken into account by management teams, boards of directors, investors as well as policy makers. Radical experimentation in both the technology and business model dimensions is unlikely to be productive.
2. Most technology entrepreneurs need to focus experimental business model learning very early on in the process and keep doing so until a first market segment is verified through repeatedly successful sales.
3. The most important "measurement data" in the early experiments are what customers that are willing to pay for what the company offers, as well as information on cost and quality of needed resources. It is important that business models are sought that makes this possible

early on in the process so that the learning process is accelerated. Most probably long lead-times to sales, co-varies with failure because of the lack of real, "hard data" market feedback.
4. As the venture matures and the commercial success develops, the drive for increased effectiveness will make frame based learning the dominant mode as opposed to experimental. This is precisely the cognitive effect behind why older organisations, sometimes also larger ones, tend to fail when entering into times of radical external change where experimental learning again becomes key. If the processes of detecting the inappropriateness of frame based learning is not in place companies may come to gravitate towards treating the environment as predictable and stable in a non-functional way in non predictable eras.

7. Conclusion

In conclusion, two questions of importance will be brought to the fore in relation to the process view elaborated: Firstly, a key issue derived from the above reasoning is: what learning modes are more likely to be growth inducing in the early stages, when the venture is developing, and what are the dynamics involved? As argued before, from a learning perspective, letting all parameters of the venture be up for questioning all at once does not seem to generate rational outcomes. It becomes impossible to know if the observed changes in response to one's actions are in fact an effect of changes in business model or resulting from changes in technology. Allowing all critical parameters to vary at the same time makes it difficult to build understanding regarding what changes lead to what effects and thus to learn the principles operating in that particular venture space at that time. Consequently we would expect firms that follow the 'Odysseus learning mode' to be less successful. As a corollary, companies that reveal a frame-based learning mode relative to the business model as well as to the technology dimension would expect to be successful by accident rather then by rational choice. If their original business model and technology happen to be workable they will succeed, but for new innovative businesses, which require the ability to adapt sensitively to the circumstances while retaining a strong element of direction, that is rather unlikely. Instead, and as argued above, we would expect companies that exhibit the learning mode of the technology developer or technology exploiter to be more successful. These firms allow incremental learning to take place in at least one of the two main venture dimensions, for example improving the understanding and mastery of one core technology, while allowing the business model to be experimented with and radically adapted to changing circumstances. Icomera and Permanova displayed the two main variants of this mode of learning.

However, as a company grows and becomes more successful, we would expect its learning mode to gravitate towards what we have labelled 'stick to the knitting' and it make sense because it capitalize on investments to uncover the opportunity, so the impetus to experiment tends to decrease if not challenged. Challenges may derive from entrepreneurial forces that are spotting new possibilities and therefore comes to challenge the way the business is run. Jack Welch is a good illustration of such a force. He is attributed with institutionalizing a management routine with clear effects for business and technology learning. Under Welch, GE had a challenging drive: "Would you rather be in toasters or in CT-scanners" illustrating his strive for higher value added products with better margins. The Welch-factor also states that in each of the businesses GE should dominate by being number one or two, be strongly on the way of becoming so or withdraw. For those businesses that succeeding in becoming number one or number two Welch asked : 'How would your business and the market you serve be defined [business model] if you redefined it so that you only have 1/3rd of the market share you have today?' Such cognitive challenges aim at fostering learning on how to grow the business by trying to find entrepreneurial growth opportunities in redefining the business model, is a counterforce for gravitation into 'stick to the knitting' and help avoid to manage the company into economic decline, and the destruction of shareholder value[5].

[5] Compare the development of GE under Jack Welch with the development of ABB under Percy Barnevik for an illustration of such phenomena.

Chapter 2:

Entrepreneurial learning in academic spin-offs – a business model perspective

Summary

This chapter has three aims. To begin with, it intends to investigate how academic entrepreneurs learn when creating and developing start-up ventures. Secondly, it addresses how learning behaviors of academic entrepreneurs are influenced by the nature of the environment. The final point pertains to the research method, as this article attempts to empirically apply an innovative framing of learning combined with the business model concept. It is argued that not all form of learning can lead to change in business models as such change represent a change in the entrepreneurs' cognitive frame. Data on the development of business models as well as associated learning behaviors was collected through semi-structured interviews with the founders of eight academic spin-offs in four Nordic countries. Nine learning behaviors were identified as leading to changes in business models. Six of those represented experience-based learning while three involved learning through external relations, i.e. learning aided by actors other than customers, suppliers or business partners. Learning through external relations was only found in those countries which provide supportive environment for academic spin-offs. Interestingly, external actors such as venture capitalists and incubator services were not found to have much influence on changes in business models. The main implication of the study for academic entrepreneurs is the awareness of different learning behaviors leading to changes in business models. For policy makers it is important to understand the specific need for learning leading to changes in business models and how experience-based learning behaviors can be complemented by learning through external relations. For policy makers in the Nordic area the study points to the weakness of traditional support structures for academic spin-offs.

1. Introduction

Observations have been made on the changing role of universities in society (e.g. Etzkowitz et al., 2000). In addition to the traditional roles of knowledge production and diffusion through research and teaching, universities have become more actively involved in the commercialization of knowledge. One means of commercialization, the creation of academic spin-off ventures, has received increased attention (e.g. Shane, 2004; and Powers and McDougall, forthcoming). Academic spin-offs are seen as important means for enhancing local economic development, generating income to support research, and encouraging inventor involvement (Shane, 2004, pp. 17-39).

In parallel to the changing role of universities, the role of academics in academic spin-offs has also changed. From being more likely to have the role of advisors, facilitating the transfer of knowledge to the new venture, they are today more likely to be members of the entrepreneurial team; hence, playing a greater role in identifying and developing the business opportunity, acquiring resources, and organizing the venture (Zucker et al., 1998; Murray, 2002). Being able to accomplish this requires knowledge of industry conditions as well as business and managerial competencies (e.g. Chandler and Jansen 1992), which academics and their students are unlikely to have in the start-up phase (Klofsten et al., 1988; Roberts, 1991; Cooper and Daily, 1997).

To build up the necessary business-related knowledge and competence requires learning. Clarysse et al. (2000) found that the early stage of development in research-based spin-off ventures is characterized by this learning, both through trial and error and interaction with external actors. They also provide some evidence that the relative importance of each learning process is dependent on the nature of the environment of the firms. For example, firms without access to external actors with entrepreneurial experience are more likely to rely on learning through trial and error.

Despite the recognition of the importance of learning in academic spin-offs and the role of the environment in moderating the learning processes taking place, we lack systematic knowledge on how academic entrepreneurs learn different aspects of creating and developing a viable business, and how their learning behaviors are influenced by the nature of the environment. The purpose of this chapter is to address these issues by answering two research questions:

- How do academic entrepreneurs learn when creating and developing a start-up venture?
- How are learning behaviors of academic entrepreneurs influenced by the nature of the environment?

The research questions are answered through empirical investigation of academic spin-offs in the Nordic countries. The empirical work is guided by the business model concept, which is used for delineating various aspects of creating and developing a viable business. The concept is also used as a mean to discriminate between learning within a given cognitive framework, i.e. a given business conception, and learning leading to changes in cognitive frameworks, i.e. leading to changes in entrepreneurs' business conceptions. The latter, which

is the focus of this chapter, is especially important when entrepreneurs are inexperienced and, hence, are unlikely to have a clear or viable conception of their business at start-up.

The chapter is structured as follows. First, a frame of reference is constructed for the empirical analysis. Academic spin-off ventures will be briefly touched upon, before discussing the business model concept. Thereafter, learning will be elaborated upon, followed by a discussion of environmental influences on learning behaviors, before presenting a summarised frame of reference to guide empirical work. At this stage, the methodology is explained. A case study approach is selected where data is collected from academic spin-offs in Sweden, Denmark, Finland and Iceland. While these countries have many political and cultural similarities, there are important differences in entrepreneurial activities and direct and indirect mechanisms supporting academic spin-offs, such as university support services, seed financing and entrepreneurship policy. Then, data is presented on learning behaviors leading to changes in business models exemplifying how academic entrepreneurs learn to create a viable business, and also how these learning behaviors are moderated by the national environment. Finally, conclusions are drawn and implications presented for academic entrepreneurs and policy makers.

2. Frame of reference

2.1. Academic spin-off ventures

Academic spin-off ventures are new firms which have their origins in universities or other research settings. There exist a number of concepts and definitions describing the academic spin-off venture, which differ in their scope regarding possible parent organizations, the origin of the entrepreneurial team and the degree of knowledge transfer from the parent organization to the spin-off ventures (see Pirnay et al 2003 for an overview).

For example, Clarysse et al (2000) define research based spin-offs as new companies set up by a university, technical school or a research institution to commercialize results from research and development (R&D), irrespective of the origin of the individuals who found the firm. On the other hand, Roberts (1991) define new technology-based firms as new companies established by individuals currently, or formerly, associated with a university or a university research laboratory, irrespective of the degree of knowledge transfer involved.

This chapter focuses on entrepreneurial learning by academic entrepreneurs in engineering and the natural sciences who are likely to have little business experience. The focus is therefore on researchers and students in universities that are actively engaged in the creation and development of a new firm based on scientific- or technical knowledge

originating within the university. Based on McQueen and Wallmark (1982) we thus define academic spin-offs as new ventures meeting the following criteria: 1) the founding team is composed of university researchers and/or university students; 2) the activity of the venture is based on scientific- and technical knowledge generated in the university environment; and, 3) the transfer of knowledge has to be direct and not through intermediate employment.

As this chapter addresses business-related learning, there is a need for a concept that can capture core business activities, while at the same time connect researchers and practitioners. It is here argued that the business model fulfills these wishes; it can broadly be depicted as representing the script, code or logic of how a venture intends to generate profit, and by viewing it we are able to observe significant changes in the business conception.

3. The Business Model

3.1. The business model as a cognitive boundary object

Chesbrough and Rosenbloom (2002) explore the role of the *business model* in capturing value from early stage technology, and also state that a successful business model creates a heuristic logic that connects *technical potential* with the *realisation of economic value*. According to Hedman and Kalling (2002): ”The discussion about business models refers to existing perspectives on strategy, including also theories and models applied independently of the paradigmatic perspectives of the resource-based view, industrial organisations and the strategy process perspective.” In fact, they state that the interrelations, the integration of concepts normally belonging to different theoretical paradigms, comprise the overall distinction of the business model. Hence, the business model has the potential to overcome the potential incommensurability between perspectives, which makes it a concept around which many different actors can gather. Star and Griesemer (1989) point this out as a so-called *boundary object*, characterised by linking together actors from diverse areas and backgrounds. It is thereby an excellent means of communication, but it has also been credited as a useful tool for learning by Boland and Tenkasi (1995). These authors have also argued that as a visible representation of an individual’s knowledge becomes available for analysis and communication, it becomes a boundary object (p. 362).

With respect to the failure of incumbent firms (see e.g. Christensen, 1997) to manage well in the face of technological change, Chesbrough and Rosenbloom (2002) argue that it can be viewed as a difficulty in viewing and enacting new business models, which points to the importance of understanding the cognitive role of the business model in order to commercialise new technology. This said, Chesbrough and Rosenbloom (2002, p.550) mean

that the mental framework constrains the firm's radius of action, and also that a company's sense-making activity will be constrained by its *dominant logic*, e.g. strongly influenced by current business models. Witt (2000) also discusses the cognitive framework set by the business model, and therefore implicitly its constraining nature. On the other hand, the start-up ventures envisaged in this empirical study will plausibly not be as constrained by previous activities; according to Woo, Daellenbach and Nicholls-Nixon (1994:p. 509) new ventures are not bound by norms, momentum, identity or routines constraining their capacity to act. This might be true, but they are still guided, or even constrained, by their existing cognitive frameworks (Witt, 2000), i.e. how they see things.

3.2. The relation opportunity – business model

Departing from Venkataraman (1997), arguing that researchers of entrepreneurship have shifted attention to the nexus of enterprising individuals and valuable opportunities, Shane and Venkataraman (2000) have described the entrepreneurship field as involving the study of sources of opportunities, the processes of discovery, evaluation, and exploitation of opportunities; and the set of individuals who discover, evaluate, and exploit them. Ardichvili et al. (2003) point to the intimate relation between the business opportunity and the business model; Markides and Charitou (2004) discuss the two terms jointly; Hedman and Kalling (2002) portray the business model as the reflection of the opportunity identified; and, Amit and Zott (2002) assign business models with creating value through the exploitation of business opportunities. Sanz-Velasco (2004) has argued that the business model is the action-related operationalisation of the opportunity, set within the frame of a business conception (Witt, 2000), and that business models are changed in accordance with changes in the opportunity perception. It is therefore argued that as an entrepreneur pursues an opportunity, i.e. goes into business, there exists *de facto* a business model, whether conscious or not, and that by observing the business model, we see a footprint of the opportunity pursued.

3.3. Business model definitions

To begin with, a business model definition suggested by Sjölander and Magnusson (2002, p. 5) comprises the interrelated insights responding at least to this limited set of questions: *"Whom shall the firm supply with what, and how is this done; how is value created by the customer and user while the product and/or service of the firm are being used; how and by what mechanisms shall the firm, in competition, secure a sustainable and fair share of that value, in a way that allows it to keep cash above zero, eventually make a satisfying profit, in*

order to satisfy critical stakeholders and increase its resources and value so that lasting longevity is secured and its investors' expectations on return on their investment are being met?" Quite simplistically, one can summarize this definition as consisting of 5 questions and 3 prerequisites.

Secondly, we will contrast this with the definition given by Chesbrough and Rosenbloom (2002), instead focusing on the business model's functions. It is argued that the six functions of the business model are to: 1) articulate the *value proposition*, i.e. the value created for users by the offering based on the technology; 2) identify a *market segment*, i.e. the users to whom the technology is useful and for what purpose, and specify the revenue generation mechanism(s) for the firm; 3) define the structure of the *value chain* within the firm required to create and distribute the offering, and determine the complementary assets needed to support the firm's position in this chain; 4) estimate the *cost structure* and *profit potential* of producing the offering, given the value proposition and value chain structure chosen; 5) describe the position of the firm within the *value network* linking suppliers and customers, including identification of potential complementors and competitors; and, 6) formulate the *competitive strategy* by which the innovating firm will gain and hold advantage over rivals.

When comparing the two previous attempts to define the business model, it appears that they contain many similar traits, even though they apparently have two different approaches, i.e. answers to questions and functions, respectively. Some of the differences are the specification of the cost structure and profit potential, as well as the competitive strategy, included in the latter, but omitted in the former definition. Another striking difference is that the former definition points out issues such as satisfying profit, satisfying stakeholders and keeping cash above zero. In this respect, even though awkwardly combined with the market segment, Chesbrough and Rosenbloom (2002) do point out the revenue model, but the explicit mentioning of appropriation is still lacking. Some general reflections are that the former definition appears more directed to start-up ventures, containing pressing issues for them that are often related to venture capital, but it is also more instantaneous in its approach. The focus on strategy in the latter definition is more directed to processes over time than a footprint of the business at a given point in time.

When trying to settle for a synthesized definition here it has been guided by a wish to keep it as simple and limited as possible, containing the most important elements, and directing it to start-up ventures. This means that the definition will be portrayed as the answer to a set of questions such as by e.g. Magretta (2002); Sjölander and Magnusson (2002);

Sjölander and Hellström (2005) and, Mitchell and Coles (2004: 17) but in the sake of simplicity some of the dimensions will be collapsed, resulting, in many cases, in fewer number of dimensions. The first two points to be included are the customer and the offer, as a prerequisite for a market to exist. Since we are dealing with for-profit organisations, it has at least two implications. The value created should be included as the third point, since without it there is little use in discussing appropriation, which is the fourth. It can be noted that a vast majority of business model authors emphasize the creation of value. Finally, a fifth point to be included concerns how all this, i.e. the four prior points, will be accomplished, i.e. sourcing, development, distribution and sales, jointly with technology issues. When comparing with the other points brought up, this last point is the most comprehensive and thereby the most un-precise; however, its omission would mark a sharp deviation from any value-chain discussion. There are three important merits of this business model definition. To begin with, it shows how different business parts fit together and thereby the coherence in the approach. It is also intuitive and simple enough to be used in practice and research. Thirdly, the definition arguably contains some of the most important aspects of venturing, which brings us to the outlining of the chosen definition. The business model as used in this study is therefore the set of answers to the following five questions:

1) What is the offer to the customer?
2) Who is the customer?
3) What is the value thereby created for the customer?
4) How can the firm appropriate a sufficient share of that value?
5) How is that offer conveyed to the customer, e.g. sourcing, development, distribution, and technology?

As can be seen, a number of important aspects mentioned in chapter 1 have been omitted, such as making a long-term profit, cash-flow, satisfying stakeholders, and the competitive strategy. The two main reasons are that these points are not so closely related to the problem of business coherence associated with the five questions above; and also, they do not have the instantaneous nature we are addressing, i.e. to capture a business footprint. Moreover, the value chain is of fundamental importance, and it can only partly be addressed through points 3 and 5 above, though not explicitly. But in the choice between accuracy and simplicity (Weick, 1979), the latter is here chosen. Other than that, resource assembly could also be an

issue to include; however, it has been omitted since entrepreneurs in action are addressed, but also due to the instantaneous nature earlier discussed.

After having elaborated upon this important field of knowledge for academic entrepreneurs, and also having defined the business model, which appears to enable empirical investigation of business-related topics, let us now address learning, while still keeping the business model in mind.

4. An empirical model of entrepreneurial learning

Woo et al. (1994, pp. 509-510) describe the process of entrepreneurship as essentially governed by learning, and consequently characterize venturing as a learning process, and Hill and Levenhagen (1995) argue that venture creation is a knowledge-intensive process encompassing the entrepreneurs' being at the brink of their knowledge. However, it can be argued that research on learning explicitly directed towards entrepreneurial start-up ventures has been scarce, even though there are some interesting examples such as Nicholls-Nixon et al. (2000), and Willquist (2001).

Nevertheless, a number of interesting but different perspectives on learning in general have indeed been proposed. By reviewing learning literature, it becomes apparent that it has been conceptualised and operationalised in a variety of ways, e.g. absorptive capacity (Cohen and Levinthal, 1990); operating and competitive experience (Ingram and Baum, 1997); and, level of analysis, reflection and action (Edmondson, 2002). It is still valid, as argued by Fiol and Lyles (1985), that "no theory or model of organisational learning has widespread acceptance". As an example of a knowledge definition, Nonaka and Takeuchi (1995), upon discussing Western philosophical tradition, settle for knowledge as "justified true belief". By taking this stance, learning would consequently be portrayed as the "process of achieving justified true belief". This appears difficult to apply empirically as the meaning of it is not intuitive; does 'justification' apply only to the mind or also to the physical reality? There are two perspectives representing 'justification', i.e. a cognitive (e.g. March and Simon, 1958), and a behavioristic (e.g. Baron, 1998), which will now be combined in order to enable a meaningful empirical approach to learning.

While these two perspectives are ontologically different and, arguably, incommensurable stances, there has been attempts to integrate them in a pragmatic spirit, such as by Argyris and Schön (1978). A short summary of Argyris and Schön's (1978) depiction consists of two steps; first, learning is distinguished from interpretation by the concept of action, as it involves a new response or action, based on the interpretation; second,

learning is a process of putting cognitive theories into action. A rather similar approach is taken by Daft and Weick (1984: 286) where the three consecutive steps are: Scanning (data collection) → Interpretation (data given meaning) → Learning (action taken); followed by feedback loops.

When discussing the opportunity concept within entrepreneurship, the importance of action has been pointed out by Gartner et al. (2003, p.124), arguing that "without action there is no insight", as a corollary of stating that "in entrepreneurship, it is entrepreneurial activity that matters". Let us continue in a pragmatic spirit; on the basis of e.g. Lewin's pragmatist theories of learning, Kolb (1984) devises a scheme comprising four sequential steps, which 'spirals' the learner towards higher levels of understanding. This process is typically initiated by a person carrying out an act and observing its consequences, which could therefore be called an experimental model of learning. However, as pointed out by Coleman (1976), this understanding may be of a very simple and tacit nature. The formation of abstract concepts does not necessarily imply them being complex; in fact, Kolb points to the use of concrete, 'here-and-now' experiences to test fairly simple ideas, and use of feedback to change practices and theories (Kolb, 1984). To sum up, both cognitive and behavioristic perspectives on learning have been brought forth, and our stance is that both are valid and necessary ingredients in venturing learning processes. It can be argued that a suitable way to frame business-related learning among academic entrepreneurs is to talk about learning behaviors that lead to improved business conceptions, i.e. changed cognitive frameworks, in the form of e.g. better functioning business models.

Another influential approach is that distinguishing between different orders or levels of learning. Boland and Tenkasi (1995) have suggested the differentiation between perspective taking and making. Their discourse often pertains to 'communication', here set equal to learning, which we find uncontroversial regarding the context. Perspective taking is higher-level learning that strengthens the unique knowledge of a given community, i.e. within the boundaries of that community. Perspective making is lower-level learning that improves a given community's ability to incorporate knowledge from other communities. It appears that young ventures will be involved in both these processes, simultaneously, as they need to create and build a niche in its own right, while at the same time forcefully incorporating exogeneous knowledge to speed up the venturing process. While drawing on Burgoyne and Hodgson (1983), in their article exploring the learning process of entrepreneurs, Cope and Watts (2000) depict different levels of learning in another way. They suggest viewing learning occuring at three levels: (1) learning within a given cognitive frame; (2) learning

enabling a new cognitive frame; and, (3) reflection on the personal learning. Keeping in mind the earlier depiction of the business model as a cognitive framework, this approach arguably appears more suitable to observe changes in the business model, through level 2 learning, as compared to Boland and Tenkasi (1995). The three levels of learning by Cope and Watts (2000) will now be outlined in relation to our empirical context.

Level 1 learning causes changes in cognition and behavior within a given cognitive framework, meaning no significant changes to the way of doing business, i.e. business conception, or the cognitive framework (Witt, 2000) guiding business activities. Referring to Argyris and Schön (1978) this resembles single-loop learning.

Level 2 learning regards de facto changes to the business conception, which means a significant development of the perception of the opportunity pursued. Another way to frame this level is that there has been a change in the cognitive framework. It is interesting to note that Normann (1977) discusses the firm's 'dominant ideas' in the sense of a (interpretative) 'framework', while arguing that it is one of the most difficult things to change, but necessary to do so if wanting to achieve long-term impact. O'Driscoll and Rizzo (1985), working from within the tradition of Austrian economics, suggested that entrepreneurial learning is essentially about moving from one interpretative framework to another. While O'Driscoll and Rizzo could not explain exactly how entrepreneurs move from one frame of reference to another, they did suggest that learning within a frame was neither determinate nor random, and that each subsequent frame has a 'loose dependency' on its predecessor (p. 38) (c.f David, 1988). The notion of learning within frameworks is part of the authors' typical Austrian notion that entrepreneurship is about coping with uncertainty and surprise. This indicates that the entrepreneur begins within a frame**,** basically what he/she knows, believes to be true and is familiar with**,** which may be gradually refined and changed, but which essentially retains significant influence over how the entrepreneur refines and develops knowledge of the business process. Again, referring to Argyris and Schön (1978), it is here argued that level 2 might incorporate both single- and double-loop learning, but it is a matter of degree; the changes in business conception could be either of an adaptive nature (e.g. Bhidé, 2000), or actually be accompanied by a deeper understanding. To emphasize, the major difference to level 1 is that in level 2, the learning is manifested in a change of the core business activities.

Level 3 learning, finally, is of a slightly different nature. It is here suggested that it encompasses a more fundamental process, namely personal reflection on the learning process

per se. Again, this could incorporate double-loop learning, but it specifically addresses reflection on one's own learning process.

Settling the learning discussion with these three levels, it is now time to address how this applies to the environment. As this study aims at addressing significant, observable changes in the business conception, in the form of the business model, level 2 learning is primarily envisaged. In terms of how this level 2 learning is accomplished, we expect there to be a number of different learning behaviors available to the academic entrepreneurs.

