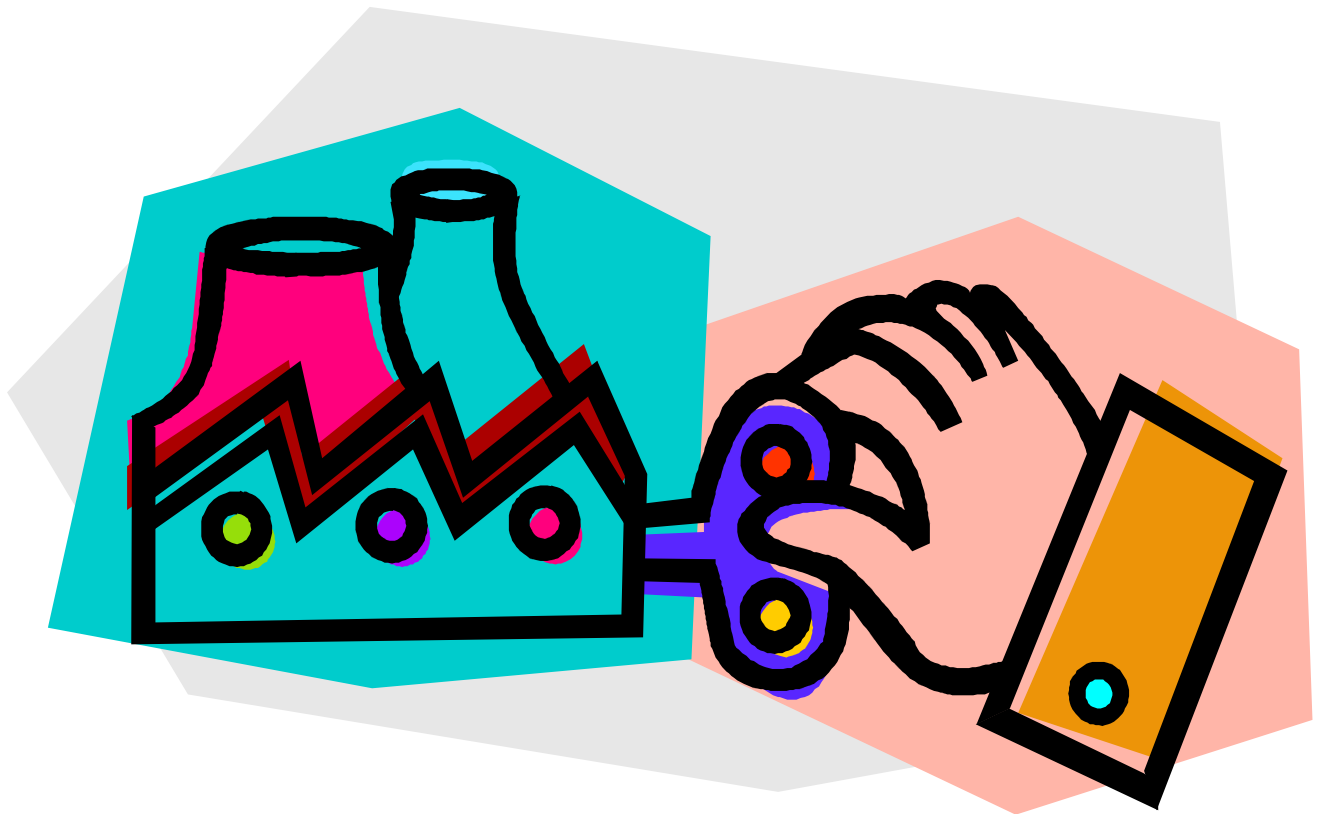




CHALMERS
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The Academic Entrepreneur

Motivations to Utilize University Innovations

Teacher's Exemption vs. University Ownership

Master's thesis in the Master Degree Programme, Entrepreneurship and Business Design

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Abstract

Academic entrepreneurship is not a new phenomenon but it has not been researched thoroughly in the Teacher's Exemption environment of Sweden. This thesis compares the motivations behind researcher's motivation to commercialize their inventions in a teacher's exemption environment with those in a university ownership (Bayh-Dole style) legislative arena. The model tested and compared reveals that the differences in motivation to commercialize between the legislations are minor but the paths to entrepreneurship face different motivations.