5. Environmental influences on learning behaviors

Clarysse et al (2000) argue from their study of research-based spin-offs in Belgium that the environment determines the entrepreneurs' possibility of learning. Their argument is based on the identification of three distinctive learning environments which they term unaware, aware and supportive. To begin with, in an unaware environment there is little interest in commercialization of research and lack of funding for research-based spin-offs. Incubation times are long as entrepreneurs are not able to focus on their original opportunities, taking on various unrelated activities in order to raise money to survive. Learning through experience, which Clarysse et al (2000) term 'cumulative learning', is thus inhibited. Secondly, in an aware environment there is an interest in the commercialization of research, but few supportive services. Funding for growth is available, but there are few possibilities for seed funding. Incubation times are shorter as firms are better able to focus on their core activities and learn through experience. Finally, in a supportive environment there is strong interest in the commercialization of research and there are professional services available to assist entrepreneurs in evaluating and developing their business opportunities. Seed capital is also available. Not only have firms better possibilities for cumulative learning through experience on the market, but they are also able to take advantage of learning through external relations. The latter learning process, which Clarysse et al (2000) term 'complementary learning', involves learning through actors in the environment, such as financiers, experienced entrepreneurs, consultants and others. Clarysse et al (2000) argue that the combination of cumulative and complementary learning is likely to speed up incubation times.

The learning processes identified by Clarysse et al (2000) provide an additional dimension to our previous discussion of different levels of learning, and help us understand how the environment influences learning behaviors that lead to changes in the business model. In environments that are more supportive of entrepreneurs, one would expect a wider range of possible learning behaviors that lead to change in the business model, as compared

to less supportive environments. While learning through experience cannot be substituted by learning through external relations, the latter is likely to complement learning through experience. It is also likely to be especially important in helping entrepreneurs adjusting their cognitive frameworks, thus building a framework for effective experience-based learning. Hence, it could be expected that learning behaviors involving interaction with external actors have, on one hand, strong impact on changes in business models within supportive environments, and on the other hand, little or no impact in environments where there are fewer opportunities for such interaction.

6. The business model and learning in academic start-up ventures

The frame of reference will now be summarised in order to pave way for empirical investigation. Academic spin-offs have been defined as new ventures meeting the following criteria: 1) the founding team is composed of university researchers and/or university students; 2) the activity of the venture is based on scientific- and technical knowledge generated in the university environment; and, 3) the transfer of knowledge has to be direct and not through intermediate employment. As academic entrepreneurs are likely to have little business experience, obtaining business-related knowledge is crucial for their success.

The business model concept has been choosen to represent the dimensions of business-related knowledge that academic entrepreneurs need to master in order to connect the technical potential of their academic knowledge with the realisation of economic value. These dimensions are:

1) What is the offer to the customer?
2) Who is the customer?;
3) What is the value thereby created for the customer?
4) How can the firm appropriate a sufficient share of that value?
5) How is that offer conveyed to the customer, e.g. sourcing, development, distribution, and technology?

The business model is depicted as the action-related operationalisation of the opportunity, set within the frame of a business conception. Thus, by observing the business model, we see a footprint of the opportunity pursued and how it develops through the learning behaviors of the entrepreneurs.

Two dimensions have been identified as characterizing the learning behaviors of academic entrepreneurs. The first dimension describes different levels of learning. Three levels of learning have been identified. Level 1 learning refers to day-to-day learning within a

given business model. Level 2 learning refers to learning leading to changes in business models. Level 3 learning refers to learning about own learning processes. As changes in the business model is the main concern of this chapter, focus is exclusively on level 2 learning, i.e. how academic entrepreneurs learn to create and develop their business conception as depicted by changes in their business models.

The second dimension makes a distinction between experience-based learning and learning through external relations. Experience-based learning is based on own experience from doing business, while learning through external relations refers to learning based on the experience and knowledge of actors external to the venture. It is argued that the environment greatly influences to what degree learning through external relations is possible. Academic entrepreneurs working in supportive environments are more likely to have the opportunity to complement their experience-based learning with learning through external actors as compared to entrepreneurs in less supportive environments, thereby increasing the range of learning behaviors which can lead to changes in business models.

The dimensions used in the analysis are elaborations of the concepts of experimental learning and frame-based learning introduced by Sjölander and Hellström (2005). The two ideal types identified by Sjölander and Hellström represent, one hand, the inexperienced learner who has little knowledge of the context of learning, what need to be learnt, and possible methods of learning, and on the other hand, the experienced learner who is knowledge about the context, content and methods of learning. The two dimensions identified here are a conceptual tool for understanding how academic entrepreneurs, who are likely to have little prior business experience, move from being an inexperienced business learner to becoming a more experienced one. Instrumental in that development is the learning behaviors needed to reach a viable business model. The dimensions also enables us to make a distinction between 'on-the-job' learning through interaction with customers, suppliers, competitors, and other business partners and learning through interaction with other external actors, such as financiers, consultants, and support agencies. Such distinction is important from policy makers' point of view.

This summary of the frame of reference enables the addressing of the initial research questions, i.e. how academic entrepreneurs learn when creating and developing a start-up venture, and how this is influenced by the nature of the environment. In the next section the research setting and methods of the empirical study, conducted to answer these questions, are presented.

7. Research Setting and method

As the purpose of this study is to investigate contemporary and complex action, the case study approach has been selected (Yin, 1994). The semi-structured interview is necessary for using the business model as a boundary object for communication between practitioners and researchers. While the business model concept helps focus the discussion, the open-endedness of the interview situation helps the respondents to provide a richer description of changes in business models and the associated learning behaviors, than what would have been possible through predefined answers. These types of descriptions are needed in order to understand complex interactions between individuals as well as evolution over time. Below follows the selection of cases, data collection, analysis and limitations of the selected approach.

7.1. Selection of cases

As the purpose of the study is to investigate learning behaviors and how they are influenced by the environment, it is important to include sufficient variance in the selected cases to capture the diversity that exists. As this diversity is unknown, it is difficult to determine with certainty what variance is needed, or even in what dimensions variance is needed. Nevertheless, in this study three dimensions were chosen. First, cases were selected to represent different origins within the university, i.e. including both students and researchers. In addition, researchers could either hold a permanent position within a university, e.g. professorship, or not. Second, cases were selected to represent differences in the degree of science-technology interaction. Some academic spin-offs, e.g. bio-tech start-ups, are very dependent on further developing their scientific knowledge, while others, e.g. many software start-ups, are not. Third, cases were selected from four different Nordic countries (Denmark, Finland, Iceland and Sweden) having many similarities, but differing in the degree of support for academic spin-offs.

§In addition to these three dimensions it was deemed important for our empirical endeavours that the ventures have been able to build a viable business, i.e. to have attained a stable foundation for further growth and development, after a series of changes in their business models. In addition, the ventures should be relatively small and not too old, in order to allow for us the focus on early development. Table 1 below describes the ventures selected according to criteria presented above.

Ventures	Founders	Technology	Country	Established
3Dfacto	PhD students	Software	Denmark	1998
Chempaq	PhD student	Medical equipment	Denmark	1999
Smartner	MSc students	Software	Finland	1999
Juvantia Pharma	PhD students	Biotechnology	Finland	1997
Lyfjathroun	University professor	Biotechnology	Iceland	1991
Trackwell	Researchers / Engineers	Software	Iceland	1996
Icomera	MSc students	Software	Sweden	1999
Q-Sense	University professor / PhD and MSc students	Instrumentation	Sweden	1996

Table 1: *Description of case study firms*

7.2. Data collection and analysis

Data was collected in 2004 through semi-structured interviews with founders. The interviews were structured using the business model concept, focusing on changes in all dimensions of the business model, as earlier defined, and learning processes related to these changes. Questions were asked open ended, i.e. no predefined categories of change or learning behaviors were used. In total 16 persons were interviewed, each interview lasting 1-2 hours. The analyses of the interview data consisted of identifying learning behaviors leading to changes in individual cases, and then using results from the individual cases to create categories of learning behaviors. Hence, the categories were generated from the empirical data without any pre-defined categorization. In addition to the interviews additional data was collected on the nature of the environment within each country. In line with Clarysse et al (2000) two dimensions were used to judge how supportive the environment is to academic spin-offs. First, the existence and quality of professional services, e.g. direct university support through incubator organizations. Second, the availability of seed capital. Available secondary data on the support environment in the Nordic countries (Johansson, 2005) and the seed capital market (Nordic Industrial Fund 2001) were used for estimating these dimensions. The influence of the environment was evaluated by comparing learning behaviors in the different countries.

7.3. Limitations

There are three important limitations to the empirical analyses of this study, which are all related to how general its conclusions are. First, it is unlikely all possible learning behaviors have been captured in the study. The study thus only provides a partial picture of how academic entrepreneurs learn to create and develop viable businesses. Second, the relative importance of different learning behaviors is unknown. Combined, these two limitations require extreme care in interpreting the results from the study. Third, as the case firms need not be a representative sample of academic spin-offs in the selected countries, the results on the influence of the environment are tentative. Despite these limitations the study provides a basis for further investigation of learning behaviors in academic spin-offs using the business model concept.

8. Research finding and analysis

In this section the results of the case analyses are displayed, beginning with the presentation of results on learning behaviors leading to changes in business models. Nine different such learning behaviors have been identified in the case ventures. The characteristics of these behaviors are described as well as how they relate to changes in business models. Second, results regarding environmental influence on learning behavior are presented. The characteristics of the environment in each Nordic country are described and related to learning behaviors observed in each country.

8.1. Learning behaviors leading to business model changes

All of the case firms have made important changes to their business models during their development. Changes have been made for various reasons within and across firms. Collectively, nine different learning behaviors have been observed as leading to changes in cognitive frameworks, as expressed by the subsequent changes in the business models. These behaviors are listed below in Table 2 and classified as either experienced-based learning or learning through external relations.

Experienced-based learning	**Learning based on external relations**
Market scanning	Adding new employees
Virtual market experimentation	Obtaining external expert advice
Interaction with existing customers	Participation in entrepreneurial education programs

Interaction with new customers with new requirements	
Imitation	
Responding to external changes	

Table 2: *Observed learning behaviors classified into two categories*

Below, the characteristics of each of these behaviors are further explained and exemplified. It is important to note that these learning behaviors do not exclusively lead to changes in cognitive framework, i.e. level 2 learning, but are also used for day-to-day learning within a specific framework, i.e. level 1 learning. Nevertheless, this chapter is primarily concerned with how these learning behaviors are related to level 2 learning.

Market scanning

Scanning the market is a behavior that involves information collection regarding potential customers. This information collection may be systematic or ad-hoc, containing varying degrees of personal interaction with potential customers. In the case firms entrepreneurs used scanning to learn who their customers were and what would be a valuable offer to them. The learning is often indirect and incomplete as in the case of Icomera in Sweden, which learned through market scanning that its original offer and customer conception was not viable, and therefore had to be changed:

> *The original idea was to automate the monitoring of power lines. After collecting information and interviewing potential customers it became obvious that they did not have a case. There was no need for this automation, and even if there was, the business would not be profitable.*

In this instance the learning behavior simply falsifies hypotheses about offering and customers, but does not generate ideas on how to proceed.

Virtual market experimentation

A central element of virtual market experimentation is the demo, or the prototype, which is presented to a potential customer for evaluation or feedback. A demo or prototype provides a more powerful representation of the potential product or service, addressing more senses than written or verbal communication. In the case firms the entrepreneurs used virtual market experimentation to learn who the customers were, and what offer would be valuable for them.

In the case of the Danish firm 3Dfacto the entrepreneurs built prototypes for experimenting with different customer groups:

> *"To use a turban sale is to try a lot of things, back and forth. We made some prototypes, then we took a customer segment: It must be useful in the kitchen industry. And then we made a kitchen demonstration. But then, okay, they were not mature enough, and then another customer showed up, but also with an interest in the kitchen: to build a playground is like building a kitchen. So by that it was reasonable enough."*

The difference from scanning is that virtual experimentation is more likely to help you generate ideas, going from one customer segment to the next through new knowledge of possible functions of the product/service:

> *"That's why it is an advantage to concentrate on one segment at the time, and when you come to the next customers you can say that you also have that kind of problem. That was why we originally started with the kitchen industry, since once you have been with the first, then you could confront the next with the question: Is it not hard always getting those lists equal? And then he says: that's right!"*

Interaction with existing customers

After completing a sale to a customer, there is often considerable interaction between the venture and the customer. This is especially common in early phases of venturing when the product or service is in its infancy and needs to be improved through use, which may then lead to considerable changes for the product or service. In the case of Smartner in Finland the entrepreneurs learned that their customers would prefer a service instead of a product:

> *"At the beginning we were selling to companies. Then we realized that many companies don't want to buy these kinds of solutions themselves but would prefer a service instead. The reason that they prefer the service is that it [the system] is actually quite difficult to understand – many companies can manage their email systems alone but mobile email is more challenging and they don't have required expertise. Therefore we started to create service that would add mobility to their data base systems."*

In the cases the interaction with existing customers was usually a more direct learning experience, i.e. giving concrete direction, than interaction with potential customers, which rather generated ideas for change.

Interaction with new customers with new requirements

Facing new requirements, especially through the addition of new customers having different preferences from existing ones, is a learning behavior that can fuel changes in the business model. In most cases these changes were related to the ambitions of the entrepreneurs to increase the scope of the ventures' businesses, following the identification of new customer groups. In the Trackwell case from Iceland the interaction with new customers with new requirements influenced both the offering and the revenue model:

> *Trackwell started out by doing consultancy work in a large government sponsored project related to location-based services, being paid by the hour. After being involved in a couple of such projects the firms offered a technology-independent platform solution for location-based tracking, getting paid through a more complex revenue model, including licensing, consulting fee and revenue sharing.*

Interacting with new customers with new requirements was also found to change conceptions about distribution. In the case of Smartner in Finland, moving into new geographical markets required new forms of distribution due to new requirements:

> *"There are countries where customers don't trust operators as suppliers of these systems. Therefore, we also need different retailers. Operators can be in it, if they wish, they can buy our software, or components of it, and offer the service like Radiolinja does in Finland. We also have retailers who know [the] companies, can provide software and services for them, and do more than operators. Operators don't always have competence to provide and install software and provide the service – they are more specialized in delivering SIM-cards and selling data transmission."*

Obtaining external expert advice

Obtaining external expert advice pertains to learning behavior, not involving customers, but rather the temporary involvement of experts outside the firm, such as consultants, investors, experienced entrepreneurs or other expert networks. Advice can be purchased or simply given for free. In the case firms the entrepreneurs used external advice to help develop the offer and the customer focus. Q-Sense of Sweden used a scientific network, and in the Juvantia Pharma case of Finland, a scientific advisory board influenced the offering of the firm:

> *The most important source for this type of knowledge [what to offer] is the scientific advisory board. "It is an expert panel, where we have the world's six leading scientists who are working as experts in drug development in pharmaceutical companies. This panel gives us insights and knowledge."*

In the case of Chempaq in Denmark investors have advised (or required) the firm to maintain focus on a narrow customer segment until obtaining a proof of principle for the original product idea:

> *"That we have done because the investors want to secure our focus since our original business plan was 'developed' on the oncology segment. If we had said that we also wanted to focus on the general practice at that time, they would be afraid of us shifting focus, that the business idea wasn't as we originally had told them. So they wanted to secure that before we reached the next stage, until we were in the stage where we had developed our product properly, that there was a market potential. Before that stage they would not listen to anything else. And after that we have expanded it."*

Adding new employees

The adding of new employees brings along the knowledge and experience of those individuals. While the effect may be similar to external advice it is likely to be more influential considering that a new employee is a permanent addition to the organization as is thus likely to have a greater learning influence on the entrepreneurs through continuous interaction. In the cases new employees were found to lead to changes in the offer and in the customers served. Q-Sense was initially lacking market knowledge, but as a new Managing Director was recruited, important changes followed:

> *Over time, Q-Sense created a scientific network. This was not an idea from the beginning…but was primarily driven by the new Managing Director. She came from another player in the life science industry where this was already established. The idea is that participants receive discounts and better service in exchange for promoting Q-Sense and generating customer leads. The customer offer has been significantly developed, for example due to the scientific network. During the new Managing Director's tenure, sales agents were also brought on board.*

Participation in entrepreneurship education programs

Engaging in entrepreneurship education, before or during the development of the venture includes participation in a structured program aiming at coaching entrepreneurs through the creation of a viable business plan. This involves the articulation of the business plan, which may help clarify latent ideas about the business model. Only two of the case ventures were involved in such programs, but they had a broad influence on the business model of those ventures. For example, the founders of Icomera in Sweden were strongly influenced by two entrepreneurship education programs:

One of the founders was a student of Chalmers School of Entrepreneurship, which was a Master's program where the students actually founded a venture during studies. He initially teamed up with the other founder, and a third person who was an intern at McKinsey, within the frame of Venture Cup – a business plan competition for start-up ventures. In this environment, they also met the third person to enter the venture. The founders continually received feedback during the competition, and it also spurred them to advance the business model creation in order to meet deadlines.

Imitation

Imitation pertains to the observation of the behavior of other firms, i.e. competitors or partners, and replicating that behavior, possibly with some minor adjustments. Whereas Smartner explictly stated that their competitor used an inefficient revenue model, which they did not want to try, many of the case firms were found to imitate their competitors' revenue models. Lyfjathroun in Iceland used publicly available information on contracts in the biotech industry as a model for own revenue models.

"We have access to a database in the US where you can look at the basic structure of all contracts in the US. All big contracts in the US are entered in the database, you don't get to see the amounts involved, but the database hold information on what type of contracts are being made, with whom etc. We read through it and try to understand it."

Responding to external change

This learning behavior is distinct from other learning behaviors mentioned above. Whereas the other learning behaviors seek to learn about the current state of things this one is rather a reaction to information that the current state has changed. A part of the reaction might be to engage in other learning behaviors. In the case studies, responding to external change could lead to profound changes in the business model. In the case of Lyfjathroun in Iceland almost all dimensions of the business model changed in response to the changes in the biotech industry at the turn of the century:

"The business opportunity has changed. For many years we built our opportunity on platform technologies were we had built solutions which could be used for a number of drugs and vaccines. We signed a partnership contract [along these lines] in 2001, but then the environment changes. NASDAQ melts down in year 2000, then everything starts to change. Everybody starts to think about products. One year ago we stopped developing our platform technologies and decided to work on four products we had been working on and push them through clinical trials. Today our business opportunity is based on those four products and additional five products we have in the pipeline."

8.2. The influence of the environment on learning behaviors

The first step in analyzing the influence of the environment on learning behaviors is to identify the differences in the environment for academic entrepreneurship in the Nordic countries. As argued in a previous section, access to external actors that can provide support in the development of a viable business is likely to improve with stronger support environment. Similarly, academic entrepreneurs who lack a supportive environment are more likely to be more dependent on learning through trial-and-error. Table 3 below summarizes the differences in the environment for academic entrepreneurship in the Nordic countries. Please note that the classification is relative, i.e. only describes the relative position of the Nordic countries against each other.

Country	University support system	Seed financing
Denmark	Medium	Medium
Finland	Strong	Strong
Iceland	Weak	Medium
Norway	Medium	Weak
Sweden	Strong	Strong

Table 3: *Summary of relative differences in strength of environmental support for academic entrepreneurship in the Nordic countries.* The evaluation is based on Johansson (2005) and Nordic Innovation (2001).

From the table one can infer that the most supportive environment for academic entrepreneurs is found in Finland and Sweden. Academic entrepreneurs in these countries are therefore more likely to complement their experience-based learning with learning through external actors, while entrepreneurs in Denmark, Norway and Iceland are more likely to be dependent on their own trial-and-error learning.

Interestingly, the case studies support this picture. Only in one case outside Sweden and Finland were external actors found to influence changes in business models. Despite being involved in the ventures, e.g. as financiers, and influencing day-to-day learning, external actors were not reported as involved in learning behaviors leading to changes in business models. In contrast, all the spin-off ventures in Finland and Sweden were found to have changed their business model following learning through external relations.

9. Conclusions and implications

The purpose of this chapter was to improve our understanding of how academic entrepreneurs learn to create and develop a viable business, and how this learning is influenced by the nature of their environment. Empirical investigation of academic spin-offs in the Nordic countries was conducted using the business model concept to delineate various aspects of creating and developing a viable business, and as a boundary object to bridge the communication between researchers and practitioners. In this section the findings will be discussed in relation to the two research questions posed at the beginning of the chapter, as well as their implications for academic entrepreneurs, policy, venture capital and future research.

One of the basic assumptions in this chapter is that academic entrepreneurs are likely to lack business and management skills when starting their ventures. Hence, they are unlikely to have a clear and viable business model at start-up, and therefore need to make changes before arriving at a viable venture. The process of changing a business model involves a change in their cognitive framework on what their business is about, i.e. the business conception, which requires a type of learning that is distinct from day-to-day learning. Day-to-day learning is related to adjustments within an already defined cognitive framework. In this chapter such learning is termed level 1 learning. To change the business conception requires changing the cognitive framework. Such learning is termed level 2 learning. Both types of learning are important for developing the venture, but as the academic entrepreneurs are unlikely to have a clear conception of the business at start-up, it is impossible to develop a viable business without succeeding with level 2 learning.

In the study a number of learning behaviors have been identified as leading to changes in business models. Some involve varying degrees of customer interaction, and others involve learning through external actors other than customers and suppliers. There is also imitation of competitors as well as responses to external changes in the business environment. These occurences provide different possibilities for academic entrepreneurs to engage in level 2 learning, which eventually support them in arriving at a viable business model.

In addition it has been found that the environment influences the availability of certain learning behaviors. In more supportive environments, such as Sweden and Finland, external actors were found to be involved in learning behaviors leading to changes in business models. In less supportive environments, such as Denmark and Iceland, this involvement was scarcely found. Thus, in supportive environments learning from experience is more likely to be

complemented by learning through external relations, as compared to less supportive environments. Academic entrepreneurs in supportive environments were thus found to have access to a richer set of learning behaviors leading to needed changes in their business models.

When observing the learning behaviors reported by the entrepreneurs as leading to changes in business models, it is important to note the absence of influence from venture capital investors and conventional university support services, such as incubator services or technology transfer offices. While these actors are visible in the cases and support the development of the ventures, they are not reported to be involved in learning processes leading to changes in business models. This is an interesting finding considering previous studies on the role of these actors in the development of academic spin-offs (Bygrave, 1992).

There are three possible explanations for these findings. First, the entrepreneurs may be unaware of the influence of these actors or not willing to acknowledge their contribution. This could be related to strained relationships with these actors, as they likely have the ambition to closely monitor and control the venture (Sapienza and De Clercq, 2000). Second, the influence of these actors might be cumulative and not captured by our method, i.e. their involvement in day-to-day learning might be important preconditions for learning behaviors leading to changes in business models. Third, even if these external actors are involved in the venture, they might lack the experience and expertise needed in order to contribute to level 2 learning. Previous studies on incubators and the venture capital industry in Sweden (Deiaco et al 2002, Karaömerlioglu and Jacobsson 2000), which are indeed critical about the expertise of these actors, indicate that this might be a plausible explanation.

While the influence of conventional university support services is absent, it is interesting to note the influence of unconventional support measures such as entrepreneurship education programs and business plan competitions. As these support measures are directed towards the development of business opportunities, it might not be surprising that they influence learning behaviors leading to level 2 learning.

The main implication of the study for academic entrepreneurs is the importance of level 2 learning leading to changes in business models and the awareness of the different learning behaviors that are available. The different learning behaviors may be seen as possibilities to learn how to build a viable business. It is also important for academic entrepreneurs to understand the distinction between level 1 and level 2 learning and the complementary roles of learning through experience and learning through external relations. In this respect it is important for academic entrepreneurs to be able to understand if external

actors are able to contribute to level 2 learning, or if their contribution is limited to level 1 learning. Contributing with level 2 learning is especially important in early stages of venturing in order to provide a viable direction for the venture as quickly as possible. Failure to do so may greatly influence the likelihood of survival.

The main implication for policy makers is the need to provide academic entrepreneurs with opportunities for both level 1 and level 2 learning. When constructing policies and support systems for assisting academic entrepreneurs, it is important to note the distinction between the two learning levels and to make sure that possibilities for both are provided. More research is needed in order to better understand how these opportunities can be provided, e.g. possible division of labor between different actors in the support system. Is it, for example, viable that venture capital investors and entrepreneurship education support specialize in providing level 2 learning support while actors such as incubator services and technology transfer offices specialize in level 1 support? Could various industry organizations act as information clearing-houses providing industry specific information and expertise needed for level 2 learning? How are the learning capabilities of each actor to be signaled to the entrepreneurs?