Acknowledgments

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Contents

1. Introduction	1
2. Research Questions	2
3. Methodology.....	3
3.1. Research Design	3
3.2. Data Collection.....	3
3.3. Data Analysis.....	7
3.4. Quality Measures	7
3.5. Data Limitation.....	8
4. Literature Review.....	9
4.1. Academic Entrepreneurship	9
4.2. Legislation	11
4.2.1. University Ownership.....	11
4.2.2. Teacher's Exemption / Professor's Privilege.....	13
4.2.3. Denmark: From Teacher's Exemption to TTO.....	14
4.2.4. Ownership Responsibility.....	15
4.3. Researcher Motivation.....	18
4.3.1. Identification of the model and factors of research motivation	19
5. Results.....	22
5.1. Demographic information about the sample	22
5.2. Motivations for creating a company.....	23
6. Discussion.....	50
6.1. Motivational and Important Factors.....	50
6.2. Motivational factors: Comparison with Spain	51
6.2.1. Personal Motivations	54
6.2.2. Entrepreneurial Opportunity	54
6.2.3. Scientific Knowledge	55
6.2.4. Available Resources	55
6.2.5. Incubator organization / Home University	56
6.2.6. Social Environment	57
6.2.7. Motivational Factors ranked by importance.....	58
6.3. TTO vs. TE – Hypothetical change in ownership	59
7. Conclusions	61
8. References	63

9. Appendix	65
Appendix 1: Motivational Factors – Deviations and Importance	65
Appendix 2: Factors for Motivation: University Ownership vs. Teacher's Exemption	67

Table of Figures

Figure 1 Ownership of Academic Patents by Domestic Inventors.....	11
Figure 2 TTO Mission Statements	12
Figure 3 From Idea to Commercialization.....	17
Figure 4 Researcher Motivation - Various Countries – Adapted from Morales-Gualdron et.al (2009)	19
Figure 5 Model of Researcher Motivation to Utilize – Morales-Gualdron et.al (2009).....	21
Figure 6 Demographics: Universities and Industry	22
Figure 7 Area of Operations.....	23
Figure 8 Decision to commercialize	24
Figure 9 Possibility of Commercialization	25
Figure 10 Personal Motivations to commercialize	26
Figure 11 Desire to make money vs Desire to apply knowledge	27
Figure 12 Cutting edge technology vs. Desire to advance scientific field scatter plot	27
Figure 13 Leveraging a Business Idea	28
Figure 14 Available Resources	28
Figure 15 investing own funds vs. Difficulty Commercializing.....	29
Figure 16 Institutional culture and the decision making process	30
Figure 17 Colleague's Attitudes to Commercialization	30
Figure 18 External Motivational Factors.....	31
Figure 19 Attitudes.....	31
Figure 20 Promoting Entrepreneurship and Society's attitude	32
Figure 22 External Collaboration	33
Figure 23 Prior Experience	33
Figure 24 Trigger to Commercialize	34
Figure 25 Idea Spark - External Factors.....	34
Figure 26 Basic Research vs Industrial R&D.....	35
Figure 27 Business Risk Figure 28 Perceived Risk	36
Figure 29 Business and Personal Objectives.....	36
Figure 30 Start-up creation issues	37
Figure 31 Production facilities vs Supplier Relationships	38
Figure 32 Production vs Sales	39
Figure 33 Suppliers vs Management Team.....	39
Figure 34 Entrepreneurial Services Available	40
Figure 35 University Involvement.....	40
Figure 36 University assistance vs. Finding Capital.....	41
Figure 37 University Involvement.....	42
Figure 38 Average level of University involvement	43
Figure 39 Change in Involvement	43

Figure 40 Private vs University ownership.....	44
Figure 41 Delay Publication	45
Figure 42 Commercialization vs Personal Efforts	46
Figure 43 Ownership vs Delay.....	47
Figure 44 Ownership vs Management.....	48
Figure 45 Publication delay vs Management.....	48
Figure 46 Importance factors.....	49
Figure 47 Results Normalized for comparison.....	53
Figure 48 Mean Importance Per Factor – Teacher’s Exemption vs. University Ownership	58

1. Introduction

Numerous studies in the past have sought to measure and analyze the effects of technology transfer from universities into industry, most of which have been focused on the Western regions of the world. This transfer is referred to as utilization which is defined by the Merriam-Webster Online dictionary as “to put to practical use” (Merriam-Webster, 2013).