There are specific implications for improving the support for academic entrepreneurs in the Nordic countries. There is a need to strengthen the venture capital industry in the Nordic countries. Not only is there a need to increase the expertise of venture capital investors, it is also important that venture capitalists can signal their competence to both their own investors and of course to the entrepreneurs. Investors would be better able to judge the expected performance of venture capital funds and entrepreneurs should be better able to judge the venture capitalists' ability to contribute to level 2 learning. More research is needed on how this could be implanted in a Nordic context and the possibility of Nordic cooperation. For example, the limited size of venture capital markets in each of the Nordic countries suggests that a coordinated Nordic action might be necessary to increase the leverage of available funds and speed up the build-up of expertise needed for contributing to level 2 learning.

This study has focused on level 2 learning and related it to level 1 learning. No attention has been given to level 3 learning. Level 3 learning is concerned with increased ability to learn. Engaging in Level 3 learning is therefore important for academic entrepreneurs for more effective level 2 and level 1 learning. More research is needed on how the three learning processes are interrelated and how they can be supported.

As mentioned before there are important limitation to the generality of the findings of this study due to its design. While these limitations are unfortunate, the study is an important first step in using the business model concept for investigating the interaction between opportunity development and learning in new ventures.

Chapter 3:

Entrepreneurship education programs at Nordic universities

Summary

If and how entrepreneurship can be learnt and taught has been a much debated topic. As entrepreneurship theory over time has developed from being primarily concerned with entrepreneurs' individual traits to focusing also on venture creation processes, the idea of developing entrepreneurs have become more accepted, but the question how to do it remains. Arguably, entrepreneurship does not only comprise analytical knowledge, but also skills gained through experience and participation. In order to comply with this, entrepreneurship programs cannot rely solely on traditional pedagogical means. This study investigates to what extent entrepreneurship programs at Nordic tertiary institutions have embraced these development trajectories. Entrepreneurship programs in all Nordic countries have been mapped in order to analyze their use of different pedagogical means. Based on this mapping, three different categories of entrepreneurship programs are proposed, and their advantages and disadvantages are discussed. Finally, implications for policy and university management are derived.

1. Introduction

The questions whether entrepreneurship can be learnt and taught have been debated for a long time. Today, it seems as though the question is rather how this should be done, given the emergence of numerous entrepreneurship education courses and programs. The various designs of these different programs give rise to questions concerning the underlying base of entrepreneurship theory on which they are founded. Research in the field of entrepreneurship comprises a multitude of perspectives and disciplines, and has over time migrated from the early ideas focusing on individual traits to gradually move over to venture characteristics and eventually on to deal with venture creation processes. In line with the development in e.g. strategic management (see e.g. Mintzberg et al., 1998), there has also been a movement within the field of entrepreneurship from theories based on a behavioural perspective and a focus on analysis and planning to embrace also interpretive perspectives underlining the importance of experiential learning and non-linearity of processes. The aim of this article is to provide an overview of existing entrepreneurship programs at Nordic universities and to investigate to what extent these entrepreneurship programs adher to recent developments in the field of entrepreneurship research, as reflected in terms of the program content and the pedagogical means that are used. Based on the findings, potential opportunities for

improvement of the way entrepreneurship is promoted at Nordic tertiary institutions are discussed.

2. Development of entrepreneurship theory

Based on received theory, it is possible to distinguish two related development trajectories in the field of entrepreneurship. The first one of these is the gradual change from a focus on entrepreneurs as individuals with a set of particular traits to the deepened interest in venture creation processes. Secondly, we can note a movement from the view of entrepreneurial action as an analytical endeavour to an activity that to a large extent is nurtured by experiential learning and the capacity to adapt to non-linear and dynamic events. We will now briefly turn to these two developments within entrepreneurship theory.

2.1. From entrepreneurial traits to venture creation processes

A few decades ago, most entrepreneurship research aimed at proving that entrepreneurs were different from non-entrepreneurs (Gartner, 1985). This research on personal traits primarily concerned identifying the characteristics of entrepreneurial individuals, much in line with earlier theories on leadership. Over time this arguably narrow focus has come to be extended to include also organizational characteristics beyond the single entrepreneur, such as e.g. team composition and funding. Altogether, these theories can anyhow be considered to have addressed only a limited part of the complex endeavour involved in entrepreneurship, in particular leaving out the venture creation phenomenon (Gartner, 1985).

Lately, however, the process of venture creation has received increasing attention (see e.g. Bhave, 1994), and today we see that this stream within the entrepreneurship research field has grown substantially. Despite this development, Shane and Venkataraman (2003) just recently underlined the necessity to move away from person-centered theories of entrepreneurship and instead pay more attention to the context in which the entrepreneurial activities take room. Consequently, entrepreneurship still has a long way to go in order to generate more comprehensive theories on the venture creation process.

2.2. From analytical to experiential approaches in entrepreneurship

Just like in management theory at large, focus in entrepreneurship has primarily been put on analysis and planning, something that for instance is reflected in the abundance of recipes for writing business plans. The traditional emphasis on this specific part of entrepreneurship has however been the target of substantial critique. More in-depth studies of venture creation

have revealed that entrepreneurs find it useful to write business plans (Bhidé, 2000). Though, the reason for business planning is not necessarily to stick to these plans, but to use them as a means of communication with other stakeholders and to prepare the entrepreneur for unexpected events. In their reasoning about what entrepreneurship is, Jack and Anderson (1999) give the following explanation:"…it has to be an inductive process in conditions of uncertainty. It is a process of becoming, not the stasis of being. Consequently, it cannot be predictable; its generic form is unstructurable; it is unknowable and hence unpredictable." (Jack and Anderson, 1999, p. 112). This description of what characterises entrepreneurial positions is much in line with the view that strategic experimentation is a normal part of the work entrepreneurs undertake in order to find a suitable position for their firm (Nicholls-Nixon et al., 2000). In line with this overall trend away from planning to sensemaking and adaptation, Bhidé (1994; 2000) advocates an approach to entrepreneurship based on opportunistic adaptation. Given the high uncertainty involved in starting a new business, the possibilities to forecast and plan business development are arguably very limited, and instead an experimental, trial-and-error way of working appears to be more feasible. This suggestion points to the limitations of applying management science in entrepreneurship, just like the reliance on analytical management approaches has been criticized in e.g. the fields of organization theory and strategic management (Mintzberg et al., 1998).

3. Teaching entrepreneurship

In a study of Norwegian graduates, Kolvereid and Moen (1997) found that graduates with a major in entrepreneurship were more likely to start new businesses than students with other majors. However, on a general level there is still limited evidence for a correlation between entrepreneurship education and entrepreneurial behaviour (Peterman and Kennedy, 2003). This limitation to our knowledge has however not stopped the development of entrepreneurship education programs. Davies et al. (2002) mention that the first entrepreneurship programs (e.g. the one at Babson College) were actually based on the assumptions that entrepreneurship could not be taught, but that the skills to be successful could. For a long period of time, the question whether entrepreneurship can actually be taught has been frequently recurring, to little use for the development of new entrepreneurship programs. Today, we finally seem to move on from this stage to a more constructive approach. As stressed by Kuratko (2003), the question regarding entrepreneurship education is not *if* entrepreneurship can be taught, but *how* it should be taught.

There are at least two different dimensions of entrepreneurship teching that need to be taken into consideration when designing entrepreneurship programs; (1) content and (2) pedagogical means. While the content dimension may at a first glance appear to be a straightforward issue, this is not necessarily the case. As entrepreneurship theory is a field consisting of contributions from a wide range of different academic disciplines, there is little agreement about what entrepreneurship means, which can also be reflected in what is taught. As seen above, large parts of entrepreneurship theory have primarily dealt with individual traits, or structural characteristics distinguishing successful ventures from less successful ones. Empirical studies of these factors normally consist of broad survey data and are primarily of a descriptive character, providing knowledge about the phenomena of entrepreneurship in its wide sense. Consequently, teaching that is based upon these particular studies tend to be of a descriptive nature and only rarely comprise action-oriented components.

A second important difference in terms of content can be found between the focus on SME management and venture creation. With this distinction, we refer to the differences between running a small business at a more or less steady state and starting up new businesses. As argued in the wide range of literature on small business management, there are a number of particular characteristics of small firms that make them different from larger ones, and this calls for somewhat different management approaches. However, there is a perhaps even larger difference between managing a small firm that has existed for some time, and the start-up and development of a completely new venture. Despite this, both these topics are sometimes included under the umbrella-like concept of entrepreneurship. Jack and Anderson (1999) underline the importance that universities should teach entrepreneurship in a way that assists in the creation of reflective practitioners that can be involved in entrepreneurship, and not only contributes to the creation of low value SMEs. Such individuals would be able to deal with both new venture creation and intrepreneurship in established firms.

Turning to the pedagogical means used, it is easily understood that while SME management can be taught with traditional pedagogic approaches, this is not necessarily possible with venture creation, the art of which is experiential and based on heuristic practice (Jack and Anderson, 1999). An analog distinction between management and design has been presented by Lester et al. (1999). They argued that management, as it is normally perceived, taught and exercised, is overly analytical and could benefit from learning from design activities which are more experiential and less linear. Another key thing in teaching

entrepreneuship thus appears to be to move the learning beyond knowledge about entrepreneurship to comprise also entrepreneurial skills. In order to do so, there is a clear need for components based on the participation in practice. As Jack and Anderson state, "[e]ntrepreneurial knowledge is the concepts, skill and mentality which individual business owners use or should use. Yet, the experience, knowledge and skills may not be readily acquired through conventional pedagogical routes." (Jack and Anderson, 1999, p.113). As entrepreneurial skills are fundamentally experiential, entrepreneurship programs with an ambition to generate any significant impact in terms of promoting entrepreneurial action should include the participation in entrepreneurial practice, as well as a solid theoretical base to help students make sense of their hands-on experience (Jack and Anderson, 1999).

A related distinction between different types of entrepreneurial learning is suggested in chapter 1 which proposes a distinction between frame-based and experimental learning. Frame-based learning takes place within an established mental framework and aims at improving within this fixed framework. A typical frame-based learning situation would be to rely on an analytical model and not considering changing it. Experimental learning, on the other hand, refers to the revision of the mentioned mental frameworks. Experimental learning is more likely to be based on actual experience and action, as it is first when our established frameworks encounter a specific situation in practice that we can observe whether the mental framework works or breaks down. As is pointed out in chapter 1, there is a need for both learning modes in entrepreneurial ventures, implying that entrepreneurship education should not focus exclusively on analysis, but also include practice-oriented tasks to provide a suitable learning context.

In order to promote experiential learning, a wide variety of learning tools that are more or less closely related to entrepreneurial practice can be deployed (Kuratko, 2003):

- Student business start-ups
- Consultation with practicing entrepreneurs
- Computer simulations
- Behavioural simulations
- Interviews with entrepreneurs
- "Live" cases
- Field trips

Apart from the components mentioned above, Jack and Anderson (1999) point to a number of components that could contribute positively to entrepreneurial learning, e.g. the provision of

role models and apprenticeships. Similar to this, Peterman and Kennedy (2003) underline the need for interactive, experience-based learning, highlighting the use of role models, and links to business and community. The attention that needs to be given to this particular kind of learning is of course also a result of what entrepreneurship education is aiming at. If it is simply a way of increasing the knowledge level concerning entrepreneurship and its importance for societal development, then traditional, analytical and distanced ways of learning may be perfectly fine. However, if a purpose of entrepreneurship programs is also to promote entrepreneurship and prepare students for the creation of future high-growth firms, then the demands in terms of students acquiring hands-on venture creation skills are radically different.

Summarizing the theoretical exposition above, we can observe an increasing interest over time in the process of venture creation. This increased focus on process aspects has contributed to revealing the shortcomings of an overly analytical approach to dealing with entrepreneurial ventures. It seems reasonable to assume that this shift in focus and perspective should imply changes also to the way that entrepreneurship education programs are designed and performed. This highlights the call by Kuratko (2003) for intensified research on teaching methods used in entrepreneurship programs and leads us to the formulation of two specific research questions:

RQ1: What is the content of entrepreneurship education programs at Nordic tertiary institutions?

- To what extent do these programs deal with SME management and entrepreneurship, respectively?
- Is entrepreneurship addressed in terms of knowledge about entrepreneurship, or in terms of knowledge and skills that are directly useful in venture creation?

RQ2: In what ways do entrepreneurship education programs at Nordic tertiary institutions support the development of action-oriented entrepreneurial knowledge and skills?

- What different pedagogical means are used to facilitate experiential learning of entrepreneurship?
- To what extent do the specific designs of Nordic entrepreneurship programs allow for the development of knowledge and skills regarding venture creation?

4. Methods used

In order to capture the different pedagogical means used in Nordic entrepreneurship programs, descriptions of existing programs have been collected via Internet. Since universities are keen on displaying their offerings to potential students, the information available on the web is with very few exceptions rich and detailed. In a few cases, the information available was lacking or was very limited, but in almost all of the identified cases it was possible to gain a good understanding of the contents of the programs, and the way it is structured and performed. One risk with the applied method is that universities may give an overly positive impression in order to attract new students to their programs. However, since this study does not aim at doing an in-depth investigation of the results of each program, but relate their content and structure to the existing theory on entrepreneurship, this is of minor importance.

The analysis of the collected data was performed in two distinct steps. A first step consisted of providing an overall description of the state-of-the-art of entrepreneurship programs at Nordic tertiary intitutions. This primarily consisted of mapping the programs and their focus in terms of program content and pedagogical approaches used. Based on this initial mapping, different categories of entrepreneurship programs were identified in an inductive manner, by attending to a few differentiating dimensions. Based on the derived categorization, some of the key learning mechanisms deployed were described and an evaluation of their strengths and weaknesses was performed based upon received theory. Finally, the different categories of entrepreneurship programs and the learning mechanisms they use are contrasted in order to generate implications for policy and university management.

5. Entrepreneurship programs at Nordic universities

A large number of entrepreneurship programs today exist at Nordic universities (see appendix 1 for a full list of the identified programs). No less than 35 different programs with a nominal study length of at least one year could be identified. This does not include single courses, or even combinations of single courses amounting to one year of studies or more, but only integrated programs with a clear emphasis on entrepreneurship have been covered. From the Internet search it stands clear that the by far largest numbers of these programs are found in Sweden (15) and Norway (10), and that the number of such programs in Finland (6) and Denmark (3) is more limited. No entrepreneurship programs could be identified in Iceland. Furthermore, it can be seen that the programs are more or less evenly distributed between

universities and university colleges. About 50% of the programs are at a Master level and the remaining 50% consist of Bachelor programs and a few more practically-oriented programs that lead to a univeristy certificate. In 12 of the programs there is an explicit focus on science and technology in combination with entrepreneurship, while the majority has a strict focus entirely on entrepreneurship.

Several programs, especially in Denmark and Finland, are constituted by traditional areas of specialization in the field of business studies, i.e. business administration programs with a major in entrepreneurship. This can be contrasted with the situation in Sweden, where a few programs with very particular curricula were observed, such as for instance programs aimed at artists and combinations of studies in the humanities and entrepreneurship. Also in Norway, a number of less traditional initiatives can be seen. Of particular interest is to see the strong emphasis on international business and the extensive collaboration with leading foreign universities in the Norwegian programs.

5.1. Program content

A closer look at the programs' curricula reveals that courses explicitly including venture creation processes are included in all of the programs where this information was available. Actually, fewer programs include traditional courses in entrepreneurship, focusing on e.g. entrepreneurial characteristics. Hence, in terms of content it appears as though these programs are in line with the recent developments in the field of entrepreneurship. It should of course be noted that most of these programs are very young and it thus would be strange if they had depended on earlier theories to a larger extent.

A less homogeneous picture is seen when a distinction is made between small firm management and entrepreneurship. Out of the identified 34 programs, only nine can fully be considered to address venture creation processes in an extensive manner. While all programs include this subject in one or more of the courses, the majority does not include any tools for experiential learning related to the creation of new firms. While there most certainly is a need for skilled managers in SMEs, it can be questioned to what extent these programs prepare students for taking on the challenges of creating new ventures that hopefully will result in future high-growth firms, and not only in an increased total number of small firms.

Another observation considers the overall content in the programs, i.e. what is included apart from entrepreneurship courses. What is seen here is a clear tendency that entrepreneurship constitutes a part, often a final specialization, of a Business Administration degree program. Some shorter programs more or less exclusively deal with different aspects

of entrepreneurship and small firm management, while yet others offer combinations between entrepreneurship and studies in e.g. the humanities, social sciences, and art. What is slightly surprising is the limited number of programs aiming at combining entrepreneurship with engineering, the natural sciences and medicine. Arguably, these subjects ought to be more interesting in terms of potential sources for future high-growth businesses. Nevertheless, only a few programs explicitly attempt to tap into this potential.

5.2. Pedagogical means used

Large differences are found when it comes to the use of pedagogical means for experiential learning. Here, we can observe a wide variety of approaches, ranging from no use of such learning mechanisms to combinations of several different tools. The traditional business administration programs with majors in entrepreneurship appear to be the most conservative in terms of teaching approaches, and apart from a few exceptions they do not contain more substantial components for experiential learning, apart from temporary internships or limited project assignments for companies. On the other side of the spectrum, we see that the number of firms working in accordance with a more pronounced focus on practice is still limited, but these few examples merit a closer examination.

5.3 A categorization of entrepreneurship programs

Based on the above description of the population of Nordic entrepreneurship programs, a number of basic program categories can be suggested. The categorization proposed here is based upon two key differentiating dimensions that have been observed in received theory as well as in the empirical data. These dimensions are: (1) focus on venture creation or small firm management, and (2) attention to experiential learning. By combining these dimensions we can distinguish a number of different types of entrepreneurship programs:

1. Traditional academic programs with emphasis on SME management and/or entrepreneurship

These programs are conventional academic programs, primarily in Business Administration, in which a set of courses focusing on small firm management and entrepreneurship are included. While the part of the program made up by theses courses may be substantial, the pedagogical means used are traditional lectures and seminars, sometimes combined with case studies, study visits and guest lectures. A total of 15 programs can be considered to belong to this category.

2. Practice-oriented small firm management programs with emphasis on entrepreneurship.

In terms of the pedagogical approaches used, these programs show a strong bias towards internships or project assignments related to host SMEs. The period that students are in touch with these firms may be short and very intense, or the relationship may last for as much as a couple of years. Examples of this category are the identified Danish programs. In each of these, students perform project tasks for the firms and thereby have the possibility to connect theory to practice. A different kind of program within this category is Gründerskolen in Norway. This highly ambitious program sends students abroad to work for a couple of months in companies in entrepreneurial areas such as San Francisco, Shanghai and Singapore. While the international outlook received by the students must be highly valued, the experiential entrepreneurila learning achieved may be more limited as the students are not confronted with the first stages of firm creation but take active part in their development at a later stage. Altogether, nine of the studied programs can be considered to be of this kind.

3. Programs combining entrepreneurship training and new business creation.

A number of programs have chosen to have an extremely action-oriented approach to teaching and learning entrepreneurship. The first of these programs with an explicit aim at not only developing entrepreneurs but also creating new businesses, is Chalmers School of Entrepreneurship, founded in 1997. Close to identical programs today exist at Uppsala University in Sweden, and in Norway at the Norwegian University of Science and Technology in Trondheim, and the University of Oslo. Furthermore, there are a few other programs in Sweden which include vital components of this category of programs.

These programs have chosen a completely different approach to furthering entrepreneurial skills. Instead of focusing on internships, they instead rely on student-driven business development projects. In the more advanced programs, these projects are based on university research and are provided to the students through thorough search and allocation processes. These projects constitute a key learning platform in the program and student assignments are when possible performed based on these projects. The drawbacks of this approach are the uniqueness of each project, and the consequent problems to find a general format for teaching and student assignments. Furthermore, the tension between different actors involved needs to be managed as there are real business ideas at stake and different stakeholders may have confliting ideas regarding how to develop the business. Another problem is that in order to get this system to work well, there may be need for other mechanisms, such as seed funding and access to professional services concerning patents, accounting etc. Nevertheless, this approach holds great promise to actually generate new firms, especially if there is a

substantial base form the business in terms of resonably complex technology that cannot be copied easily. The number of these firms observed in the total population is nine.

6. Discussion

We will now turn to a discussion of the results displayed above. First, a reflection is made regarding the extent to which the studied entrepreneurship programs are in line with the development in entrepreneurship theory. Thereafter, the usefulness of the different categories of entrepreneurship programs is discussed. Finally, implications for policy and university management are derived.

6.1. Discrepancies between entrepreneurship theory, education, and practice

The survey of Nordic entrepreneurship programs reveals that entrepreneurship education to some extent seems to be lagging behind the rest of the field of entrepreneurship in terms of its propensity to embrace recent ideas concerning the entrepreneurial process. While it is clear that the program focus in terms of content mirrors the migration from entrepreneurial traits to venture creation processes, the switch from an analytical perspective to a more experiential one only seems to have influenced a limited part of the existing programs, in terms of the approaches to learning and teaching that are deployed.

An interesting observation is that the number of entrepreneurship programs is much higher in the countries rated as less entrepreneurial, i.e. Sweden and Norway, while Denmark and Finland seem to have less emphasis on this way of promoting entrepreneurship. To this can be added that Iceland, the Nordic country rated as number one in terms of entrepreneurial activities, does not have a single entrepreneurship program. Given that the identified programs are all young or very young and therefore could not possibly have had much impact on an aggregated level, even if they had been performing very well, it is probably probably more correct to interpret the recent boom in Norwegian and Swedish entrepreneurship as an attempt to improve a part of the economy that could be performing better, rather than being surprised by the fact that they so far have not generated a large number of new high-growth firms. However, one should on the other hand be aware that the potential of several of the identified programs for contributing to increased firm creation may be limited due to their lack of action orientation, and that a strict focus on the total number of programs may lead to exaggerated optimism.

6.2. Different categories of entrepreneurship programs

As seen above, a categorization of the identified entrepreneurship programs into three different groups is proposed.

The usefulness of traditional academic programs for teaching entrepreneurship can be questioned, as long as we do not agree on reducing entrepreneurship to its earlier dominant theories. This approach may have been necessary for the entire field of entrepreneurship to be accepted by the already established domains of business and economics. However, the narrow perspective on entrepreneurship reflected in these programs would most certainly benefit from getting impulses from the other program categories.

While the programs with a strong emphasis on internships most certainly offer students valuable hands-on experience, the reliance on existing companies leads to the exclusion of experience from venture formation. Even though some of the companies that are used as host firms most certainly would be considered to be entrepreneurial, the activities that students can participate are primarily the ones related to small firm management. A question also arises to what extent students are allowed to participate in strategic decision-making, given that they are in the firm primarily to observe and learn.

While there is a need for improved small firm management in most countries, and this can be stimulated by the internship-focused approaches mentioned above, it is necessary to see that these programs will hardly do the work in terms of creating new high-growth businesses. Here, the programs with an explicit focus on business creation appear to have a function to fill, especially in the fields of science and technology. Though, these initiatives are with few exceptions very young and they still need to prove their functionality. To carefully study these initiatives in order to find mechanisms that facilitate both learning and firm formation stand out as one first task in future research.

6.3. Implications for policy and university management

While the inclusion of courses on venture creation issues in all observed programs is promising, it is also necessary to point out some potential problems for innovation and education policy. The apparent confusion regarding the use of the term entrepreneurship may mislead policy-makers to believe that enough is already done in terms of entrepreneurship programs at universities and university colleges. Apparently, there has in Sweden been a strong tendency to label new education programs as entrepreneurship programs, possibly contributing to the dilution of the meaning of this concept. However, when examining the programs more in detail it becomes clear that a large part of them primarily focus on small

business management and not so much on the knowledge and skills needed to generate new firms.

As is seen, some of the more advanced programs in terms of practice-orientation are closely connected to commercialization of university research. Clearly, this is something that takes place primarily at technical universities, where there is a fertile ground for entrepreneurship in terms of the development of new science and technology that can potentially be commercialized through the creation of a new venture.