The traditional way of thinking of utilization is for companies to develop a product in-house with knowledge researched and developed by the scientists employed by the company. In the past couple of decades, the utilization of research has been emerging from a different source: universities. This emergence is not only through collaborative efforts between industry and universities where industry sponsors research but the academics themselves have been taking the necessary steps to commercialize their own research (Finn & Lund, 2006). Researchers have been writing business plans, raising capital, leasing production facilities and recruiting staff all with one goal in mind: to capitalize on the knowledge that they’ve created.

These companies, created by academic entrepreneurs are made to exploit the results from their results and they contribute to job creation and knowledge transfer into industry (Morales-Gualdrón, et al., 2009). A scientist’s goal has traditionally been to contribute to science (Etzkowitz, 1998) and it has not changed, instead they are realizing that in a tight economic job market, new opportunities for dissemination and commercialization of knowledge have opened up.

Entrepreneurship is not an easy task, full time lecturing, research and conferences do not leave much time for starting a business. But here we are, in the last few decades, academic entrepreneurship has grown substantially and it can be attributed, if only partially to legislative changes in the ownership of university patents.

There exist two main pieces of legislation which govern the ownership and commercialization of knowledge generated at universities. In the United States, the Bayh-Dole act assigns ownership to the universities who may then proceed to license, sell or create a spin off through the intermediary technology transfer offices. This model of university ownership is very widely adopted but on the other side of the world, Sweden looks at ownership differently. The teacher’s exemption is a law within the Act on Employee’s Inventions in Sweden which allows university and public research organization employees to maintain ownership of their inventions. This grants the rights to the inventor, to transfer their knowledge to the public in the best way they see fit, be it public disclosure, sell or license it to industry actors or if they are willing to attempt it, take on the task of commercializing it on their own.

The motivation to leave the comfort of the university setting must be very strong. This thesis looks to understand what these motivating factors are and how they help the academic entrepreneur decide whether to commercialize or not. With this information, the writer hopes to contribute to the understanding the motivation behind researchers’ decision to spin-off their inventions in the Swedish environment. A stronger understanding of the motivational factors can lead to stronger support systems and a more robust entrepreneurship ecosystem.

2. Research Questions

Prior research into the underlying motivations for academic researchers to commercialize their innovations has revealed a number of possible factors. These factors may have been a one-time, situation specific event, a culmination of circumstances over time or an inherent and potentially unrealized ambition to pursue entrepreneurial activities. On the opposite end of the spectrum, there may be real or unrealized obstacles to utilizing the innovations researchers develop during their university careers.

The desires and motivations vary greatly between researchers motivations for seeking to utilize their inventions. Thus, the purpose of this research, which has been evaluated with the following questions is: to identify and understand the effects regarding ownership and responsibility of university inventions with regards to the motivational factors which influence the decision to commercialize university inventions in the Swedish Teacher's Exemption ownership environment and to contrast them with the University Ownership environment in Spain.

RQ1: What are the key motivational factors that drive academic researchers to commercialize their results Sweden?

In Sweden, the Teacher's Exemption allows the researchers to choose if, when and how to initiate and engage in commercialization activities. How do personal factors, financial availability, social environment and other potential factors affect the motivations and decisions for researchers to utilize their innovations?

RQ2: How do Swedish and Spanish researchers differ regarding in their motivation to commercialize?

The motivational factors within university ownership structures are identified from the study conducted by Silvia Morales-Gualdrón in *Entrepreneurial Motivation in Academia* (2009) within Spain. The inherent difference in the ownership structures between Swedish research organizations and in those which the university maintains ownership may prompt different reasons to commercialize. What are these differences and how do they effect the utilization of university developed technologies?

RQ3: How do the different ownership models affect the motivation for researchers to commercialize?

Given the choice between owning and commercializing on their own or allowing the university to take the reins and compensate appropriately, which would be preferable to the researchers? Is protecting the innovation through official channels i.e. patenting worth a delay in publication and how do the motivational factors identified differ when offered a choice between the two legislations?

3. Methodology

In this section of the thesis, the reader will be given an explanation of how participants were selected for data collection, the analysis of the data, and the limitations of the chosen methodology.

3.1. Research Design

The thesis follows a quantitative research strategy with a comparative data research and analysis component. The quantitative data is collected through online surveys while a secondary qualitative survey collects additional primary qualitative data. The theories are generated and adjusted as the study progresses thus following a more inductive approach (Brymann & Bell, 2003). The comparative strategy lies in the direct comparison between the analysis of the data stemming from the teacher's exemption legislation and its effects researcher motivation from this thesis and a similar study performed in a cross-cultural setting in Spain which operates under the university ownership model.