That so many programs with a traditional approach to teaching were observed may be slightly surprising. The reasons behind the revealed pattern can only be speculated about, given the lack of in-depth data. However, there appears to be an inherent tension between the ambition to turn entrepreneurship into an accepted scientific area, implying the use of traditional research and teaching methods, and the need for practice-oriented learning. The paradoxical result of this would be that in order to make entrepreneurship a legitimate academic subject, it must be studied in a manner that contributes little to practice. Furthermore, since most of the entrepreneurship programs are run at institutions in the business and/or engineering fields, there may be a bias towards analytical aspects of entrepreneurship, which would potentially distance theory even further from its application. As is argued by some authors (seee e.g. Jack and Anderson, 1999) entrepreneurship could benefit from being perceived as art and not science. A problem with this suggestion is that there is no clear entrepreneurship profession, as one can be an entrepreneur in many different areas. This renders it very difficult to argue that there is a specific entrepreneurial role that calls for a certain set of skills. This could be contrasted to artistic professions, and even medicine, where it appears to be completely natural to base fundamental parts of the educational programs on practice. In order to arrive at an understanding of entrepreneurship that is fruitful for society, experimentation in terms of both research and education may be necessary to break the existing mental frameworks, which apparently still hamper this field of activities. To manage this experimentation stands out as a challenging task for university leaders.

Appendix 1 Entrepreneurship programs at Nordic tertiary institutions

Country	University	Program	Degree	Entrepreneurship courses	Venture creation courses	Emphasis on science/technology	Teaching/learning approaches	Program category
Denmark	Aalborg University	Innovation and Entrepreneurship MIKE-B, Master program	Master	Y	Y	N	Lectures, internship, project assignments	2
Denmark	Herning Institute of Business Administration and Technology	Business Development Engineer	Bachelor	Y	Y	Y	Lectures, internship, project assignments	2
Denmark	University of Southern Denmark	Bachelor program in Entrepreneurship and Innovation	Bachelor	Y	Y	N	Lectures, case studies, internship	2
Finland	Helsinki School of Economics	MBA - High-Technology Entrepreneurship	MBA	Y	Y	Y	Lectures, case studies, business games, project assignments	1
Finland	Pirkanmaa Polytechnic	Degree program in Business Administration - Entrepreneurship	Bachelor	Y	Y	N	Lectures, internship	2
Finland	Seinäjoki Polytechnic	Business School: Postgraduate Program in Entrepreneurship	Postgraduate program	?	?	N	Lectures, business development project	1
Finland	Seinäjoki Polytechnic	School of ICT: Degree Program in Business Information Administration - Media Entrepreneurship	Bachelor	?	?	Y	Lectures	1
Finland	University of Jyväskylä	Master in Business Studies - major in entrepreneurship	Master	Y	Y	N	Lectures, business plan writing	1
Finland	Sydväst Polytechnic	Business Administration - Major in Entrepreneurship	Bachelor	?	?	N	Lectures, internship	2
Norway	BI	MSc in Management - Major in Innovation and Entrepreneurship	Master	Y	Y	N	Lectures	1
Norway	Bifrost School of Business	MS/MA in Entrepreneurship	Master	?	?	?	?	?
Norway	Agder University College	Entrepreneurship and the network economy	Bachelor	Y	Y	N	Lectures, case studies, guest lectures, project assignments	1
Norway	Hedmark University College	One-year program in innovation, entrepreneurship and company development	Part of Bachelor program	Y	Y	N	Lectures, project assignment	1
Norway	Telemark University College	One-year program in innovation and entrepreneurship	Part of Bachelor program	Y	Y	N	Lectures, seminars, business plan writing, project assignment	1
Norway	Östfold University College	Technological innovation and entrepreneurship	Bachelor	Y	Y	Y	Lectures, project assignments	1
Norway	Norwegian School of Information Technology	Bachelor in information technology; major in company start-up and innovation	Bachelor	N	Y	Y	Lectures, project assignment	1
Norway	Norwegian University of Science and Technology Trondheim	NTNU School of Entrepreneurship	Master	Y	Y	Y	Lectures, business plan writing, business development project	3
Norway	University of Oslo	Master in Innovation and Entrepreneurship	Master	Y	Y	Y	Lectures, case studies, business plan writing/competition, internship, business development project	3
Norway	University of Oslo (Oslo), BI (Sandvika), NTNU (Trondheim), NHH/UiB (Bergen),	Gründerskolen	Master	Y	Y	N	Lectures, guest lectures, business plan writing, internship, seminars	2

	NLH (Ås) and the University of Tromsø (Tromsø).							
Sweden	Borås University College	Master in Entrepreneurship and Business Design	Master	N	Y	N	Lectures, case studies, business development project, mentors	3
Sweden	Chalmers University of Technology	Business development and entrepreneurship in the construction industry	Bachelor	N	Y	Y	Lectures, guest lectures	1
Sweden	Chalmers University of Technology	Chalmers School of Entrepreneurship	Master	Y	Y	Y	Lectures, case studies, business plan writing/competition, guest lectures, business development project, seminars	3
Sweden	Dalarna University College	Bachelor program in entrepreneurship	Bachelor	Y	Y	N	Lectures, guest lectures, internship	2
Sweden	Dalarna University College	Rural business 80p	University certificate	Y	Y	N	Lectures, guest lectures, internship	2
Sweden	Göteborg University	Postgraduate program in Business Administration - Major in Entrepreneurship (Entreprenörsakademin?)	Master	Y	Y	N	Lectures, business development project	3
Sweden	Jönköping International Business School	Self-employment 70p	University certificate	Y	Y	N	Lectures, business development project, mentor	3
Sweden	Malmö University College	Entrepreneurship 40p	University certificate	Y	Y	N	Lectures, guest lectures, project assignments	1
Sweden	Skövde University College	Entro Gothia Science Park 40p entrepreneurship program	Postgraduate program	Y	Y	Y	Lectures, business plan writing, guest lectures, business development project, seminars	3
Sweden	Stockholm University	Entrepreneurship 40p	Master	Y	Y	N	Lectures, guest lectures, project assignments, business development project	3
Sweden	Södertörn University College	The entrepreneur program	Bachelor/Master	Y	Y	N	Lectures, guest lectures, internship	2
Sweden	Umeå University	Entrepreneurship in the network society	University certificate	Y	Y	Y	Lectures, project assignment	1
Sweden	Umeå University	Master's programme in entrepreneurship and dynamic business contexts	Master	Y	Y	N	Lectures, guest lectures, seminars, case studies	1
Sweden	Uppsala University/SLU	Uppsala School of Entrepreneurship	Master	Y	Y	Y	Lectures, guest lectures, business development project	3
Sweden	Örebro University	Creative Business Management	Master	N	Y	N	Lectures, project assignments	1

Chapter 4:

Policy barriers and facilitators to entrepreneurial learning at universities in the Nordic countries

1. Introduction

The past two decades has seen increasing attention being paid to the seemingly unrealized potentials residing within public research organizations. This has been followed by an unprecedented shift in research policies in the last ten years towards promoting interaction between business and the public research sectors either in part or in its entirety in all OECD countries (OECD, 2001). The issue has been of particular concern in the Nordic countries as all countries exhibit relatively high expenditures on research as a share of GDP, but has not realized the economic payoffs expected. In this chapter, focus will be on a comparative overview of various mechanisms to promote commercialization of public research. More specifically, the chapter will focus on those aspects that influence one sub-area to commercialization of public research, namely entrepreneurship in academic settings. The empirical referents of this study are the policy mechanisms influencing academic entrepreneurship in the Nordic states: Finland, Norway, Denmark, Sweden, and Iceland.

In accordance with the objective, a review will be made of reforms made and measures taken at in the respective countries that may influence entrepreneurial learning. However, there are few measures that specifically targets academic entrepreneurship, instead policy measures more commonly address the broader issue of commercialization of research. Therefore it is rather these measures that will be reviewed and the consequences for academic entrepreneurship will instead be assessed from them. Entrepreneurial learning in academic settings is moreover not only influenced by policies directed at universities and the commercialization of research, but also by the wider regional and national context of which academic entrepreneurship forms a part. This refers to more general policy measures, often understood in the light of measures aimed at stimulating entrepreneurship in general, institutional, legislative, or infrastructural changes, or in terms of other regional or national programs. Such policy measures will therefore also be reviewed, albeit in a more general fashion. The review may thus be said to focus on measures that affect academic

entrepreneurship either directly or indirectly, although this distinction is not always clear cut. This study is moreover intended to be a review of extant research in the area, and thus little new research has been conducted for the report.

The structure will be as follows; the first section will deal with limitations of the study, followed by a review of theory and policy trends in the area concerned with the role of the university in society, and more specifically the area concerned with the commercialization of research. The country cases will then be presented, with emphasis on policies with a direct influence on the commercialization of research, but also reviewing measures influencing this more indirectly. In the final sections the area overview and the cases will be elaborated upon in order to draw conclusions on barriers and facilitators to academic entrepreneurship. Finally, implications will be made.

1.1. Limitations of the study

In studying the four countries some methodological problems were discerned that need to be mentioned. A first assumption for a report benchmarking measures taken in various countries is that they are sufficiently similar for comparisons to be made. In the case of the Nordic countries these share some form of common history and political ideologies, however, for the purpose of this study they also exhibit some important differences. For the first, all the countries have a broad mix of public research organizations ranging from universities and polytechnics to more applied and industrial research institutes. In addition they all have a part of the public research structure which is known as the sector organizations. These are organizations that conduct research in order to support policymaking activities in a given sector. Further examination of this common landscape reveal important differences as one moves from country to country. Sweden is the outlier in this case with a heavy dependence on universities for its public research needs and a small and fairly weak institute sector. Norway, Denmark and Finland have much more in common here in that there is a fairly large and thriving institute sector in all these countries. Finland is perhaps leading in this regard with the VTT – a 3000 employee strong research institute covering almost all fields – being one of the largest research institutes in Europe and certainly the largest in the Nordic region. Iceland, lastly, has traditionally not had an equally complex public research structure, much due to the relative size of the country. Of late this has however changed, and the number of universities has for example increased from one to nine in the last decade. Thus, policies directed at the public research sector may have somewhat different impact in the different countries with regard to their different structures.

In recent years, most of the countries under study have been in the process of making new policy in areas that are directly or indirectly part of the brief of this study. For instance, Denmark, Norway and Iceland has only recently implemented important new legislation which changes the basis for ownership of intellectual property at universities and thereby the basis for commercialization. Other reforms of the university sector are also being made. Also Finland has experienced some changes in the policy for the commercialization of public research. Sweden has been in the process of considering reforms for several years and recently Vinnova has put forward a proposition to the government that appears to have the support of most universities. The proposition states that Sweden should keep the professor exception rule and that universities should be assisted with the necessary resources to provide support for commercialization. While the report includes as much updated material as has been available, it is merely of an informational character since these policies are naturally too new to evaluate their impact. Even though many of these policies are at least five years old, it is still too early to assess how they will eventually impact on academic entrepreneurship for a variety of other reasons that will be explicated later.

2. Academic entrepreneurship

In general, academic input to policy discussions, together with the European Union programs, the visibility of best practice cases particularly from the US and Italy, have led to a considerable cross national convergence of policy (Lemola, 2002). This convergence shows in innovation policy in general but can also be discerned in more specific areas such as entrepreneurship, turning science into business, and academic entrepreneurship. In these areas, references to adaptations in the US have been prominent although not exclusive (on Bayh-Dole, cf. Mowery et al., 2001). Rightly or wrongly, there has also been a notable recognition of the applicability of the experience of other Nordic countries. As a result there are some overarching tendencies and challenges that often recur in several contexts related to entrepreneurship in general as well as to, commercialization of research.

Entrepreneurial learning in academic settings may be influenced by a wide range of factors. In terms of policy these may, as mentioned in the introduction, broadly be divided into measures targeting commercialization of research and those directed toward the regional or national institutional framework more generally but with consequences also for academic entrepreneurs. In the former case, involving, for example, ownership rights and university policies, there is more of an exclusive influence on individual researchers and universities.

The influence of the latter, including for example, national entrepreneurship programs, on academic entrepreneurship is more difficult to pinpoint due to their wider applicability and effects. The overview below will treat theory and policy regarding both the role of the university and entrepreneurship in the national context, and the commercialization of research, with a focus on those particularly relevant for academic entrepreneurship.

3. Universities and entrepreneurship in a national context

The recent shift in research policies toward increased interaction between the academe and business has also been accompanied by a surge of innovation system approaches where universities and public research organizations are one of the cornerstones for regional and national development. This line of research started in the late 1960s in close cooperation with policy makers in the EU (Mytelka & Smith, 2002). Researchers in this domain started to outline a new conception of how research disseminated to industry and the wider society, moving away from an earlier predominantly linear view to a more systemic understanding of how factors interacted in the creation of innovations and regional and national growth. This research gained momentum in the late 1980s and 1990s and resulted in several similar approaches and cross national comparative studies (eg. Nelson, 1993).

In Innovation System literature innovation is the driver of growth and thus the principal aim for regional and national economies. It is created in universities and industry, or in the interface between these and the government. This is perhaps most clearly pronounced in the Triple Helix model (e.g. Etzkowitz & Leydesdorff, 2000) where focus is on the three helixes of university, business and government and the interaction between them. Two of the cornerstones for the dissemination of innovations are university – industry collaboration and entrepreneurship. One major noteworthy shift in the Nordic countries' general policy in the last ten years is towards promoting entrepreneurship rather than support to SMEs. There has also been a general trend in the OECD to assign university – industry interaction a central role in the policy effort to develop the IS and to stimulate the creation of new knowledge intensive firms as well as the upgrading of existing SMEs. This role has been particularly accentuated in Sweden and Finland due to that the comparatively large investments in R&D have not paid off as expected. The most powerful trend that can be discerned as a result of this is a shift from directed support programs to a focus on framework conditions. In fact, initiatives to stimulate entrepreneurship and university-industry collaboration often come to focus on improving upon framework conditions, or underlying functions (Carlsson et al., 2002), and promoting interaction between actors in the system. These framework conditions relate to

several different aspects, such as managing the funding system to influence interaction between business and science, and improving the institutional set up in terms of a functional venture capital market, improving upon patent protection, business incubators, advisory offices and support programs to stimulate entrepreneurship. In the end the basic logic often sums up to one of stimulating finance and knowledge, managed through the infrastructure (the system), support programs and networking (collaboration).

With regard to commercialization of research, the issue of stimulating finance is important in primarily two respects. Firstly, the availability of research grants to universities has been shown to be positively associated with entrepreneurial activity (Markman et al., 2004). While this is not surprising, it points at the same at the problem for the Nordic countries, suggesting that the structure of the funding system may play a role and that other factors are at least as important to increase the entrepreneurial activity. Secondly, the availability of financial support to academic entrepreneurs in terms of grants, and, in later stages, venture capital is important for the formation of university start-ups. All countries in this study have rather underdeveloped venture capital markets, especially with regard to the early and seed financing phases (European Commission, 2002). Due to the relative immaturity of the venture capital market in the Nordic countries, there have also been concerns of the competence of the same.

The stimulation of knowledge, or advice, may be promoted through a range of mechanisms. Many of these relates to the infrastructure as such (Smith, 1997), relating to, for example, science parks, business incubators, and institutes, functioning either as promoters of interaction between academe and industry, or as providers of advice and knowledge more generally. These infrastructures in turn operate inside an institutional framework which in one context emphasizes regulation. One aspect that has received a lot of attention is the legal system and the issue of promoting awareness and use of IPR. In relation to this efforts have been made in the Nordic countries to pursue a pan-Nordic patent protection initiative in order to strengthen the patent protection. The stimulation of knowledge may also be said to include support programs to stimulate, for example, a general awareness of entrepreneurship as an alternative, i.e. influencing the culture. With the exception of Iceland, where no such programs have been implemented, this has been a concern of the Nordic countries due to that rankings on entrepreneurship attitudes have generally left the Nordic countries for more to wish (e.g. GEM, 2003).

But it has been difficult to find the right policy design for stimulating entrepreneurship and university – industry collaboration. There are two main reasons for this, the radical heterogeneity in the SMEs sector (Hoffman et al., 1998; Woolgar et al., 1998), and that we know little about the actual conditions for many start-ups. Regarding the latter, there is much research conducted in the biotech area but as we move outside of this domain the extent of knowledge available rapidly decreases (Smith, 1997). Regarding the heterogeneity, the wide range of different start-ups and SMEs can roughly be divided in two broad categories; traditional SMEs in traditional sectors, and start-ups basing their business on sophisticated technologies. The latter can in turn be further sub-divided into stand-alones and spin-offs from for example universities (Carayannis et. al., 1998, Mustar, 1998). While these diverging kinds of firms have some common denominators in terms of support needed and dependence on the immediate local environment (Asheim, 2002; Kaufmann & Tödtling, 2002), it is also clear that they exhibit very different and specific requirements for stimulation. The collaborative practices to upgrade the technology of a traditional SME are for example likely to differ radically from the collaborative practices needed for providing a high-tech university spin-off with additional basic research. We thus turn to a closer examination of the needs and requirements that pertain to the level of commercializing university research, or more specifically, entrepreneurship in academic settings.

4. The commercialization of academic research

The challenges that surround the commercialization of academic research often resort to efforts similar to the ones for stimulating entrepreneurship in general. That is, to stimulate the creation and development of relevant human and intellectual capital, and financial and institutional resources for its transfer from the university to industry. The transfer itself may occur in the form of industrial employment of researchers, of knowledge transfer through for example collaborative arrangements, licensing, or through the establishment of new firms. In either case, successful commercialization of academic research depends on the active participation of the researchers who were the original discoverers of the knowledge to be commercialized (Siegel et al., 2003; Zucker et al., 1998; Audretsch and Stephan, 1996). In order to achieve this, incitements and a supportive institutional framework need to be in place to facilitate this.

A debated issue in the Nordic countries in relation to this has been the issue of ownership of research findings. Contrary to other employments ownership to research findings has traditionally belonged to researchers in accordance with the teacher's exemption

clause. This legislation has however been changed of late in some of the Nordic countries, the rights now belonging to universities. There are primarily two issues that bear on this. Firstly, it has been argued by Henrekson (2002) that the universities do not have the same incentives to commercialize research as their American counterparts why this change may not be as successful in the Nordic countries. Secondly, there are not sufficiently developed structures for the commercial exploitation of research. This is supported by a newly released OECD report on Turning Science into Business noting that a removal of the clause is not in itself sufficient to improve conditions for commercializing academic research, it may not even be necessary. The removal does provide a set of benefits on a structural level, including that it provides greater legal certainty for involved parties, that it lowers transaction costs for partners/better bargaining position, and that it fosters more formal and efficient channels for knowledge and technology transfer (OECD 2003). But it may also be a costly affair for universities since development of competencies is required, something which is not in place yet in the Nordic countries, and since the administration for handling patenting and licensing is costly in itself. Moreover, studies from the US show that the substantial part of the income is often generated by a very small part of the patents (Jensen & Thursby, 2001), and return on investments is thus dependent on the creation of these few lucrative innovations.

The importance of these support structures has led some researchers to suggest that there are entrepreneurial universities rather than entrepreneurial academics (e.g. Lockett et al., 2004). However, the precise relation between formal university policy and entrepreneurial academics remain unclear. Nonetheless, universities need to develop both the competence and the support structure as such in order to commercially exploit their research. This includes providing academics with incentives and rewards in relation to both the academic meriting system and monetary incentives. It also relates to the academic work in itself, the mobility across sectors, and the attitudes within universities.

The academic system of meriting needs to motivate academics to commercialize knowledge. Traditionally, the career path within the academe has been, and to a large extent still is, to publish or perish. To commercialize research has not been aligned with the academic goals, and has not been something taken into account in promotions etc., but has rather been a means to secure inventor compensation (Goldfarb and Henrekson, 2003). Inventor compensation is often regulated by a three way split between the university, the department and the researcher/researchers, unless ownership rights belong exclusively to the researcher. Research on incentives tends to diverge somewhat, but its importance is generally acknowledge, as is the need to tailor the system according to the efforts made (Markman et

al., 2004). There are also studies pointing to the importance of supplementing structures allowing universities to, for example, take equity stakes in return for paying upfront patenting costs as in the US (e.g. Di Gregorio & Shane, 2003).

A supportive university structure also refers to arrangements that facilitate labor mobility between academe and industry (Zucker et al., 1998), as well as make possible more flexible recruitment structures within universities to hire staff in relation to present and anticipated demand. These structures clearly also need to go beyond the university itself and involve the surrounding region, forming milieus that by themselves create incentives for researchers to engage in collaborative work (Zucker et al., 1998).

The structural issues are also interrelated with the university culture and attitudes towards entrepreneurship and commercialization. While some (e.g. Gibbons et al., 1994) tend to downplay the contradictions, others (e.g. Ziman, 2000) pay attention to the social significance of strongly institutionalized forms of academic conduct. This is an important issue not least in the Nordic countries, since these are not regarded as very entrepreneurial as mentioned above (e.g. GEM, 2003). Changes may be brought about by acknowledging the incidences of successful commercialization that do occur, pay attention to researchers' perceived seriousness of constraints, and communicate the formal policy support from management (Kassicieh et al., 1996). In addition, it may be necessary to provide business expertise to help researchers and universities to recognize commercial potentials (Lockett et al., 2004), and to adopt business-oriented mind-set when it comes to commercialization (Bower, 2003). That is, to assist in the process of entrepreneurial learning.

Moreover, it may also be important to recognize a temporal aspect in this process of entrepreneurial learning. To assist entrepreneurial learning is not only to provide some of the prerequisite knowledge for starting up a new venture, but also includes its subsequent growth. It can be discussed when the "entrepreneurial" phase actually becomes replaces by a "small business", or "growth venture" phase, and who should provide additional assistance. But it may be of concern for the management of universities as many knowledge-intensive spin-offs are likely to remain attached to the university for a long time, for better or worse. This since scarce resources coupled with need for additional research make continued contacts with, for example, the home department a cheap and probable option to turn to.

Finally, as for entrepreneurship in general, it may be difficult to find one right policy for stimulating academic entrepreneurship, and commercialization of research, since different scientific areas exhibit different requirements with respect to the technologies produced, and likely also with respect to local norms (Wright et al., 2004). Software and biotechnology, for

example, may represent very different logics with regard to IPR, commercialization etc., why multiple but separate spin-off policies may be required also within single universities.

To sum up, commercialization of research is influenced by a number of structural and cultural features and set ups on various levels. More specifically, academic entrepreneurship is likely to be directly affected by policies that directly bear on the individual researchers, such as the incentive system, the academic meriting system, labor mobility etc. In the case studies, such policies have been subsumed under university reforms. In addition to this, researchers willing to start a venture are also affected by more general structural features applying either to the research funding system, the innovation infrastructure in general, or national entrepreneurship programs. In the cases, the sets of policies which include the effects of the public research funding system, and start-up funding in terms of for example venture capital, have been subsumed under Funding. The organizations and institutions set up to provide advice and support rather than funding have been subsumed under Infrastructure for commercialization of research, while more general support programs have been subsumed under General support for entrepreneurship and regional development.

5. The cases

5.1. Sweden

The public R&D sector in Sweden is distinguished from that of other Nordic countries by its relatively large size as a share of GDP. Another peculiarity in relation to other Nordic or even OECD countries is that the majority of publicly financed R&D is conducted within the university and consequently the public institute sector is relatively small. Over the last ten years, a fairly standardized package of policy instruments for promoting innovation has emerged in Sweden. Two key components of this package are: to promote the commercialization of university based research and to some extent education, and to promote the growth and development of small and medium sized enterprises. In many respects, the logic behind the two policy initiatives is similar and rests on interdependent arguments.

The universities

Many of the instruments and initiatives taken by the Swedish government to promote the commercialization of academic research are premised on the view that Sweden's investment in higher education and research is currently much higher than its output in terms of innovation measured in patents. Swedish policymakers feel in particular that the level of return on investment is lower than that obtained in Finland (Andersson et al., 2002).

In Sweden, the process of the university reform has been an incremental one that has been taking place more than a decade now. Some of the main highlights of this reform process are representation of external stakeholders on university boards, limited experimentation of ownership of universities (2 new foundation universities), and introduction of university holding companies to overcome barriers to ownership in the existing legal structure of most universities. Moreover, regional university colleges have been integrated into the strategy for development in the regions. There has also been a legislation of the Third Mission making universities legally responsible for disseminating research results within their organizations. This task is not specifically about commercialization of research results but dissemination of all kinds, however, many of the commercialization activities have been promoted under the rubric of the Third Mission.

In Sweden, contemporary law allows researchers at universities to keep ownership of patents, which is an exemption from the general regulation on patents developed by employees. Whether to keep or remove this clause has been debated during the 1990s, partly because patenting is a very costly affair and the jury is still out as to whether the benefits for universities outweigh the costs. The issue was raised again in the government research bill of September 2000 (prop. 2000/01:3) where it was proposed that Sweden should await the Danish experience. This proposition recommends that the professor's exception rule should be upheld and that the government should provide resources to universities to give them the possibility to offer support to researchers who are interested in commercializing their research. Further, the Vinnova proposition rightly points out a number of auxiliary measures as equally important focusing issues for policy intervention in this area. These include supporting increased mobility between the academe and corporate sector, which still is problematic in the Swedish university system, as well as promoting the development of a Nordic initiative for patent insurance at the European level.

It may also be mentioned that a case study of some USOs in Sweden revealed often very long-term dependencies toward the home department for continued research efforts, while development was carried out within the company (Johansson et al., forthcoming). To the extent that such dependencies are strong it may point to a certain vulnerability on behalf of the USOs, in so far as their continued existence to some extent becomes dependent on the university department's ability to attract further funding, as well as on the general public research funding climate.

The funding system

Sweden began to slowly outline a new science policy direction in the early 1990s. The first significant, and controversial, act in this was the creation of a number of strategic research foundations with funding that was not tied to annual budget allocations but based on stock market earnings from an initial capital outlay. These foundations were all oriented towards funding research of a strategic cut that had hitherto not been common in Sweden. The original intent with forming the wage earner foundations was to provide an additional capital injection to Swedish research from an actor that was to be independent of the government and current state research policy doctrine. Moreover, they were supposed to work directly for promoting collaboration between universities and firms and for the commercialization of academic research. However, once the social democratic party regained control of the government, it devoted a great deal of time and effort in trying to disband the wage earner foundations and it was only in 1998 that they were officially accepted. In the meantime, the government has become more influential although indirectly in many of the foundations and through a policy of reducing public research budgets it has managed to dilute the potential effect of the wage earner foundations. The result of which is that the wage earner foundations, although still important actors, are no longer seen as special players. Instead the role of the wage earner foundations is taking on a sharper focus. This focus may be described as funding the development of a critical mass in new areas, (e.g. nano-technology) modernizing aging structures (e.g. upgrading the industry research institutes) and investments in promoting research leaders among younger academics.

A further change in the system for funding public research was introduced in 2000 with the reorganization of the research council system. The older system was characterized by a radical heterogeneity and a large number of actors. This system was radically restructured and a new and more centralized organizational structure was introduced.

Another significant reform, supported by the change in the structure of funding of university research, is the competitive research system. It is designed to promote the commercialization of university research in so far as it ensures that universities have to resort to the competitive funding market for a sizeable portion of their research funding. According to the National Agency for Higher Education, the goal is that at least 50% of research funding comes from competitive sources.

Apart from this there is a set of organizations providing funding for start-up entrepreneurs. These include private as well as public venture capitalists, and the funding provided by technology and science parks. The private venture capital market rapidly

increased from the mid-1990s to the early 2000s. In 2002 the Swedish venture capital market was the largest in the OECD in relation to GDP (Eurostat, 2003 in VA 2004:01), but it has since then declined considerably, as in many other countries. There have also been concerns of the immature, and thus competence, of the venture capital market. Also, the high-risk pre-seed stage of financing has largely been neglected and Sweden does not seem to have been well equipped with public pre-seed financing mechanisms. There has also been a general lack for financing the early stages of R&D-based inventions, as the science- and technology parks has not had enough financial resources, or business competence to reach a critical mass (VA 2004:01).

The infrastructure for commercialization of research

In the 1970s, a number of mechanisms were introduced to promote the transfer of knowledge from universities to the wider society, many of which are still in effect today. Among these were for example the establishments of contact secretaries whose duties partly included assisting university researchers in patenting, and in starting companies. Measures allowing researchers at universities or university colleges to work either part or full time for a company or another organization during a specified period were introduced. Adjunct professors and industrial doctoral students were also introduced to increase networking and collaboration with industry.

In the early 1980s the first science parks were established. The purpose was to offer a good working environment for R&D intensive firms. Two main types of activities can be found in the science parks, firstly the R&D departments of large firms for the purposes of networking and recruitment, and, secondly spin-outs from universities or university colleges. Initially science parks were limited to providing physical facilities (offices and practical service); later the functions of science parks have been expanded to include support for patent application, venture capital, etc.

With a somewhat longer history there are also industrial research institutes (30, see www.iris.se for more information) for the purpose of transferring knowledge from universities to industry. Among the main tasks are doing industry related research, technology transfer, collaboration and coordination of larger research programs with higher education institutions, industrial research institutes and industry as partners, contacts with foreign firms, institutes and other knowledge centers. However, this sector constitutes a relatively small part of the public research sector in Sweden.

In the 1990s, eleven University Holding companies were formed for financing the commercialization of patents. Technology Bridge Foundations were also formed and located in seven university or university college areas. The purpose is to contribute to increased knowledge exchange between academia and industry. These two organizations also jointly set up Patents & Licensing Offices (Forskarpatent) at the major universities in Sweden to assist researchers in the patenting and licensing processes.

Apart from these institutions, there are some major actors with a direct but more overarching responsibility for the university – industry interaction. These are; Vinnova (Verket för Innovationssystem) established in 2001 through the merging of three other agencies. The National Agency for Energy, STEM, established in 1998 and with responsibility to coordinate and implement the main part of the actions needed to restructure the energy system. Finally, the Royal Academy of Engineering Sciences (IVA) that promotes the engineering sciences and entrepreneurship in industry in order to achieve social development. While these organizations may be regarded as the frontline of university – industry interaction, in order for them to be able to have any impact on the system as a whole a series of other interventions had to be made. These include the promotion of an entrepreneurial culture at universities and institutional support structures for supporting the emergence of this culture. However, the infrastructure developed so far for the commercialization of academic knowledge also exhibits deficiencies in so far as it is overly focused on patents and knowledge that can be packaged in the form of patents. While this is not a problem unique to Sweden but true of most EU countries, it still remains a significant barrier in so far as it encourages a distorted pattern of investment where disciplines that are perceived to be not 'relevant' to commodification processes may not be seen as worthy of strategic investments.

The general support structure

The view that Sweden lacks an entrepreneurial culture applies more generally than to academe alone and several measures have been taken in order to improve that. With the establishment of Vinnova in 2001, the responsibility for enterprise development and fostering of entrepreneurship became more centralized. The new organization was given the mission to promote sustainable growth by financing research, technology and development and developing effective innovation systems. In 2002, the government also launched a national entrepreneurship program, mainly targeting young people. Several independent activities have

already been tried within this field, but this program will be the first strategic and coherent action for entrepreneurship in Sweden.

With a shift toward a more systems oriented view, there has been a move from selective, delimited policy measures directed at SMEs to a more general and horizontal entrepreneurship policy approach that emphasize the development and promotion of institutional preconditions for new businesses and SMEs. The general guiding principles on which this new policy for small firms rests are:

- Strengthening Sweden's industrial and international competitiveness by promoting good conditions for growth and renewal. This includes a consistent competition policy, and easy access to competence and capital (information, advice and funding)
- Improving the legislative and regulative framework
- Good access to finance and facilities for stimulating entrepreneurship
- Special measures for targeting disadvantaged groups e.g. women, minorities, youth
- Promotion of networks and clusters

As a part of promoting the last principle, a national cluster program was launched in September 2001 and will run from 2002 to 2004. The outline of the cluster program focuses on methods and analyses in order to identify and support existing, as well as potential, national and regional clusters. One of the objectives is to expand and upgrade the regional university colleges while integrating them in regional strategies for economic development.

In terms of entrepreneurial attitudes, the higher education and research system in Sweden has traditionally been one that actively promoted a set of beliefs and behaviors that did not favor entrepreneurship. For this reason, the policy package for promoting commercialization of academic knowledge also has placed high emphasis on promoting the emergence and development of enterprise culture at Swedish universities and colleges. At the same time as efforts are being made to change cultural values, the infrastructure for supporting the new set of values is also being put into place, often through the same mechanisms such as network building etc. Thus, a perusal of policy initiatives would show that attention is given to bridging mechanisms which would act as facilitators for commercialization either through capital infusion (technology bridge foundations), network and competence exchange (science parks, incubators, etc.) or in terms of education programs. Despite the level of investment in these activities and the fact that the technology bridge foundations and other such mechanism are important additions, together they have not proved to the stimulus for innovation expected. A recent article by Henrekson and Rosenberg (2001)

suggested that one of the reasons for this is that there are not enough incentives at an individual level for academic entrepreneurship in Sweden.

Concluding remarks

An analysis of the thrust of the initiatives gives a good idea of the current policy perception of the main drivers of commercialization of academic knowledge: enterprise culture; infrastructure for commercialization of knowledge and steering mechanisms that could promote innovation policy needs in competitive research regimes. While a large part of the infrastructure exists in terms of, for example, science parks and advisory offices, recent years have seen an increase public support to commercialization of research. However, universities and PROs, but particularly universities, in Sweden still lack much of the managerial and administrative competence to deal with the commercialization of knowledge. Universities will therefore need to devote more attention to governance mechanisms for competitive and collaborative research as well as commercialization activities. Support mechanisms for project management, contract diversification, leadership development at the institutional level, etc. will have to be created.

5.2. Finland

In Finland, all the universities are state-run, with the government providing some 70 per cent of their funding. In addition to the universities the public research sector consists of a network of 29 polytechnics that is becoming an important source of research, and 19 public research insitutes. Another significant research body is the Technical Research Centre of Finland (VTT), under the Ministry of Trade and Industry. VTT is an impartial expert organization that carries out technical and techno-economic research and development work, and represents a relatively large part of public research committed. In 2000, a total of 70,000 people were involved in research and development, over half of whom in business enterprises, 30 per cent in the university sector and 16 per cent in the public sector. The Finnish research system is currently undergoing a reform the measures of which were outlined during the 1990s.

The universities

The universities in Finland are increasingly taking part in the commercial utilization of research results, partly because a new proposal includes it in the function of the universities. The institutional and regulative framework on intellectual property rights in universities have, however, been recognized as barriers on the effective utilization of research. The law

regarding university inventions is therefore undergoing a reform aimed at clarifying practices and rules in the intellectual ownership of inventions, and thus intensifying the commercialization of research results (Ministry of Trade and Industry, 2002). According to the new proposal, the researcher and teacher exception rule would be reversed, meaning that university researchers would be in the same position as any other employee. But the act will be contractual, meaning that the regulations will be applied if not contracted otherwise by the parties involved. The new act would moreover not cover the intellectual property rights in free academic research where the inventor has the right to decide the primacy of publishing or utilization of the invention.

While this reform is ongoing, VTT and Helsinki University of Technology have already adopted a more rigorous IPR strategy than many other universities and research institutes who are still in the learning phase. Observations[6] regarding the implementation of the IPR policy at VTT indicates that a general policy for the protection of intellectual property at an organizational level is difficult to apply for different fields and does not in itself guarantee effective commercialization of results. However, a common policy for commercial activities has increased the awareness of the need for protecting results and also the potential economic utility of the research. The research environment, attitudes of leaders and customers towards ownership and protection of intellectual property and also personal rewards for participating in commercialization affect the way in which researchers have adopted the new policy targets. Also, an early recognition of the potential commercial utility turned out to be an important factor in managing the commercialization of research. But, the increasing cost of protecting IPR within VTT was seen as a growing concern of the staff and some researchers were also concerned about losing research contracts with important customers because of attempts to keep the rights with VTT.

Apart from changing the intellectual property rights there are other developments that have been supportive of the commercialization of research results and academic entrepreneurship. For example, increasing attention has been paid on making the universities more market oriented, as well as allowing commercial and strategic considerations to influence the direction of research. Also, practical help with business start-up, management, risk assessment and financing and IPR management has been offered, although voices have been raised for the need to strengthen competencies about IPR issues among university administration and staff. In recent years, power has also been delegated to the universities,

[6] These findings are result from the study carried out by Kutinlahti & Elo (2003), which analyses the implementation of IPR policy at VTT.

which has increased their autonomy in internal management. Consequently, universities have developed and introduced new strategies and formal mechanisms to promote innovation activities in the organizations. Examples are that most universities have internal consulting services and invention advisors[7] to assist researchers in innovation issues. Moreover, much progress has been made in the university sector in setting up technology transfer and innovation offices at universities, although these still remain at an early phase of their learning curves.

However, some obstacles pertaining directly to the commercialization of research have also been observer. For example, the regulations on equity investment by research organizations in firms are regarded as such. A government organization funded directly from the state's budget is not allowed to invest in the private sector without the specific consent of the Parliament. To circumvent this, several universities have their own foundations that are able to make equity investments. These foundations have made equity investments in technology transfer companies together with the National Fund for Research and Development (Sitra) or in regional development companies jointly with other regional organizations.

The funding system

One of the most prominent trends in Finland has been the rapid increase in both public and private research funding during the 1990s. In the public sector, the increase in funding has been channeled through Tekes, the National Technology Agency established in 1983, while the Academy of Finland has also increased its contribution in real terms. Increased external project funding, an explicit aim of the Ministry of Education, has also provided the universities and government research institutes with more resources (Tuomaala et. al 2001). In universities, for example, R&D funding provided by business enterprises tripled from 1991 to 2000. However, the most significant single funding resources for university research remains with the public funding agencies.

As for Tekes, they take a positive view in their funding policies on projects that involve networking with other companies, the contracting of services from other Finnish research institutes and universities and the promotion of international cooperation. For universities this

[7] **Invention advisors** of Finnish Foundation for Inventions provide advice to individual inventors on technology, the development of inventions and on marketing. The experts are primarily from universities and research institutions, and abide by the confidentiality, which is a principle of the Foundation. The network of invention advisors covers the whole country and there are currently 16 advisors in TE-centres and 12 in universities.

however implies that large firms become more attractive partners, since the cost of starting a new project is almost constant regardless of the size of the project.

There are several public institutions providing finance for businesses in Finland. The most significant public venture capital organizations are Sitra, established in the 1960s and under the supervision of the Parliament, and Finnvera, a state owned specialized financing company created in 1999 through the merger of Kera and the Finnish Quarantee Board (Hyytinen & Väänänen, 2002). Sitra played a significant role in the establishment of the Venture Capital Association in 1990. Sitra's own activities include technology transfer and venture capital investments in emerging and technology-based start-up companies as well as spin-offs from large companies. Sitra's PreSeed service package has been created to accelerate the emergence of new technology-based businesses, improve capital management and introduce companies to the providers of further funding, including private venture capitalists. The PreSeed service consists of LIKSA and INTRO. LIKSA is a joint funding service operated by Sitra and Tekes that can be used to obtain information and services related to the commercialization of technology and the development of relevant business plans. The INTRO service takes care of the efficient presentation of start-up enterprises so that they can find both institutional and private investors who might be prepared to provide simple, straightforward funding in the future. Other public venture capitalists include Finpro, and Finnish Industry Investment, which was established in 1995 to promote the development of venture capital in Finland.

Financing also flows from the budgets of various ministries and from various regional governmental and semi-governmental venture capital firms. In general, the Finnish private equity and venture capital market has experienced significant growth in terms of both investors and operations. While governmental agencies have pioneered the Finnish private equity investing, and still play a significant role especially in the seed capital segment (Seed capital investment in Nordic countries, 2002), many private management firms had become prominent players by the end of the 1990s and today account for most of the market. However, there are some overlaps between the public sector organizations, and between public and private sector that could be improved upon (Ministry of Trade and Industry, 2003).

The infrastructure for commercialization of research

Tekes also has a prominent role in promoting commercialization of research in Finland and linkages between public research organizations and SMEs. In addition, Tekes takes part in the planning of Finnish technology and innovation policies along the lines given by the Ministry

of Trade and Industry. One of Tekes programs, the TULI-program, has the main goal to promote new, technology-based businesses coming from applied research in Finland. The focus of the scheme is in the R&D activities at universities and research institutes. In practical terms, the aim is to transfer the commercial potential of research projects towards commercialization and new ventures.

Apart from that, the role of institutes is very important. Especially that played by VTT, being one of the largest independent actors in the public research organization that border to industry. Other important institutional structures that support university – industry interaction and commercialization of research results are the incubator schemes that have been established in close association with the regional technology parks and universities since the late 1980s. At a regional level, technology centers, science and technology parks, centers of expertise, and other similar operations (e.g. Foundation for Finnish Inventions and technology transfers companies) form a supporting expertise network which provides advice on matters relating to the development of inventions, their patenting and related strategy.

The general support structure

Finland has also been concerned with stimulating different regional development programs in order to stimulate commercialization of research results as well as innovation in general. Recently, there have been two major initiatives to promote cross and intra-sectoral collaboration in particular. The first initiative, the Center of Expertise Program, is a national measure that aims to enhance regional competitiveness by strengthening innovation through renewing the production structure and creating new jobs within the expertise areas selected. The second initiative, the cluster programs, aims to support R&D activities that strengthen clusters and collaboration between the industry and public organizations. While the cluster programs have already initiated a degree of productive cooperation, a recent report points out that more focus should be given to the objectives, that the coordination between financiers should be improved, and that the reporting requirements are too complex. There is also some overlap between support programs that together with a lack of coordination may expose the system for financial misconduct. Tekes also run technology programs in order to promote networking, these have however been criticized for being too technology-oriented and too fragmented, and not allowing room for unconventional approaches (Tuomaala et al. 2001).

According to the EU Innovation Scoreboard (2001), Finland is rated rather poorly in terms of entrepreneurship and overall remains relatively averse to risk taking. To counteract this, a government initiated Entrepreneurship project began in early 2000 and came to

completion in early 2003. Nine ministries as well as the Association of Finnish Local and Regional Authorities participated in the project. The project included various measures, which set out to increase the establishment of new firms and increase the growth and competitiveness of existing enterprises. Measures taken to improve the environment for entrepreneurship have focused on several issues including the administrative obligations involved in running a business, financing, counseling and development services for businesses, and further on improving the operating environment in the social welfare and health care services, etc.

Concluding remarks

While Finland have an existing supporting structure for commercialization of research results there are concerns regarding the lack of competence in the protection of intellectual property and technology management within the Finnish universities and research organizations. Other identified bottlenecks in promoting the commercialization of research and university start-ups are the lack of risk financing to develop results to more mature stages, lack of incentives for researchers to play a role at the early stages of the commercialization process and high thresholds to move from an academic career to an entrepreneur. That is, there is a need to increase the mobility of workers in public R&D organizations and companies, and researchers also need more incentives to put their time and attention to the new tasks. Moreover, although some steps have been taken, building up an infrastructure for commercial activities at universities is costly and the economic revenues from commercial activities still remain uncertain.

Another critical area for concern in Finland is the lack of entrepreneurial culture and motivation amongst the population in general. Finland has too few financial incentives for entrepreneurial activities and taxation is considered to be backbreaking, particularly for new firms. Cultural aspects and entrepreneurial education are to be considered if they are aimed at nurturing the commercialization of research at universities and other public research organizations.

5.3. Denmark

In Denmark the public research sector is organized into universities, government research institutions, and technological service institutions. Sector research constitutes about 20 percent of public research conducted in Denmark. Of late, Denmark has been on the verge to carry out a number of reforms within the entire public R&D and innovation system, including

a reform of the advisory system and management at universities. The reforms are intended to improve the transparency of and accessibility to the research and innovation system as well as improve co-operation between the institutions.

The universities

As mentioned above, a number of reforms have started, or are on the verge to be carried out within the Danish R&D and innovation system. Among the initiatives taken in recent years that specifically direct the universities is the university reform which is intended to partially build a formal bridge to the surrounding world. The reform includes professionalizing the leadership of the Danish universities through the use of professional boards of directors appointing professional principals. Each of the 12 universities has to have their new boards constituted by January 1st 2005. Moreover, the heads of the departments will be employed by the management whereas today they are democratically elected. In order to support the universities in this transformation, reorganization reserves that were earlier taken from the universities have been redirected back to the universities. Another major legislative change within this university reform was to remove the teacher exemption clause in 2000 (Lov om opfindelser ved offentlige forskningsinstitutioner', Law nr. 347 from 2nd of June 1999), turning ownership of research findings into the hands of the universities. However, to date only few of the Danish universities have yet begun to actively handle their intellectual property and appropriate inventions. But the ones who have (i.e. Danish Technological University, Aalborg University Centre) have established solid partnerships with industry and account for a relatively large number of patents and spin-offs from their activities.

The funding system

The public funding of research primarily flows from the different research councils and committees within different areas. While there seems to have been increasing encouragements for collaborative research from these councils and committees, the competitive to fixed funding ratio for research is still unclear in the new landscape. The organizational change process within Danish universities also seems to have generated some problems regarding funding. The closer the research objectives in the universities are to the commercial objectives of firms, on the one hand, or the policy objectives of Government departments and agencies, on the other, the more those commissioning the research should themselves have the incentive for funding an activity. However, with funding policies in favor of the former and a university

reorganization that has not fully made the transition, firms are still not willing to commission that much more research.

Another important cornerstone in the promotion of new businesses is to support a functioning venture capital market. Of late, in 2000 to 2001, Denmark showed an impressive relative growth in the venture capital market, especially with regard to seed and start-up capital. This at least in statistics because parts of the relative growth is due to the listing of the Danish Growth Fund as a venture capital company. The majority of private venture funding in Denmark to date has flowed to firms in the ICT and biotechnology sectors.

The infrastructure for commercialization of research

In Denmark, the government body with the main responsibility for policy development with respect to innovation and university – industry interaction is the Danish Ministry of Science, Technology and Innovation. The ministry was recently formed as the result of the transformation of the former IT and Research Ministry. Its formation was also part of a more general reorganization that allocated many innovation related activities under the umbrella of the new ministry, making for example policy development for universities the responsibility of this ministry instead of the Ministry of Education. This reflects an aim to centralize innovation related activities in order to create greater transparency in the system. It is also in line with the growth strategy of the Government and its objective to turn Denmark into a stronger knowledge based economy (cf. 'Vækst med vilje', published by the Ministry of Economic and Business affairs may 2002). One of the objectives of the Ministry of Science, Technology and Innovation is to promote the interaction between trade, industry and centers of research and education, as well as to strengthen coordination in the pursuit of industry and science policy. At the turn of year 2002-2003 the Government proposed an action plan to further strengthen the co-operation between trade, business and knowledge institutions, focusing on the future interface between the technological service system, research parks, incubators, and the government research institutions and industry.

In addition to this, and with the start in the autumn of 2002, a number of additional legislative initiatives have also been taken with the aim of improving the efficiency of the Danish innovation system. These included measures to simplify the structure of the research advisory system, as well as measures to improve the transparency of the public research system.

There is a set of different institutions that constitutes the infrastructure that is to support the measures and policies taken for the promotion of interaction between universities and

industries. The main such institutes include the research institutes, the Technology Service Institutes (GTS), the Technology Information Centers (TIC), and the science parks and other innovative environments.

The aim of the government research institutions is to provide the ministry under which they are placed with research based counseling. There are 28 sector research institutes that together constitute about 20 per cent of the public research conducted in Denmark. The research is primarily problem oriented with a clear purpose of application in society.

The Government Technological Service Institutes (GTS) are functioning as self-governing institutions of public utility. Thirteen different institutes are spread around the country, each with their own strategic and business focus. The main focus is to develop and transfer knowledge to different companies, and let this knowledge be internalized in these companies. The GTSs are privately managed and management has the sole responsibility that the institute survives and develops in relation to its competences. Revenues from counseling services etc. are used for consolidation, development of services and research and development.

The Technological Information Center (TIC) is a nation-wide, independent, non-profit organization with at least one regional centre in each county. TIC is a 'free-of-charge' program that offers expertise and consultancy on possibilities and tools for development and growth in SMEs and acts as a contact to relevant experts and knowledge centers.

The science parks, finally, have as a primary goal to promote and enhance the establishment of new companies through the use of knowledge from a range of research institutions connected to the science park.

Many of these institutions have over their years of existence come to serve important roles as knowledge brokers in the research system. However, with the changing roles of universities where the universities are supposed to disseminate and commercialize the findings themselves to an increasing extent, it is uncertain whether all of them will continue to exist on the same scale. It largely depends on whether or not they can establish distinct roles as important partners in the new research landscape. This issue will be important to address as some of the organizations are competing with universities, as well as with other similar institutions, for public funding a competition which potentially could hamper the overall development of market-drive knowledge services.