The experimental/deductive research strategy was considered as an option but was not chosen as there are a minimal number of studies related to entrepreneurial motivation within the teacher's exemption environment which can be used as groundwork for theoretical background required to conduct valid research. The experimental design requires at least two groups to be studied experimental and control (Brymann & Bell, 2003). The dependent variables are pit against the independent variables to gain a better understanding as to what the effects are on the variables. This provides a qualitative and thoroughly scientific approach from which theories are tested through experimentation (Brymann & Bell, 2003).

A case study approach was also considered as an option for conducting the current research in which an extensive literature review would be conducted on past studies within a single environment such as a single company, country, university, etc. (Brymann & Bell, 2003) Thus providing a more in depth view of a single environment over a longer period of time. This approach would limit the scope of the research to a very narrow spectrum within the boundaries of a single university or company and would not allow for exploration of motivational or other external factors which may contribute to researcher motivation outside of the focus of the case study.

The inductive, qualitative approach coupled with a short case study was chosen as the research design method for this thesis as it builds upon the deductive, quantitative experimental design chosen by Silvia Morales-Gualdron (2009) by utilizing a similar quantitative data collection. The experimental data was supplemented with qualitative data through the use of follow-up interviews. Additionally, as a basis for comparison for countries which have changed ownership environments, a short case study was conducted on Denmark as an example of what happens when a country changes the ownership structures within its borders.

3.2. Data Collection

The primary data was collected using an online survey distributed via e-mail. The goal of the data collection is to discover the underlying motivational factors that have led or may have led to the academic researcher creating a start-up based on innovations developed at a given university or public research organization.

The initial collection period took place from October 1st to December 2nd, 2013. A follow up questionnaire, which sought additional clarification, was sent out to the respondents in February 2014 and lasted three weeks.

Secondary data was collected from peer-reviewed journal articles available through the Chalmers University of Technology library, as well as online sources for accredited papers, essays, studies and articles i.e. Google Scholar, World Intellectual Property Organization (WIPO), and European Patent Office (EPO).

Target Sample

The participant population for this study constitutes of entrepreneurial researchers from Chalmers University of Technology and Gothenburg University's holding company, GU Holding. Individuals were chosen on a number of criteria such as: 1) are in the process of; wish to initiate the process; have created a spin-off or attempted to do so in the past; 2) have applied to patent technology which has been developed at a university; the firm was/is to be founded on the patented technology; 3) were fully or part-time employed at a university at the time of patenting; 4) the respondent was a founder of the spin-off based on the patented technology. Note: Founders who were engaged in PhD studies during the business development stage are also included in the sample.

Sample Size

The sample size for the questionnaire was not known before the study commenced thus the required sample size was calculated using the formula for "Unknown Sample Size" below (Whitley & Ball, 2002).

$$\text{Necessary Sample Size} = ((Z\text{-score})^2 * \text{StdDev} * (1\text{-StdDev})) / \text{Margin of Error}^2$$

Equation 1 Necessary Sample Size

A total of 108 potential participants were contacted: 43 from Encubator at Chalmers University of Technology and 65 from GU Holding. The initial questionnaire yielded a 20% valid response rate of 21 participants: two and 19 respondents from Encubator and GU Holding, respectively. Participants were later contacted again to complete a follow-up questionnaire. Of the 21 valid participants, four responded to the second round of data collection.

Equation 1 was applied to calculate the margin of error and confidence intervals using the final sample size of 21 respondents. The resulting calculations yielded a standard deviation of 0.5 and a Z-score of 1.645 (found on a Z-score table at (UTDallas, 2014)), based on a 90% confidence interval and an 18% margin of error.

The issue of a small homogenous sample size is considerable (further discussed in Section 3.5). A potential solution to increase sample size as well as decrease the sampling error/bias would be to contact and request contact information from all the incubators and technology transfer organizations in and around Gothenburg. This would allow for a larger sample of academic entrepreneurs who have already engaged in entrepreneurial activities around the Gothenburg area. A similar attempt to increase the sample size was conducted in the data collection phase by requesting information from a prominent IP consulting firm in Gothenburg, unfortunately they did not provide the necessary contacts needed.