A potential blindside in the current system is that while the actors in the research system, specifically the universities, increasingly have met a political demand for focus on high-tech sectors there has been a tendency to overlook and disfavor other scientific fields and

firms. An ongoing debate concerning the consequences of the one-sided discourse has taken place during the last 1-2 years, fostered by reports by Danish Commerce & Services, Danish Industry and Greater Copenhagen Authority etc[8]. The theme of the discussion concerns the identification of high growth industries, labor market demands, and which business sectors that will secure continuous growth and welfare in the future.

The general support structure

The action plan presented by the government at the turn of 2002/2003 also included a framework for the promotion of entrepreneurship and early-phase idea generation, aiming at improving the climate in general as well as in the public research organizations. The action plan focuses on stimulating an entrepreneurial culture, access to start-up capital, and improving the regional advisory system for entrepreneurs. It involves for example the establishment of business incubators functioning as a first link into an intertwined system of financial institutions such as the Danish Growth Fund, venture capital investors, business angels, institutional investors, etc. In addition, the government plans improvements of the capital structures for SMEs through loan guarantee schemes, tax, changes etc., as well as improved and cheaper patent services directed toward SMEs.

In order to encourage the use of the intellectual property system, the Danish Patent and Trademark Office (DKPTO) has also launched an initiative for supporting SMEs and entrepreneurs to the challenges related to effective use of IP system. In the initiative is included:

- A two year project to strengthen the Danish IPR culture.
- Creating better support structures, such as for example call centers, courses in IP management etc.
- Free of charge use of library services, primarily intended for SMEs.

The latest addition in the plethora of public initiatives to increase the application of new research results, an area in which Denmark is lagging (e.g. Growth Conditions in Denmark, Vækstvilkår I Danmark68) is the development of regional growth environments (see the Ministry of Science, Technology and Innovation for more information, www.vtu.dk). A regional growth environment is founded on collaboration between industry, research and educational institutions, technological service providers (i.e. GTS) and other relevant actors and takes its point of departure on industrial competences in a geographical area. The aim is

[8] 'Vejen til vækst', Danish Commerce & Services 2002. Rapport xx, Danish Industry, Rapport xx, Greater Copenhagen Authority

to support the development of each specific regional competence, to make research and education oriented and targeted to the regional industries needs for new products and processes, as well as making them more proactive in establishing relations with the regional industries. Eleven such growth environments are planned, each focusing on specific areas as diverse as fishing, music and robot technology. The growth environments are financed by the government, in collaboration with the Ministry for Trade Economic and Business Affairs, and are ensured additional co-financing from regional funds. Other initiatives in relation to this include the establishment of regional network centers and policy institutions like the Greater Copenhagen Authority that functions as a unifying umbrella organization for a range of municipalities and administrative districts in the Greater Copenhagen area.

Concluding remarks

Denmark was first of the Nordic countries to introduce a change in the ownership rights to invention in universities. However, the legislative change does not seem to have been accompanied by sufficient additional changes in the supporting structure within universities, and the new law has so far had limited effect in most cases. The universities, and public support, therefore need to pay attention to the build up of supportive structures within the universities. In addition, there is a possible need for a revision of the support structure surrounding the universities, e.g. the technological information centers, in the light of the new role of the universities.

5.3. Norway

The university sector in Norway is peculiar in that it concentrates large R&D expenditure among a small set of large institutions. The combined R&D expenditure and employment of the four state universities alone account for 23% of the country's total, which is roughly equal to industry and mining together. There is also a relatively large sector of 114 specialized research institutes (NIFU, Statistics Norway) that forms a middle-ground between the public and the private sectors, and constitutes an important intermediate space for the commercialization of academic research. Both the university and the institute sector have experienced a period of change in recent years where measures for increasing the commercialization of research results have been taken[9].

[9] This section draws on Iversen, E. J. 2004. SMEs and the new role of academic research: Case Norway. STEP Report 01-2004.

The universities

Today, a focus on universities as central actors in the revitalization of the national economy has re-emerged amidst a new phase of policy activity designed to improve the basis for turning "science into business". In Norway this move is a result of the belief that the large public investments in research and education should hold unrealized potential for application in industry, and a since long expressed hope that an industrial renewal will come from academic research that is spun out into the economy in the form of start-ups. Increasing the application of academic research could thus help develop sustainable activities that can reduce the dependency on oil. This objective has now been linked to efforts (new and old) to promote the diffusion of academic research through commercial channels.

The principal elements of the new policy framework that bear on the university-industry relations are rooted in the Ministry of Trade and Industry (NHD) and the Ministry of Education and Research (UFD). During the late 1990s, the latter sponsored a set of instrumental select-committees on commercialization of academic research issues (principally Bernt[10] and Ringnes[11] Committees) which ultimately led to a new legislation that to varying degrees reflected several currents of previous policy discussions[12].

The new legislation, proposition 40: (2001-2002): § 2 nr. 4, effectively extends the mandate for academic institutions obligation to disseminate scientific methods and results to the wider society to include commercialization as a channel for such dissemination. This change is complemented by more instrumental legislation which recently went into effect. The implementation of Proposition no. 67 (2001-2002) substantially changes the basis for commercializing academic research in Norway. The measure effectively removes the 'professor's privilege' from the legal corpus, thus placing responsibility for commercialization of academic research on the universities. Other arrangements can however be made on a bilateral basis between institution and researcher. The legal amendments thereby hope to increase commercial utilization of academy based inventions while maintaining the academy's traditional goals. They emphasizes that the active participation of the institutions in the commercialization is important, as is the adaptation of the legal and

[10] Bernt-utvalget (NOU 2001: From Insight to Industry: commercialization of research results from unviersities and colleges ("Fra innsikt til industri: kommersialisering av forskningsresultater ved universiteter og høgskoler".
[11] "IPR-Committee", on specific legal considerations of changing IP title at universities.
[12] See St. meld. nr. 39 (1998 -99) Forsking ved et tidsskille. See also Mjøs-utvalgets innstilling, NOU 2000: 14 Frihet med ansvar, Om høgre utdanning og forskning i Norge; St.meld. nr. 27 (2000-2001) Gjør din plikt - Krev din rett, Kvalitetsreform av høyere utdanning, and St.meld. nr. 35 (2001-2002) Kvalitetsreformen Om rekruttering til undervisnings- og forskerstillinger i universitets- og høyskolesektoren.

regulatory framework to facilitate this, as well as the professional apparatus to promote commercialization.

In order to improve their organizations according to the new law, the government is providing the universities with support. It has also been argued in Norway that to better promote the commercial application of patentable inventions, there is in addition to the legal amendment also a need for intramural support structures. For example, the researcher and the institution should have a right to share equitably in potential profits arising from commercialization[13]. The researcher should also maintain the right to publish, and should also together with the wider research community decide what to research and how. Any "added value" from commercialization should not be used to finance other aspects of the institution's activities as this would be seen as principally suspicious. There is also a need to develop strategies whereby the researcher is encouraged to participate in commercializing the invention, and to educate researchers in intellectual property rights. In terms of patenting and licensing at public research organizations so far in Norway, one third of the actors report having active patent portfolios. Only a little over half of the technology transfer offices apply for patents and in most of the reported cases, the institution retains some ownership claims while in half the reported cases so does the researcher.

The funding system

The funding environment has also undergone changes that over the years have brought academic and private-sector research together through direct and indirect encouragement to collaborate (and compete) with industry research (cf. NOU 2001:11). The main providers of funding are the Research Council and Innovation Norway, both of which promote commercialization and collaboration.

A current tendency in the Norwegian national system is the attempt to marry public and private capital to promote start-ups or fledgling enterprises, especially knowledge-based companies at early phases. The START-Fund (http://www.startfondet.no/about/) is the result of a relatively recent joint initiative between public and private interests, providing risk-capital and advisory services to start-up companies. Another new risk-tolerant investment company, co-owned by SIVA and Invanor, is Argentum. Its public endowment is of the order of 2.45 Billion NOK, and the investment fund will be independent and more than 50% of its

[13] The provision of a 'reasonable compensation' (in the Arbeidstakeroppfinnelsesloven i lov av l7.april 1970 nr.21: § 7) has been interpreted to mean a 3 way split of equal amounts to the researcher, his institute and the university. (with reference to the University of Copenhagen)

stock will be privately held. Its intention is to provide longer-term financing for innovative companies. It is not immediately clear how it in practice will complement the existing range of (semi-) public activity directed at financing and advising innovative activity in the private sector.

There is also bonus support linked to different programs for entrepreneurs targeting public research organizations in some areas.

The infrastructure for commercialization of research

The innovation infrastructure in Norway is currently undergoing a series of changes in order to move towards a more "integrated innovation policy". There are several agencies instrumental to the commercialization of academic research that are involved in this process of consolidation. These include the Research Council (NFR), The Industrial and Regional Development Fund (SND), the National Advisory Office for Inventors (SVO), and the Trade Council. NFR was recently reorganized and as of January 1st 2004, SND merged together with SVO, the Norwegian Tourist Board, and the Norwegian Trade Council into Innovation Norway (Innovasjon Norge, www.invanor.no) a single innovation and internationalization entity that will make it easier for entrepreneurs. NFR and Innovation Norway (Invanor) are the two main national bodies that provide funding and advisory services for start-ups, existing enterprises as well as university and institute based research. They are designed to fill complementary roles and are central to the public efforts to support new knowledge in Norway, and their networks shoot through the rest of the system. NFR and Invanor provide the basis for the two central pillars for supporting SME – academy interaction through the programs of MOBI and FORNY.

FORNY is the focal point of Norway's commercialization of academic research activity efforts. The program promotes and assists the generation of new ideas in the university sector's institutions, it helps researchers to explore the marketability of the ideas, and it assists during commercialization through its technology transfer offices. It also provides financial support for the commercialization of individual ideas from the university sector (incentivmidler: NOK 200 000), and is planning to expand operations to include supporting the commercialization of R&D from public and private companies as well.

The MOBI ("Mobilizing R&D related innovation") program has long been the mainstay for the relationship between university research and SMEs. MOBI's current portfolio includes measures to promote technology transfer between research-institutes and

SMEs (TEFT), measures to promote mobility between (regional) colleges and SMEs, as well as more general measures to improve the position of colleges in regional clusters.

Another important part of the innovation infrastructure has been the build up of research parks, incubators, and business parks from the mid 1980s until today. The Corporation for Industrial Growth (SIVA) is a state-owned, independently operated innovation hub that is involved in 60 innovation centers designed to bring together commercial, financial, and R&D activities. These include 40 business parks of which 12 are research parks (http://www.fin.no). The research parks (and aligned incubators) are located near central public research organizations and offer research facilities, special conditions for localization, advisory services especially related to licensing, and in some cases some seed-capital. They receive partial funding from FORNY to especially promote the commercialization of university-based research.

Norway's large institute sector is another important cornerstone of the infrastructure. The Norwegian institute sector[44] is very broad and diverse, with over 100 institutions reporting R&D activity. Today, these public research organizations increasingly develop their own technology-transfer activities

There is also a set of other instruments aiming at improving infrastructure and collaboration. These include for example new bonus support (linked to FORNY) for entrepreneurs targeting public research organizations in the areas of Marine Biotechnology and biochemical engineering, and the Innovation and technology program in Northern Norway (NT-programmet) which includes fellowships to link the university sector researchers to SMEs. It also includes a national center for innovation support and industrial development in the Health Sciences (50) (InnoMed) which has generally increased attention to biotech research, and SIMULA Research Laboratory, established in 2001, and adapting 'basic research' in information and communication technologies to business ideas. One of its areas of activities is an organizational model (EFFEKT) for commercialization among public research organizations.

The general support structure

Invanor also offers an array of instruments, which, in sum, combine funding and advisory services. Support is offered on a general basis to inventors, to entrepreneurs involved in starting up new enterprises and to those developing an existing enterprise. Invanor has regional offices and is developing a local presence in the districts as well, a role supplemented by SIVA. There is also a entrepreneurship center providing advice for entrepreneurs and

sponsored by Invanor. Otherwise, the focus on entrepreneurship has recently become a priority in Norway. This prioritization has readdressed many of the policy instruments that in effect bring SMEs and university research together in Norway. The current process to consolidate the support structure for innovation[14] addresses some of these.

In order to encourage smaller enterprises to patent application fees were reduced by 20 % in 2000[15]. In addition, the applicant group of enterprises of 20 employees or less will be exempt from the examination fee (NOK 2000) that was recently implemented.

Concluding remarks

So far, Norway has focused on the question of making more out of the large public investment in university sector research. It is now addressing how the institutional set-up can gear itself to the considerable challenge to commercialize academic research. This includes the development of strategies whereby the researcher is encouraged to participate in commercializing the invention, the need to develop the requisite human, institutional and regulatory resources, and methods to deal with research results which might benefit by commercialization but which are not patentable etc.

Concerning the general support structure this is built around advisory and financing. There is an expressed intention that there should be an apparent diversity of instruments for financing start-ups, pre-start-ups, growing companies. Some complaints have however been heard specifically about the high cost of borrowing from the funds, of the high costs of some research parks, and of a certain short-termism in the support-structure.

5.4. Iceland

The environment for the commercialization of academic research in Iceland has changed dramatically during the last decade. Research and development (R&D) inputs have almost tripled in the last 10-15 years following a large increase in private R&D spending, the university system has been transformed from a public university system to a mixed public-private system, the structure of public funding of research and innovation has been changed, and finally, new structure of public support for research and innovation is currently being implemented after changes in legislation. The following sections will provide a description of the current state of the environment for the commercialization of academic research in

[14] See the recent White Paper: St.prp nr 51 (2002-2003) Virkemidler for et innovativt og nyskapende næringsliv. (28.03.03)
[15] kgl.res. 7 april 2000 for endring av forskrift vedrørende avgifter for Patetstyret

Iceland. The environment may still be subject to change during as the reforms are implemented.

The universities

In 1997 the Icelandic parliament passed new legislation on universities. The legislation enabled the establishment of private universities, but previously all universities had been state owned. In 1997 there were only two universities, i.e. institutions with the privilege of granting university degrees. In 2003 the number had increased to nine, whereof three were private non-profit organizations. The University of Iceland is still the largest university in Iceland, both in terms of the number of students and the number of degrees offered. The newly established universities are more specialized, for example, focusing on degrees in business, computer science and law.

To what degree new universities should perform academic research and how this research should be funded has been much debated. One point of view has been that all research, and especially research within science and technology, should be performed within the University of Iceland. This research is then to be funded directly by the state through the financing of research positions as well as funds from research funds. Another point of view has been that all public funding of research should be channelled through research funds where researchers from all universities can compete for program and project grants. This issue has not been resolved. Currently only the state owned universities obtain direct public funding for research and public research funds are very small. Some of the private universities have, despite this situation, been able to build up research competence in science and technology through both public and private funding.

The increased number of universities has increased competition and diversity at the university level. While most observes agree that this has been positive for the university system as a whole, some are afraid that this situation is not sustainable. They point out that a small country like Iceland is unlikely to be able to afford the luxury of having many small universities. Current trends indicate that a consolidation will happen and the first step is likely to be the expected merger between Reykjavik University (a private university established by the Icelandic Chamber of Commerce) and The Technical University of Iceland (a public university). This merger will create a relatively large private university in Iceland providing degrees in engineering, business and law in addition to performing research within these fields.

The funding system

Funding of scientific research and technical innovation in Iceland has traditionally been through public funds. In 1991 70% of R&D inputs in Iceland were financed by the state. In 2001 only 34% of the inputs were financed by the state. At the same time R&D inputs as a percentage of GDP increased from 1,17% in 1991 to 3,06% in 2001 (RannÍs 2003). Both relative change in public and private funding of R&D and the increase in R&D inputs can be explained by increased private funding of R&D, while public funding has stayed much the same as a percentage of GDP. A large portion of this increase can be accounted for by a single firm, deCode Genetics, which was responsible for about one third of R&D inputs in Iceland in 2001.

Public funding of research and innovation is more or less through four mechanisms. First, university research is funded directly through paying for research positions at state owned universities and research institutes. For some universities this amounts to one third of total funds provided to them by the state. For example, an assistant professor, whose salaries are paid by the state, is likely to have 40% of his duties assigned to research. Research at private universities is not financed in this manner.

Second, research and innovation is financed through public research and innovation funds. Today, there are five such funds: The Research Education Fund (Rannsóknarnámssjóður), The Equipment Fund (Tækjasjóður), The Research Fund (Rannsóknarsjóður), The Technology Development Fund (Tækniþróunarsjóður) and the New Venture Fund (Nýsköpunarsjóður). Of these five funds the last three funds are the most important ones for the commercialization of academic research. The role of the Research Fund is to fund basic research (in all disciplines) and advanced technological development. The role of the Technology Development Fund is to fund technical innovation projects. The role of the New Venture Fund is to provide equity financing to young, innovative firms. Each fund is therefore positioned to provide funding through the progression from basic research to the early growth of young firms.

Third, research and innovation is financed through specific measures. These measures may include funding targeted at certain technological fields, such as biotechnology and nanotechnology or measures to strengthen research and innovation in rural areas.

Fourth, research and innovation is financed through grants from foreign research funds. Though not a member of the European Union (EU), Iceland is able to take part in a number of

EU research programmes, including the framework programs. As the participation in these programs is paid for by the state it can be seen as public financing of research and innovation.

The Icelandic government has stated its intent to increase the size and relative importance of competitive public funding of research and innovation. Today, only around 10% of public financing of R&D is provided by competitive funds. In a recent strategy document the government has promised to double the amount of competitive funds from 800 million ISK ($11 million) to 1.750 million ISK ($23 million) during the period 2003 to 2007 (The Icelandic Prime Ministry 2004). At the moment it is unclear how this increase will affect the direct financing of university research.

Private funding of research and innovation has mostly been associated with internal funding within firms of research and innovation projects. During the dot-com boom a number of private venture capital firms were established in order to invest in innovative start-ups, e.g. academic start-ups. Venture capital investments reached its height in the year 2000 and have almost disappeared since then. Those still involved in venture capital investments today are unlikely to fund start-ups, focusing instead on later stage financing.

The Infrastructure for Commercialization of Research

The description of the infrastructure for the commercialization of research is in three parts. The first will describe the overall infrastructure at the national level (macro-structure), and the second and the third will describe the infrastructure within universities and research institutes (micro-level) respectively.

Early in 2003 the Icelandic Parliament passed a new legislation on public support for research and innovation, which redefined the institutional structure for this support. The main purpose of this reform was to provide a better connection between science policies, on one hand, and technology/innovation policies on the other. Instrumental for this purpose was the creation of a new science and technology council. This council is headed by the prime minister and includes the minister of industry, the minister of education and the minister of finance as well as representative from other ministries, the research community and industry.

In addition to the creation of the new science and technology council the legislation specified an infrastructure to support scientific research and an infrastructure to support technology development and innovation. This infrastructure includes supporting agencies and the research and innovation funds described earlier. One of the supporting agencies, Impra, has the role of promoting technological development and innovation, including the commercialization of academic research.

In 2004 the Icelandic parliament passed a new legislation concerning the ownership of intellectual property rights to patentable inventions. The legislation is based on the Danish legislation but is more general. The legislation covers employee ownership in general and does not make any distinction between employees in the public and private sector. The legislation defines a framework for employee rights and the conditions when an employer can demand that these rights are transferred to the employer for a reasonable fee. Universities and research institutes are expected to implement this legislation in their employee contracts. The current practice is to divide the profits of the invention in three parts, where the inventor gets one part, the university/research institute gets one part, and one part is used for further research.

Among the universities in Iceland only the University of Iceland has an established infrastructure for the commercialization of academic research. The central element of this infrastructure is the Research Support Service (Rannsóknarþjónusta Háskólans).

The purpose of the Research Support Service (RSS) is to strengthen the relation between the University of Iceland and industry with regards to research, innovation and competence development. The RSS provides information about funding possibilities, assists with technology transfer and innovation, and runs an incubator for academic start-ups. The assistance provided by RSS can include a search for collaboration partners, business consultants or other experts that are needed, e.g. related to patent issues.

RSS does also administrative special initiatives for encouraging researchers within the University of Iceland to commercialize their research. One of these initiatives "Upp úr skúffunum" ("Out from the drawers") consists of an idea competition as well as seminars and other forms of consulting.

The University of Iceland has for the last couple of years prepared the establishment of an on-campus science park. The purpose of the science park is to create a cluster of knowledge intensive firms, research institutes and the university. Today, the future of the science park is uncertain as necessary participation and the funding of the park's premises has yet to be secured.

A number of research institutes are run by the public sector. These research institutes are closely linked to specific industrial sectors, e.g. fisheries, agriculture and the construction industry. The purpose of these research institutes is to support industrial firms through scientific research and other support activities.

One of the research institutes, the Technology Institute of Iceland, is specifically concerned with the development of emerging technologies, technology transfer and the

provision of various services for assisting with product development and innovation in new and existing firms.

The role of the research institutes is currently being debated. The sectorial division of research institutes has been questioned and more synergies could be created by a different structure.

The general support structure

At the policy level there has been an increased awareness of the importance of innovation for the future competitiveness of Iceland. This increased awareness has lead to the reforming of the public support for research and innovation as mentioned before. One important part of this reform was the establishment of the Impra support center.

The purpose of Impra is to provide information and support to entrepreneurs and small businesses. Impra runs a number of programs and courses to encourage and train entrepreneurs as well as one-on-one assistance. Incubator services are also provided for new firms. Impra has both a national and a regional presence.

The level of entrepreneurial activity is relatively high as compared to other European countries. There is no explicit policy for supporting entrepreneurship, nor any general measures to encourage people to start new firms, such as tax cuts. General conditions favour the establishment of new firms as formal requirements are straightforward and the cost is low.

In recent years there has been an increased awareness of the importance of universities for regional development. The establishment of regional universities has been seen as an important way to improve educational opportunities as well as strengthening industrial development. Since 1998 the University of Iceland has worked towards creating a network of regional research units. The purpose of these units is to create opportunities for research at the regional level in cooperation with local governments and firms.

Concluding remarks

Iceland has during the last decade experienced changes that might lead to an improvement of the environment for commercialization of academic research. These relate to the increased activities at universities, at the same time as there has been an increased diversification and specialization of the universities. There are doubts that a small country like Iceland can sustain such a number of universities, why a consolidation is expected to occur. This together with the effects of the other changes, however, remains to be seen.

6. Academic entrepreneurship and the policy environment

In line with the structure of the report, the following discussion has tried to distinguish between policies specifically related to the universities and more general measures. In doing so it is useful to separate entrepreneurial learning aiming at making researchers apt at founding businesses themselves from entrepreneurial learning aiming to familiarize researchers with commercialization for the benefit of the applicability of their research. Because even though the overarching goal is the same, policies that promote the latter does not necessarily work to simultaneously promote the former.

6.1. The universities

In the Nordic countries, Denmark was the first country to legislate a change in the teachers' exemption clause, introducing the change in 2000. But, apart from reforms on the management side of universities, there has been an absence of other supporting mechanisms such as patent offices, changes in the competitive research system, or university reforms etc. why the change in ruling has had little chance of making any impact on the system. In Iceland the clause was removed in 2004. The removal does not seem to have been coupled with any new supporting mechanisms. However, the University of Iceland already had an established structure for commercialization. In Norway, a new law removing the teacher exception was introduced in January 2003. The new ruling was announced together with a number of other measures such as funding for commercialization and support structures such as research parks, incubators, etc. While both Sweden and Finland have a whole surrounding infrastructure that likely would facilitate a change in legislation, the issue has been under study in both countries for some time. In May 2002, a new Act was introduced in Finland which proposed among other things changing the status quo with regard to the protection of intellectual property rights. However, the Act would be contractual, meaning the regulations would be applied if not contracted otherwise by the parties involved. In Sweden, there has been a debate as to whether remove the teacher exemption clause or not. The latest proposal is to maintain the clause and await the Danish experience.

The effects of the removal on commercialization of research remains to be seen, but one may question whether the legal issue matters that much. This not least because individual researchers may contract away their rights, and could, for example, make contractual agreements with the universities as to the rights of their findings. This was actually the case in Stanford where ownership rights were not turned over to the university until 1994. In practice

this had little effect as most researchers used the technology transfer office in any case (Mowery et al., 2001). It may thus rather be a question of initiatives on behalf of the universities, and whether the proper incentive structures, support structures, legal framework, and attitudes are at place to accommodate for promoting entrepreneurial learning in academic settings.

The incentive structure supporting initiatives to commercialize research relates both to individual researchers and to universities as a whole. Of the countries in the study, only Sweden has remained in status quo regarding ownership rights. In the other countries the removal seems to generally have been replaced by an incentive structure that makes a three-way split between the researcher/researchers, the department or research group, and the university, but with room for bilateral agreements. The reactions to this new structure remain unclear both from theory and practice due to the recent implementation and to the researchers' different perceptions of incentives and rewards. One could, on the one hand, argue that there are potentially less monetary rewards in the new structure. On the other hand, this could be outweighed by the universities efforts in the commercialization process. It also depends on the flexibility of the structure, something not entirely clear from this report, although bilateral agreements are applied at some places.

In any case, Henrikson (2002) doubts that a legislative change will, by itself, promote commercialization. This partly on the grounds that the competitive situation in the Nordic countries, and Europe, is less intense than in the US, and that the state-ownership of many universities will not provide enough incentives for the universities to engage in commercialization. In addition, Henrekson argues, the effects may not come about as the university structures are not sufficiently developed yet to provide the help needed and manage the commercialization, something which is also of concern in a recent OECD-report (OECD, 2003).

The Danish experience also tells us that removing the clause is in itself not a sufficient incentive for commercialization. A surrounding support structure in terms of incubators etc., and, more importantly, an immediate support structure within universities is also needed. However, it is costly to build such a structure. Commercialization is an avenue that is much more resource-intensive than the traditional channels of diffusion, and many universities in Sweden, for example, are quite cash strapped as it is. Their existing organizational structures are not even developed enough to deal with the growing demands from contract research, let alone dealing with IPR and commercialization issues. To the extent that support structures are in place, there are also complaints on the lack of competence on behalf of the universities to

accommodate for these activities, as shown in Finland. The costs imposed on universities in taking responsibility for the commercialization are moreover not easily compensated. Research from other EU countries and the US (e.g. Jensen & Thursby, 2001) shows that despite the policy attention and investment in commodification, the largest source of external income for most universities still comes from grants for specific projects rather than profits accrued from patents or licenses. It may also be noted that the process is time-consuming, thus further driving costs. While references often are made to American universities and the Bayh-Dole act in arguing for turning ownership rights over to the universities, it is less often considered that the support structures of some universities had been developed over decades before the change took place. MIT, for example, developed administrative units supporting commercialization activities already in the 1940s.

Therefore, even in cases where universities have the right to commercialize their knowledge, it has not led to much direct impact due to the present lack of competencies and resources to commercialize all of the knowledge in possession. There is thus a need for continued financial as well as policy support for the universities to make the organizational changes required in light of the new responsibilities, something that seems to have been the case in Norway to a certain extent. Such support is obviously very important for entrepreneurial learning within universities, regardless of whether it concerns the founding of firms or the commercialization process in general.

It is also important to consider what the existing support structures within the universities offer. While all the Nordic countries have made efforts to facilitate entrepreneurial learning within the universities, many of the advisory services tend to lean towards technology rather than the market. A lot of attention has, as the Swedish case suggests, been paid to IPR-related issues or advisory issues concerning the founding of a company. Less attention has been paid to create a flow of knowledge and information from the market side, something which could aid researchers and university staff in how to commercialize the technology, how to package the technology into a proper offer, or how to create viable business models etc. (Bower, 2003). The universities may also consider structures that aid them in recognizing potential commercial opportunities, for example, by bringing in “surrogate” entrepreneurs (Lockett et al., 2004). Such outside entrepreneurs could also be offered to exploit the opportunities. Universities may thus consider making room for more proactive administrative structures that takes both the technology and the market side of entrepreneurial learning into account, rather than just nurturing an IPR-portfolio. The latter is of course also of importance, and should be managed by experienced professionals, but it

must not be the sole focus. Moreover, as different scientific areas exhibit different requirement both regarding the IPR and the market side, it may be beneficial for universities to specialize in some of their core scientific areas, while only providing more general assistance in other areas.

There are also other changes in the legal framework concerning, for example, limited ownership of universities, i.e. foundation universities, and private universities. While this is a positive development there are still other legislative barriers to commercialization as well as academic entrepreneurship in the different Nordic countries. This ranges form rules prohibiting investments by research organizations in private firms to restrictions on public servants engaging in competing economic activities. While some have been circumvented, for example by the establishment of university holding companies, a review and possible revision will be needed in light of the new policy interests.

There is also a set of interrelated structural and cultural issues influencing entrepreneurial learning. A range of measures have been aiming at issues bringing universities closer to industry, or industry needs, or at promoting entrepreneurship. Examples are the representation of external stakeholders on university boards in the different Nordic countries, following a European trend (Hellström, 2004), and, with the exception of Iceland, efforts to promote an entrepreneurial culture. So far, however, these have not paid off as expected, which may partly be attributed to that it is still too early to see the effects. Partly, however, it may also be attributed to the social significance of the traditional academic culture (Ziman, 2000), and needed additional changes. The additional changes needed include the academic meriting system that still does not seem to have undergone changes making an entrepreneurial path a credible career option. Also, problems still seem to pertain to labor mobility in and out of the academe, since it is still problematic to take sabbatical leaves to engage in start-up activities. Such mobility is important as it enables entrepreneurial learning for the researchers engaging in commercialization activities, and since these researchers may bring important lessons back into their home departments. The problem of mobility is probably related to the ability of universities, and the resources available, to plan personnel recruitment flexibly and in a strategic fashion. The exact extent to which these barriers are present in the different Nordic countries remain, however, somewhat unclear from this study.

A final point to mention is the potentially long term dependencies for knowledge-intensive USOs on universities. While a study was carried out pointing to this in the Swedish context, the underlying rationale for the dependency seems to apply more generally. New ventures often lack resources and putting research with the university and development with

the firm becomes a natural, low cost, separation for these knowledge-intensive firms, albeit one that creates dependencies. In terms of entrepreneurial learning this is in one sense positive since the experiences of the start-up is diffused to the home departments through collaboration and joint PhDs. However, the dependencies also make the spin-offs vulnerable to public research funding policies.

6.2. The funding system and venture capital

Financing is one of the cornerstones for promoting entrepreneurship, and thus also influence entrepreneurial learning in university settings. It does so in two ways. Firstly through providing seed-, and venture capital, as well as specialized bonus programs targeting commercialization of research. Secondly, through public research funding policies in so far as these policies limits or enables opportunities for the commercialization of research.

Regarding the provision of capital or bonus programs, there has been a significant diversion of financial mechanisms available to SMEs in the Nordic countries. Newer financial support mechanisms include public and venture capital as well as the soft loans that characterize the last generation of SME support-programs. There has been a growth of a fledgling private venture capital market, but there is still a general consensus of opinion in all the Nordic countries that the current generation of venture capitalists is neither competent nor risk prone enough to meet the demands of the market. The recent downturn in the venture capital markets in Sweden and Denmark, and the virtual vanishing of the same in Iceland, are seen as confirmation of this. It also suggests that public venture capital will continue to play a significant role in the near future, especially in seed funding as is evident in the Finnish case. The specialized bonus support programs targeting academic entrepreneurs in general or in specific academic sectors, such as the FORNY programs in Norway, are also important to stimulate commercialization of research through start-ups. What might be added to the range of financial mechanisms though, is support mechanisms that focus on very early stage technological and economic verification of research. One could, for example, dispose of a small amount of the research budget in suitable research projects for such techno-economic verification, and even make such verifications a criterion of eligibility. Verification in such early stages would then likely facilitate screening in later stages.

Regarding the public research funding system, much effort has been devoted to promote collaborative research as a means of bringing universities closer to industry needs. The main approach utilized in both Sweden and Finland has been to make collaboration a criterion of eligibility for academic proposals seeking funding. This is achieved through the

reservation in both countries of a significant portion of available research funding to collaborative research and in increasing the dependence of public research organizations on competitive research by reducing the size of block grants to such institutions. There is an increasing trend towards competitive funding also in both Denmark and Norway, while Iceland is still far behind.

The promotion of collaborative research is in one sense a positive development as it increases the likelihood for knowledge transfer and thus commercialization. But there is a considerable difference of opinion among many of the actors involved as there is a concern that the role of the university may come to substitute for the R&D units of private companies. Many of the large firms for instance argue very strongly for a division of labor between corporate and public R&D which leaves the more speculative and future oriented research to publicly funded university projects while company money should be devoted to research with shorter turnaround times. In terms of academic entrepreneurship the development may also have some additional consequences. The increased reliance of researchers on external funds has had the effect that university researchers prefer to work with larger firms due to the limited funds of SMEs for commissioning R&D. While bringing academic researchers closer to industry may invoke an understanding and a learning of the needs of industry, the larger companies are not likely to engage in collaborative research unless rights to ownership of important parts of the research is secured. This would thus preempt the possibilities for the researchers themselves to engage in entrepreneurial activities. Here, the distinction between entrepreneurial learning in terms of commercialization of research and starting firms becomes important.

6.3. The infrastructure and the general support structure

Sweden and Finland may be regarded as front-runners with respect to innovation policy in general and with respect to policies for commercialization of research in particular. Unlike Sweden and Finland, innovation policy and the role of universities and commercialization of knowledge in such a policy is a recent phenomenon in Denmark, Norway and Iceland. These countries are thus somewhat less advanced but seen form a European perspective these countries are ranked quite high in terms of innovative performance. There has also been a considerable amount of benchmarking against each other and against countries outside the region, especially between Sweden and Finland, where, for example, Finland has borrowed from Sweden that in turned has glanced on the US. Collaboration within the EU and the Nordic Minister's council further adds to the similarities (Lemola, 2002). As a result, many

infrastructural schemes for commercializing research are similar, the small institute sector of Sweden not included. The overarching trend in the Nordic countries towards nurturing entrepreneurship in general is, to simplify, predominantly one of resource deficit with emphasis on finance and knowledge as the resources most needed. While there has been a diversion of financing mechanisms, as discussed above, there have also been a significant amount of efforts devoted to knowledge transfer and information mechanisms, not least through advisory offices, the regional development programs, and the different research park, and incubator schemes. The different schemes and services are often equally beneficial for academic entrepreneurs as for entrepreneurs in general, although there is a risk for a skew towards "hot" areas like biotech, information technology and SMEs in science parks. So far the promotion of entrepreneurship has not paid off, at least not in Sweden that is ranked quite low on entrepreneurial indexes (e.g. GEM, 2003). Finland, and especially Norway and Denmark are ranked better although there is lot of room for improvements. Iceland is the Nordic country coming out on top in these rankings which is notable as no particular efforts in this direction has been pursued.

6.4. Barriers and facilitators

The review of policies and their potential impact on academic entrepreneurship above reveals some apparent barriers and facilitators pertaining to entrepreneurial learning in academic contexts. Since the shift towards an increased responsibility for universities to accommodate for commercialization of research is still fairly recent while the process of change progress at its own pace, some of the barriers are similar to ones pointed at in previous research. The barriers and facilitators include:

- A lack of resources on behalf of the universities to accommodate for the competence and internal support structure needed in order to deal with the requirements that follow with an increased responsibility for commercialization. This especially as universities are not easily compensated for their taking part in commercialization, and since it takes time to establish the structures needed as suggested by the US experience. This is important as fostering entrepreneurial learning is dependent on qualified support in vicinity of the researchers, something that holds true whether the teacher's exemption clause is removed or not.

- The build up of university competence for accommodating the change to an "entrepreneurial university" has so far focused much on the technology side, i.e. on IPR etc. While this is important it only captures one part of entrepreneurial learning. The other part concerns the market side why more attention should be paid also to this. That is, on how technology is packaged and commercialized etc. This could be achieved through teaching, and from opening up for a knowledge flow from industry to university. There is a risk otherwise of applying the wrong mind-set to the commercialization of research, something which may hamper the business development process. Moreover, different scientific areas are likely to exhibit different requirements, why multiple but separate policies and competences may be needed also within universities. Alternatively universities may have to specialize in commercialization in some core scientific areas, while assisting other areas in a more general fashion.

- In line with previous research there are still obstacles to move in and out of the academe. This may be related to the ability of universities to flexibly and strategically recruit personnel, as well as to the problem of that the academic meriting system needs to take commercialization activities into account. These issues bear on entrepreneurial learning as they enable and motivate researchers to themselves engage in entrepreneurial activities, to learn from them, and to bring the experience back into the universities.

- Attention could also be paid to the effects policies have on the different channels of commercialization and whether they support each other or not. That is, policies influencing learning about industry needs and commercialization may not simultaneously promote entrepreneurial learning in terms of how to start firms, and vice versa.

- The entrepreneurial attitudes and culture is, apart from Iceland, still rather low in the Nordic countries. Continued efforts should be promoted, and could benefit from a simultaneous discussion on how the academic meriting system can be attuned to entrepreneurial efforts on behalf of researchers. It could also be beneficial to investigate what constraints are perceived as most serious by academic entrepreneurs,

to secure formal support from management, and to recognize incidents of successful cases in order to foster such a culture.

- Public venture capital, especially in pre-seed, and seed stages is likely to promote entrepreneurship in general, and bonus programs targeting academic entrepreneurs are likely to lower the threshold for experimenting with starting a new business. There seems to have been some shortage in the pre-seed, and seed financing stages in some of the Nordic countries, although there are also good examples of bonus support-programs in, for example, Norway, and public venture capital funding in, for example, Finland. Financial support could also address very early stage verifications though, both technical and economic, as this probably would facilitate screening in later stages. It could, for example, be integrated already as part of research budgets in suitable projects.

- The efforts in building an infrastructure of, for example, science parks and advisory offices, are beneficial for academic entrepreneurs and potentially so also for entrepreneurial learning. But there are indications that these at times are still not fine-tuned to the needs of the entrepreneurs, and that the infrastructure, in Denmark at least, may need a revision in light of the new policy objectives.

7. But is academic entrepreneurship an undivided good?

The above discussion has mainly focused on the barriers and facilitators for academic entrepreneurship, which may leave the unintended impression that academic entrepreneurship is unambiguously a good. However, this need not be the case at all times. The issue has so far mainly been debated among academics but should also be of concern for policy-makers.

In a climate where the responsibility of commercialization has been put on the agenda of the universities, at the same time as the universities are still bound to strongly institutionalized forms of academic conduct (Ziman, 2000), there are many points of tensions. These may arise from, for example, managerialism and professional leadership, and external Ph.D sponsorship (Hellström, 2004). Furthermore, the fact that there in some cases suddenly exists a "customer" for research results may impose risks of increased secrecy and withholding of research results for the wider research community. A recent OECD-report also warned against potential risks, pointing to that commercialization efforts might limit access to publicly funded research results, that it might affect the cost and efficiency of research, that it

might reorient research towards more lucrative fields, and lead to conflicts of interests (OECD, 2003: 10). The report notes that several OECD countries have begun to feel a backlash against commercialization activity which underlines the call for safeguards against such risks. The bottom line is that researchers as profit seeking, or sponsored by actors with a profit seeking interests, may be prone to replace a multilateral sharing practice between themselves and the many academics of relevance in a research collective, with a bi-lateral sharing practice vis-à-vis the funders in question (Hellström, 2004).

From the point of view of academics it may thus be argued that a too keen focus on commercialization of research runs the risk of damaging the academic imperatives which in turn could affect universities as knowledge creating entities in the long run. Critique has also been raised from industry, as concerns have arisen that the new orientation will be to the cost of longer term basic research that is not so commercializable.

In the end, however, it may not be a question about have or not to have academic entrepreneurship. The environment is changing, and with that also the role of the university. Besides, there is probably a broad consensus on the positive effects that also may come from researchers starting their own business, on the societal level as well as on that of the individual researchers and their research. The question is thus rather one of the terms on which it should be conducted, that is, that it should be done on terms that do not run the risk of damaging the academic imperatives that made it possible for such commercialization in the first place. It is moreover a question of who should conduct it. All research is not suited for commercialization, neither are all researchers suited to become entrepreneurs, in which case alternative solutions need to be implemented. These could, for example, include bringing in "surrogate" entrepreneurs to discover and exploit opportunities (Locket et al., 2004). Such a solution could increase both commercialization and entrepreneurial learning within the universities, without turning researchers themselves into entrepreneurs.

8. Conclusions and implications

The conclusions and implications then largely become ones of overcoming the barriers toward entrepreneurial learning, together with some additional considerations important for entrepreneurial learning within university settings. Some of the points follow in the line of earlier research, which is not surprising, though, since the shift is fairly recent and the processes of change take time. The review together with theory points to several needs, including:

- *Provide continued support to organizational development at universities*
  While support has been provided, making universities responsible for the commercialization of research is a major shift that is not easily compensated and that takes time to adapt to (cf. the history of the American universities). Thus, there is a need for continued financial and policy support in order to build the competence and management support needed to reorient the university structures towards the new mission.

- *Increase focus on business competence*
  Much attention has been paid to technology and IPR-issues etc. While this is very important, it is equally important to pay attention to issues such as how to package a technology into an offer, how to construct a viable business model, how to grow etc. Since this is not a traditional area of expertise for universities, industry experience may be needed to support this.

- *Create competence and policies able to manage the diversity*
  Academic entrepreneurship is not a homogeneous activity, but the requirements can vary a lot in a software company compared to biotech company. Therefore, competence-, and policy-building needs not only be concerned with the general requirements of academic entrepreneurship but create awareness and competence for the specific requirements of various sectors. Alternatively, universities may need to focus to a certain extent on their respective core areas of research..

- *Facilitate for researchers to move between the university and business sectors*
  Entrepreneurial learning may be greatly increased by participation in commercialization efforts. This, however, presupposes mobility in and out of academia why remaining obstacles should be revised and removed. This issue is also related to restrictions on the ability to flexibly and strategically recruit personnel within universities, why the structure for this needs to be enhanced.

- *Create incentives for individual academics to commercialize their knowledge*
  This relates to the preceding point and refers in particular to attuning the academic meriting system to the new mission so that an entrepreneurial path can become a

credible career option. A review is may also be needed on how revenue-sharing and university support has been perceived by researchers in the countries where the teacher's exemption clause has been removed.

- *Promote an entrepreneurial culture*
  Entrepreneurial attitudes could be further promoted on a university level, for example by recognize incidents of successful cases, provide explicit formal management support, and to review the perceived concerns of the researchers. This is also a regional problem, for which promotional efforts in terms of entrepreneurship programs, educational programs etc. should be continued.

- *Pay attention to the academic imperatives*
  Commercialization of research is beneficial only in so far as it is compatible with the long-run mission of universities in society, that is, the other two missions of the university. Moreover, researchers may not always be best suited, neither to discover nor exploit opportunities, why alternative mechanisms such as bringing in "surrogate" entrepreneurs may be brought in. Such mechanisms may, in addition, by themselves promote entrepreneurial learning among researchers.

These points refer to improvements that can be made within the university structure, and primarily relates to the phases when an idea is conceptualized and a venture about to be founded. In addition to the points presented it may also be mentioned, albeit more briefly, that competence could be further strengthened in areas such as the venture capital industry, and incubator schemes etc. Support could also be provided for techno-economic verification or evaluation already at the closing of research programs or projects in order to facilitate the screening process in later stages. Finally, awareness should also be created of the potential interferences of different policies aimed toward increased commercialization.

Chapter 5:

Policy summary

The culture and competence of the Nordic universities must to be forcefully developed to reach the level of entrepreneurship and thereby be able to compete with the leading "entrepreneurial universities" on an international level.

Early in their development all successful spin-off companies' management need to find the right technology solutions, products/services and the business model to be able to survive and grow, and this is done through entrepreneurial learning. The normal university is sometimes a very good context for early development of new technology but is rarely a good place for industrialization of this technology or for the development of advanced commercial knowledge and skills. The university context needs to be complemented with such capabilities near to its own core activities, education and research, to make the flow of technology and business competence greater and to increase the economic impact in society of university spin-offs. Most technology entrepreneurs need to focus on experimental business model learning very early on in the process, and keep doing so until a first market segment is verified through repeatedly successful sales. Failure to do so may greatly reduce the likelihood of survival and growth. Most ventures at the university put relatively to little effort into hard commercial learning and devote relatively speaking to many resources on developing the technology and the products. This is due to a cultural and competence lack of fit between the commercial world and the academic world that has to be harmonized to radically increase the economic value of university spin-offs. This needs to be taken into account by policy makers and university management when policies and actions are designed. Often this is presently not the case.

The most important "measurement data" in the early commercial experiments are what customers that are willing to pay for what the company offers, as well as information on cost and quality of needed resources. It is important that business models are sought that makes this possible early on in the process so that the learning process is accelerated. This has to be taken into account when policymakers design new policies and when university management takes action towards the "entrepreneurial university". The following action points have been formulated with these requirements in mind.

- There are specific implications for improving the support for academic entrepreneurs in the Nordic countries: Firstly, there is a need to strengthen the early stage venture capital industry in the Nordic countries. Not only is there a need to increase the expertise of venture capital investors, it is also important that venture capitalists can signal their competence to both their own investors and of course to the entrepreneurs. The transparency of the competence of venture capitalist in university spin-off contexts must be enhanced to increase competition among VCs and to drive quality improvements. This can be done by the development of a net based quality measurement facility covering all Nordic early stage VCs and how they perform according to entrepreneurs and fund investors. This is an important area for initiatives from such policy analysts and policy creators as Nordic Innovation.

- The Nordic initiatives for increased supply of entrepreneurial competence, entrepreneurship education programs, shows promising signs and increased activity level even if the output of specially trained high tech entrepreneurs still is to low. Policy-makers should thus not be misled to believe that enough has already been done to stimulate the creation of high-growth firms at Nordic universities.

- While a large number of the identified programs include at least some component that supports experiential learning, there are *still several programs with an almost exclusive focus on traditional pedagogical means*, and a primary aim of improving students' analytical management knowledge. These means are *not sufficient* to convey a substantial understanding of the situation dependent, highly complex situations that are encountered in entrepreneurial processes relating to sophisticated products and services. University management that want to create increased flow of technology to society by using education as a force need to open their laboratory doors in a systematic way to entrepreneurs and to entrepreneurship programs. Promising such programs are under development is Norway and Sweden. In these universities, *commercializable research results from the university research groups are used as input to the student projects, thereby contributing actively to the commercialization of research*. So far this is an underexploited mechanism for promoting academic entrepreneurship, which could be used more widely and be stimulated by policy makers. While there are several entrepreneurship programs in the field of business administration, there are only a few that build upon basic studies in science, technology and medicine, where the real opportunities for creating new high-growth firms are apparently larger. *Consequently, a focus on entrepreneurship programs closely related to science, engineering and medicine should be promoted strongly along the line with attempts in Norway and Sweden.*

- Teachers with hands-on experience from entrepreneurial ventures are needed: Special policy means should be taken to stimulate the appointment of adjunct professors and "resident entrepreneurs" from the international academic entrepreneurship community to complement the normal academic faculty and to infuse relevant commercial knowledge, network and skills.

- Provide continued support to entrepreneurial capability development at universities: While support has been provided, making universities responsible for the commercialization of research is a major shift that is not easily compensated and that takes time to adapt to (cf. the history of the American universities). Thus, there is a need for continued financial and policy support in order to build the competence and management structures needed to reorient the university organizations towards the new mission.

- Increase focus on business competence: Much attention has been paid to technology and IPR-issues etc. While this is very important, it is more important to pay attention to issues such as how to package a technology into a complete commercial offer, how to construct a viable business model and how to grow a new business. Since this is not a traditional area of expertise for universities entrepreneurship experience is needed to support this.

- Need for resources to verify and make new technology from research "investable": Even if the early stage venture capital situation has been developing positively during

2004 the need for society to take risk in early stages of venture development is still great. Especially important is to continue and sometimes expand the support for incubators and early seed capital and to increase the competitive performance game among actors. There is however an unfulfilled need for money and new processes for "techno-economic commercial verification" and packaging of promising research results from universities and research institutes. Policy makers should force all government sponsored research programs to set aside 10-20 % of the total research funds for such activities and invite entrepreneurial expertise to prioritize among applications for such resources. The corresponding amount should be given to these research financing bodies not to decrease the amount of scarce resources that go into actual support, several areas are already "underinvested"

- Create competence and policies able to help manage diversity of technological domain: Also universities may need to focus on entrepreneurial learning in their respective core areas of research. Policy makers should increase the stimuli for such specialization.

- Facilitate for researchers to move between the university and business sectors: Entrepreneurial learning may be greatly increased by participation in commercialization efforts. This, however, presupposes mobility in and out of academia and is why remaining obstacles should be removed by university management and by policymakers. This issue is also related to restrictions on the ability to flexibly and strategically recruit personnel within universities, and is why the structure for this needs to be improved.

- Create incentives for individual academics to commercialize their knowledge: This relates to the preceding point and refers in particular to attuning the academic merit system to the new mission, so that an entrepreneurial path can become a credible career option and thereby help drive entrepreneurial learning.

- Promote an entrepreneurial culture: Entrepreneurial attitudes could be further promoted at universities, for example by recognizing incidents of successful cases, providing explicit formal management support, and to review the perceived concerns of the researchers. This is also a regional problem, for which promotional efforts in terms of entrepreneurship programs, educational programs etc. should be continued.

Pay attention to the academic imperatives: Researchers may not always be best suited neither to discover nor to exploit opportunities. This is why alternative mechanisms such as bringing in "surrogate" entrepreneurs into the labs may be used. Such mechanisms may, in addition, by themselves promote entrepreneurial learning among researchers. Policy schemes may be developed to reward for progressive university management, no rules need to be changed to be able to do this.

References

Aldrich, H. E. (1999). *Organizations Evolving*. Sage Publications: London.

Aldrich, H. E. and Martinez, M. (2003). Entrepreneurship as social construction: A multi-level evolutionary approach. In: Acs, Z. J. and Audretsch, D. B. (Eds.), Handbook of Entrepreneurship Research, pp. 359-400, Kluwer Academic Publishers: Boston.

Amit, R., and Zott, C. (2002). Value drivers of e-commerce business models. In: M.A. Hitt, R. Amit, C. Lucier and R.D. Nixon (eds.) *Creating Value: Winners in the New Business Environment,* pp. 15-47, Oxford, UK: Blackwell Publishers.

Andersson T., Asplund O., Henrekson M. (2002). *Betydelsen av Innovationssystem - utmaningar för samhället och för politiken*, VFI 2002:1.

Andren, L., Magnusson, M., and Sjölander S. (2003). Opportunistic adaptation in start-up companies. *International Journal of Entrepreneurship and Innovation Management*. 3(5,6), p. 546.

Ardichvili, A., R. and Cardozo, S. Ray. (2003). A Theory of Entrepreneurial Opportunity Identification and Development. *Journal of Business Venturing,* 18, 105-123.

Argyris, C. (1993). *Knowledge for Action*. San Francisco: Jossey-Bass.

Argyris, C. and Schön, D. (1978). *Organizational learning: A theory of action perspective.* Reading, MA: Addison Wesley.

Asheim, B. T. (2002). Regional Innovation Systems: The Integration of Local 'Sticky' and Global 'Ubiquitous' Knowledge, *Journal of Technology Transfer*, 27(1), 77- 86.

Audretsch, D.B. and Stephan, P. (1996). Company-Scientist Locational Links: the case of Biotechnology, *American Economic Review*, 86(3), 641-652

Bandura, A. (1986). *Social Foundations of Thought and Action*. Englewood Cliffs, NJ: Prentice-Hall.

Baron, R. A. (1998). Cognitive mechanisms in entrepreneurship: why and when entrepreneurs think differently than other people. *Journal of Business Venturing*, 13, 275-294.

Bhave, M. P. (1994). A process model of entrepreneurial venture creation, *Journal of Business Venturing*, 9, 223-242.

Bhidé, A. (2000). *The Origin and Evolution of New Business*. New York: Oxford University Press.

Bhidé, A. V., (1994). How entrepreneurs craft strategies that work. *Harvard Business Review*, 72, 150-161.

Bhidé, A. V. (2000). *The Origin and Evolution of New Business*. New York, USA: Oxford University Press.

Boland, R. J. and Tenkasi, R. V. (1995). Perspective making and perspective taking in communities of knowing. *Organization Science*, 6(4), 350-372.

Bower, J. (2003). Business model fashion and the academic spinout firm. *R&D Management*, 33(2), 97-106.

Burgoyne, J. G. and Hodgson, V. E. (1983). Natural learning and managerial action: a phenomenological study in the field setting. *Journal of Management Studies*, 20(3), 387-99.

Bygrave, W. D.and Timmons, J. A. (1992). *Venture Capital at the Crossroads*. Boston, MA: Harvard Business School Press.

Cantwell, J. Ed. (1994). *Transnational Corporations and Innovatory Activities*. UN Library on Transnational Corporations, Vol. 17, London: Routledge.

Carayannis, E., Rogers, E., Kurihara, K. and Allbriton, M. (1998). High technology Spin-offs from government and R&D laboratories and research universities. *Technovation*, 16, 1-11.

Carlsson, B., Jacobsson, S., Holmén, M. and Rickne, A. (2002). Innovation systems: analytical and methodological issues. *Research Policy*, 31, 233-245.

Chandler, G. N. and Jansen, E. (1992). ”The founders self-assessed competence and venture performance.” *Journal of Business Venturing,* 7: 223-236.

Chesbrough H., and Rosenbloom R.S., (2002). The role of the business model in capturing value from innovation: evidence from Xeroc Corporatio´s technology spin-off companies. *Industrial and Corporate Change*, 11, 529-555

Chesbrough, H., R. S. Rosenbloom. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change* 11(3), 529-555.

Christensen, C. M. (1997). *The Innovator's Dilemma – When New Technologies Cause Great Firms to Fail*. Boston, MA: Harvard Business School Press.

Clarysse, B., Heirman, A.and Degroof, J.-J. (2000). An institutional and resource based explanation of growth patterns of research based spin-offs in Europe. In P. Reynolds, E. Autio, C. Brush, W. D. Bygrave, S. Amigart, H. J. Sapienza and K. G. Shaver (Eds.), *Frontiers of Entrepreneurship Research.* Wellesley, MA.: Babson College, pp. 545-559.

Cohen, W. M. and Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly,* 35, 128-152.

Coleman, J. S. (1976). Differences between experiential and classroom learning. In M. T. Keeton (Ed.), *Experiential Learning*. Washington, Jossey-Bass Publishers, pp. 49-61.

Coleman, J. S. (1976). Differences between experiential and classroom learning. In Keeton, M. T. (Ed.), *Experiential Learning*, pp. 49-61, Jossey-Bass Publishers: Washington.

Cooper, A. C. & Daily, C. M. (1997). Entrepreneurial teams. In D. L. Sexton & R. W. Smilor (Eds.) *Entrepreneurship 2000.* Chicago, IL: Upstart, pp. 127-150.

Cooper, S. (2000). The technical entrepreneur. In Carter, S. and Jones-Evans, D. (Eds.), *Enterprise and Small Business: Principle, Practice and Policy*. Prentice-Hall: Harlow, pp. 220-241,

Cope, J. and Watts, G. (2000). Learning by doing - An exploration of experience, critical incidents and reflection in entrepreneurial learning. *International Journal Of Entrepreneurial Behaviour & Research*, 6, 104-124.

Daft, R., K. Weick. (1984). Toward a Model of Organizations as Interpretation Systems. *Academy of Management Review,* 9(2): 284-295.

Daft, R.L., and Weick, K.E., (1984). Towards a model of Organizations as Interpreting systems. *The Academy of Management Review*, 9, 284-295.

David, P. (1975). *Technical Choice, Innovation and Economic Growth.* Cambridge University Press, London.

David, P. (1985). Clio and the Economics of QWERTY. *AEA Papers and Proceedings*, May, pp. 332-334.

David, P. (1988). Path-dependence: Putting the past into the future of economics. *Technical Report No. 533*, Institute for Mathematical Studies in the Social Sciences, Stanford University.

David, P. (1988). Path-dependence: Putting the past into the future of economics. *Technical Report No. 533*, Institute for Mathematical Studies in the Social Sciences, Stanford University.

Deci, E. L. (1992). On the nature and function of motivation theories. *Psychological Science,* 3(3), 167-171.

Deiaco, E., Giertz, E.and Reitberger, G. (2002). *Teknikparkens roll i det svenska innovationssystemet.* Stockholm: VINNOVA.

Delmár, F. (2000). The psychology of the entrepreneur. In:Carter, S. and Jones-Evans, D. (Eds.), *Enterprise and Small Business: Principle, Practice and Policy.* pp. 132-154, Prentice-Hall: Harlow.

Di Gregorio, D. and Shane, S. (2003). Why do some universities generate more start-ups than others? *Research Policy*, 32 (2), 209- 228

Edmondson, A.C. (2002). The Local and Variegated Nature of Learning in Organizations: A Group-Level Perspective. *Organization Science*, 13: 128-146.

Etzkowitz, H. and Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. *Research Policy*, 29, 109-123.

Etzkowitz, H., Webster, A., Gebhardt, C. and Terra, B. R. C. (2000). The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. *Research Policy*, 29, 313-330.

European Commission (2002). *Towards a European Research Area - Science, Technology and Innovation: Key Figures 2002*. http://europa.eu.int/comm/research/era/pdf/indicators/benchmarking2002_en.pdf

Eurostat. (2003). *New Cronos database*.

Festinger, L. (1957). *A Theory of Cognitive Dissonance*. Stanford, CA: Stanford University Press.

Fiol, C.M., Lyles, M.A. (1985). Organizational Learning. *Academy of Management Review*, 10, 803-813.

Gartner, W.B., Carter, N.M. and Hills, G.E. (2003). The language of opportunity. In C. Steyaert and D. Hjorth (Eds.). *New Movements in Entrepreneurship*. London: Edward Elgar, pp. 103-124

GEM (2003). *Global Entrepreneurship Monitor, 2003 Executive Report*. See www.gemconsortia.org

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, C., Scott, P., and Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Society*. London: Sage Publications.

Goldfarb, B. and Henrekson, M. (2003). Bottom-up versus top-down policies towards the commercialization of university intellectual property rights. *Research Policy*, 32(4), p. 639-659.

Granstrand, O. (1998). Towards a theory of the technology-based firm, *Research Policy* 27, 465–489.

Granstrand, O., and Sjölander, S. (1990). Managing innovation in multi-technology corporations, *Research Policy* 19, 35–60

Hedman, J. and Kalling, T. (2002). *IT and Business Models – Concepts and Theories*. Liber AB, Lund, Sweden.

Hellström, T. (2004). Between a rock and a hard place: Academic institutional change and the problem of collective action. *Higher Education*, 48(4), 511-528.

Henrekson, M & Rosenberg, (2001). Designing Efficient Institutions for Science-Based Entrepreneurship: Lessons from the US and Sweden. *Journal of Technology Transfer*, 26(3).

Henrekson, M. 2002. *Strategier för en framgångsrikare kommersialisering av svensk*

Hill, R.C. and Levenhagen, M. (1995). Metaphors and Mental Models: Sensemaking and Sensegiving in Innovative and Entrepreneurial Activities. *Journal of Management*, 21(6): 1057-1074.

Hoffman, K; Parejo, J., Bessant, J. and Perren, L. (1998). Small Firms, R&D, technology and innovation in the UK; a literature review, *Technovation* 18 (1), 39– 55.

Hyytinen and Väänänen (2003). Government funding of small and medium-sized enterprises in Finland, in Hyytinen, A. and Pajarinen, M., (eds.), *Financial Systems and Firm Performance: Theoretical and Empirical Perspectives*, ETLA B.

Ingram, P. and Baum, J.A.C. (1997). Opportunity and Constraint: Organizations' Learning from the Operating and Competitive Experience of Industries. *Strategic Management Journal*, 18 (summer special edition): 75-98.

Jack, S.L. and Anderson, A.R. (1999). Entrepreneurship education within the enterprise culture – Producing reflective practitioners, *Journal of Entrepreneurial Behaviour & Research*, Vol. 5, pp. 110-130.

Jensen, R., M. Thursby (2001). Proofs and prototypes for sale: The tale of university licensing, *American Economic Review*, 98(1), 240-259.

Johansson, M. (2005). Barriers and facilitators to entrepreneurial learning at universities: The case of the Nordic countries. Mimeo, Department of Innovation Engineering. Göteborg, Chalmers University of Technology.

Johansson, M., Hellström, T., and Merle, J. (2005). The strength of strong ties: University spin-offs and the significance of historical relations. *Journal of Technology Transfer*, forthcoming.

Karaömerlioglu, D.C. and Jacobsson, Staffan (2000). The Swedish Venture Capital Industry - An Infant, Adolescent or Grown-up? *Venture Capital*, 2, 61-88.

Kassicieh, S. K., Radosevich, R., and Umbarger, J. (1996). A Comparative Study of Entrepreneurship Incidence Among Inventors in National Laboratories. *Entrepreneurship Theory and Practice*, 20(Spring), 33-49.

Kaufmann, A. and Tödtling, F. (2002). How effective is innovation support for SMEs? An analysis of the region of Upper Austria, *Technovation*, 22, 147-159.

Kolb, D. A. (1984). *Experiential Learning*. Englewood Cliffs, NJ: Prentice Hall.

Kolb. D. A. and Fry, R. (1975). Toward an applied theory of experiential learning. In Cooper, C. (Ed.), *Theories of Group Process*. John Wiley: London.

Kolvereid, L. and Moen, O. (1997). Entrepreneurship among business graduates: does a major in entrepreneurship make a difference?, *Journal of European Industrial Training*, 21, 154-160.

Kuhn, T. S. (1969). *The Structure of Scientific Revolutions*, Second Edition. Chicago Univerity Press: Chicago.

Kuratko, D.F. (2003). Entrepreneurship education: emerging trends and challenges for the 21st century, *2003 Coleman Foundation White Paper Series for the U.S. Association of Small Business & Entrepreneurship.*

Kutinlahti, Pirjo & Elo, Niina (2003). Ideoista innovaatioksi: IPR-politiikan soveltaminen, sopimuskäytännöt ja tukipalvelut VTT:llä. VTT:n sisäinen raportti. VTT Teknologian tutkimus & Lexwell Oy. Painamaton.

Lave, J. (1988). *Cognition in Practice: Mind, mathematics, and culture in everyday life*. Cambridge, UK: Cambridge University Press.

Lemola, T. 2002. Convergence of national science and technology policies: the case of Finland. *Research Policy*, 31, 1481-1491.

Lester, R. K., Piore, M. J. and Malek, K. M. (1998). Interpretive Management: What General Managers Can Learn from Design, *Harvard Business Review*, March-April, 86-96.

Lockett, A., Wright, M., and Franklin, S. (2003). Technology Transfer and Universities' Spin-Out Strategies. *Small Business Economics*, 20, 185-200.

Magretta, J. (2002). Why Business Models Matter. *Harvard Business Review*, 80(5), 86-92.

March, J., H. Simon. (1958) *Organizations*. New York: Wiley.

Markides, C. and Charitou, C.D. (2004). Competing with dual business models: A contingency approach. *Academy of Management Executive*, 18, 22-36.

Markman, G. D., Gianiodis, P. T., Phan, P. H., and Balkin, D. B. (2004). Entrepreneurship from the Ivory Tower: Do Incentive Systems Matter? *Journal of Technology Transfer*, 29, 353-364.

McQueen, D. H. and Wallmark, J. T. (1982). Spin-off Companies from Chalmers University of Technology. *Technovation,* 1, 305–315.

Ministry of Trade and Industry (2002). *Efficient commercial utilisation of universities' inventions* (Korkeakouluissa tehtävien keksintöjen tehokas kaupallinen hyödyntäminen). Reports of Working Groups 6.

Ministry of Trade and Industry (2003). *Evaluation of the Finnish Innovation Support System.* Ministry of Trade and Industry, Publication 5/2003. Edita Publishing Ltd.

Mintzberg, H., Ahlstrand, B. and Lampel, J. (1998). *Strategy Safari: A Guided Tour through the Wilds of Strategic Management*, New York, Free Press.

Mitchell, D.W. and Coles, C.B. (2004). Business model innovation breakthrough moves. *Journal of Business Strategy*, 25(1), 16-26.

Mitchell, R. and Chesteen, S. (1995). Enhancing entrepreneurial expertise: Experiential pedagogy and the new venture expert script. *Simulation and Gaming*, 26(3), 288-306.

Mowery, D., R. Nelson, B. Sampat and A. Ziedonis (2001). The Growth of Patenting and Licensing by U.S. Universities: An Assessment of the effects of the Bayh-Dole Act of 1980, *Research Policy* 30, 99-119.

Murray, F. (2002). Innovation as co-evolution of scientific and technological networking: exploring tissue engineering. *Research Policy,* 31, 1389-1403.

Mustar, P. (1998). Partnerships, configurations and dynamics in the creation and development of SMEs by researchers. *Industry and Higher Education*, 217-221.

Mytelka, L. K. and Smith, K. (2002). Policy learning and innovation theory: an interactive and co-evolving process. *Research Policy*, 31, 1467-1479.

Nelson R. (ed.). (1993). *National Systems of Innovation: A Comparative Study*. Oxford: Oxford University Press.

Nicholls-Nixon, C., Cooper, A. C. and Woo, C. Y. (2000). Strategic Experimentation: Understanding Change and Performance in New Ventures. *Journal of Business Venturing,* 15, 493-521.

Nicholls-Nixon, C.L., Cooper, A.C., Woo, C.Y., (2000). Strategic experimentation: Understanding Changes and Performance in New Ventures. *Journal of Business Venturing*, 15, 493-521.

Nonaka, I. and Takeuchi, H. (1995). *The Knowledge-Creating Company*. New York: Oxford University Press.

Nordic Industrial Fund (2001). *Seed Capital in the Nordic Countries: Best Practices.* Oslo: Nordic Industrial Fund.

Normann, R. (1977). *Management for Growth*. Chichester: John Wiley & Sons.

O'Driscoll, G. and Rizzo, M. (1985). *The Economics of Time and Ignorance*. Basil Blackwell: Oxford.

O'Driscoll, G. and Rizzo, M. (1985). *The Economics of Time and Ignorance*. Oxford: Basil Blackwell.

OECD (2002). *Benchmarking Industry-Science Relationships*. Paris: OECD

OECD (2002). *Small and Medium Sized Enterprise Outlook*. Paris: OECD.

OECD (2002). *STI Review*, no. 27, Special Issue on New Science and Technology Indicators. Paris: OECD

OECD (2003). *Turning Science into Business: Patenting and Licensing at Public Research Organizations*. Paris: OECD.

Peterman, N.E. and Kennedy, J. (2003). Enterprise Education: Influencing Students' Perceptions of Entrepreneurship, *Entrepreneurship Theory and Practice*, Winter, 129-144.

Pirnay, F., Surlemont, B.and Nlemvo, F. (2003). Toward a Typology of University Spin-offs. *Small Business Economics,* 21, 355-369.

Popper, K. (1959). *The Logic of Scientific Discovery*. Routledge Kegan & Paul: London.

Powers, J. B. and McDougall, P. P. (2005). University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship. *Journal of Business Venturing*. forthcoming

Proposition 40 to the Odelsting: Ot prp. Nr 40 (2001-2002): § 2 nr. 4.

Proposition No. 67 to the Odelsting (2001–2002).

RannÍs (2003). R&D Statistics 2003. Reykjavik, RannÍs.

Regeringens proposition 2000/01:3. Forskning och förnyelse. Stockholm: Fritzes

Roberts, E. B. (1991). *Entrepreneurs in High Technology – Lessons from MIT and Beyond*. New York: Oxford University Press.

Sanz-Velasco, S. A. (2004). *The Evolution of Entrepreneurial Opportunities – A pragmatic approach*. Licentitate thesis. Chalmers, Göteborg, Sweden.

Sapienza, H. J.and De Clercq, D. (2000). Venture Capitalist-Entrepreneur Relationship in Technology-Based Ventures. *Enterprise & Innovation Management Studies,* 1, 57-71.

Sarasvathy, S., N. Dew, S. Velamuri, S. Venkataraman. (2003). Three Views of Entrepreneurial Opportunity. In *Handbook of Entrepreneurship Research*, eds. Z. Acs and D. Audretsch, pp. 141-160. Kluwer Academic Publishers.

Seed Capital in the Nordic Countries: Best Practice. A report prepared for the Nordic Industrial Fund. 2002. (http//www.nordicinnovation.net/)

September 2000, also available from www.fritzes.se

Shane, S. (2000). Prior Knowledge and the Discovery of Entrepreneurial Opportunities. *Organization Science.* 11(4), 448-469.

Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science*, 11, 448-469.

Shane, S. (2003). *A General Theory of Entrepreneurship: The Individual-Opportunity Nexus*. Aldershot, UK: Edward Elgar

Shane, S. (2004). *Academic Entrepreneurship. University Spinoffs and Wealth Creation.* Cheltenham: Edward Elgar.

Shane, S. and S. Venkataraman. (2000) The promise of entrepreneurship as a field of research. *Academy of Management Review* 25(1): 217-226.

Siegel, D.S., Waldman, D. and Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study, *Research Policy*, 32(1), 27-48.

Sjölander, S. and Hellström, T. (2005). A theory of entrepreneurial learning. Mimeo, Department of Innovation Engineering. Göteborg: Chalmers University of Technology.

Sjölander, S. and Magnusson, M. (2002). *Entrepreneurial Discovery, Resource Transformation and the Growth of the Firm*. Presented at the Babson-Kauffman Entrepreneurship Research Conference, University of Colorado at Boulder, June 6-8.

Smith, K. (1997. Economic Infrastructures and Innovation Systems. In Edquist, C. (ed.) *Systems of Innovation: technologies, institutions and organizations*. London: Pinter.

Smith, N. R. (1967). *The entrepreneur and his firm: The relationship between type of man and type of company.* Occasional Paper, Bureau of Business and Economic Research, Graduate School of Business Administration, Michigan State University, Michigan.

Star, S. L. and Griesemer, J. R. (1989). Institutional Ecology, "Translations" and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." *Social Studies of Science*,19, 387-420.

The Icelandic Prime Minstry (2004). *Science and Technology Policy*. Reykjavík, The Icelandic Prime Minstry.

Tuomaala, E., Raak, S., Kaukonen, E. Laaksonen, J., Nieminen, M. & Berg, P. (2001). Research and Technology Programme Activities in Finland. *Technology Review*, 106/2001. Tekes. Helsinki.

Universitetsforskning. *Ekonomisk Debatt*, årg. 30, Nr. 2. 2002.

Venkataraman, S. (1997). The distinctive domain of entrepreneurship research. In *Advances in Entrepreneurship, Firm Emergence and Growth*, ed. J. Katz. Greenwich, CT: JAI Press.

Voelpel S.V., Leibold M., and von Krogh G., (2003). *Escaping the Red Queen effect in competitive strategy-How managers can change industry rules by sense-testing their business models,* Working Paper #03-18, Harvard Business School, August 2003.

Vygotsky, L.S. (1978). *Mind in Society*. Cambridge, MA: Harvard University Press.

Weick, K. (1979). *The Social Psychology of Organizing.* Reading, MA: Addison-Wesley.

Willquist, P. (2001). *On the Influence of Venture Capitalist-Entrepreneur Interaction in Technology-Based Venture Development*. Licentiate thesis, Chalmers University of Technology, Göteborg.

Witt, U. (2000). Changing Cognitive Frames – Changing Organizational Forms: An Entrepreneurial Theory of Organizational Development. *Industrial and Corporate Change* 9(4), 733-755.

Woo, C., Daellenbach, U. and Nicholls-Nixon, C. (1994). Theory Building in the Presence of Randomness: The Case of Venture Creation and Performance. *Journal of Management Studies*, 31(4), 507-524.

Woolgar, S., Vaux, J., Gomes, P., Ezingeard, J-N., and Grieve, R. (1998). Abilities and competencies required, particularly by small firms, to identify and acquire new technology. *Technovation*, 18(8/9), 541-554.

Wright, M., Birely, S., and Mosey, S. (2004). Entrepreneurship and University Technology Transfer. *Journal of Technology Transfer*, 29, 235-246.

Yin, R. (1994). *Case Study Research: Design and Methods*. Sage Publications, Thousand Oaks.

Ziman, J. (2000). *Real Science: What it is and What it Means*. Cambridge: Cambridge University Press.

Zucker, L. G., Darby, M. R. & Torero, M. (2002). Labor Mobility from Academe to Commerce. *Journal of Labor Economics*, 20(3), 629.

Zucker, L. G., Darby, M. R., and Brewer, M. B. (1998). Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises. *American Economic Review,* 88, 290-306.

Zucker, L., Darby, M. and Brewer, M. (1998). Intellectual Human Capital and the Birth of US Biotechnology Enterprises, *American Economic Review*, 88(2), 290-306.