To increase the sample size even further, incubators and universities from across Sweden and the various science parks would increase the heterogeneity of the sample subsequently leading to a lower sampling bias as the research organizations across the country specialize in different scientific research areas.

Online Questionnaire

The questionnaire performed for this study is based on the work performed by Morales-Gualdron, S et.al (2009). Morales-Gualdron, S et.al's research strived to understand the motivating factors within Spanish Universities and Public Research Organizations operating under the university ownership model. The instruments in this thesis' questionnaire closely follow those posed by the previous study but have been modified for the purpose of understanding how motivational factors differ within a Teacher's Exemption model.

The survey consists of a total of 52 questions which include Likert scale; multiple choice; multiple answer and open ended response options separated into seven distinct sections.

- 1) Demographic information
- 2) Motivations for creating a company
- 3) Prior experiences with business creation
- 4) Current experience with entrepreneurial ventures based on university research
- 5) Processes and activities engaged in during company creation
- 6) The role the university played in assisting/providing guidance during company creation
- 7) Hypothetical scenarios relating to ownership

The items in the questionnaire closely parallel the Spanish study and are evaluated on a Likert scale which ranges from zero (not important) to three (very important). This scale is used to maintain a level of comparative accuracy when the results from this study are paralleled to the ones from Spain. The researchers are asked general questions such as:

“How important are the following factors in the decision making process for the creation of your start-up?”

“What triggered the decision to create a company?”

“Personal motivations to create a company/commercialize” (i.e personal desires: money and independence)

“What role did the institution play in helping you to commercialize your innovation?”

Factors and variables defined by Morales-Gualdron, S et.al are detailed in Table 1.

Table 1 - Motivational Dimensions, Factors and Variables

MOTIVATIONAL DIMENSIONS	MOTVATIONAL FACTORS	VARIABLE FACTORS
PERSONAL MOTIVATIONS (F14)	F1 Need for Achievement	V1 Desire to prove own ability to establish a new firm
		V2 Personal achievement motivation
	F2 Need for Independence	V3 Desire to develop one's own ideas
		V4 Attempt to achieve a better working atmosphere
F3 Desire for Wealth	V5 Lack of work prospects	
		V6 Desire to be more independent
		V7 Desire for wealth
	ENTREPRENEURIAL OPPORTUNITY (F4)	V8 Analysis of business opportunity developed by TTO
		V9 New idea for product/service
		V10 Perceived customer needs/deficiencies in existing products
SCIENTIFIC KNOWLEDGE (F15)	F5 Desire to apply knowledge	V11 Cutting edge technological knowledge
		V12 Desire to apply knowledge into a practical use
	F6 Knowledge Transference	V13 High value added knowledge – base of new firm
V14 Difficulties in transferring knowledge to the immediate environment		
V15 Exclusivity of available knowledge		
AVAILABILITY OF RESOURCES (F16)	F7 Financial	V16 Available finances
		V17 Available personal assets to invest
		V18 Available public support – loans
	F8 Social Networks	V19 Availability of a person suitable to be manager
		V20 Good contacts for establishing a company (partners)
	F9 Production Facilities	V21 Contacts in the market
V22 Science or technology park in the city/area		
		V23 Business incubator in the area
		V24 Available production facilities
INCUBATOR ORGANIZATION (F17)	F10 Organizational Barriers	V25 Difficulty of promoting professionally within the incubator organization
		V26 High level of bureaucracy in the incubator organization
		V27 Low risk orientation of the research environment
		V28 Existence of specific rules for the creation of spin-offs in the incubator organization
	F11 Supporting Infrastructure	V29 Existence of a tradition of spin-off generation in the incubator organization
		V30 Attitude towards new business creation within the incubator organization
SOCIAL ENVIRONMENT (F18)	F12 Role Models	V31 Relatives or family members act as entrepreneurs
		V32 Advice received from friends
		V33 Examples of successful companies
	F13 Attitudes towards entrepreneurship	V34 Advice received from external organizations
		V35 Campaigns aimed at encouraging entrepreneurship
		V36 Society's attitudes towards entrepreneurship

The final section in the questionnaire differs from the previous study by asking three hypothetical questions which are focused on the ownership of inventions issue. The first question asks the researcher to choose between university ownership and private ownership. The second question seeks to understand the delay to publish results a researcher is willing to endure for the sake of security IP rights. Finally, the third question gives a choice between private management and commercialization of the invention and commercialization and management through university ownership and control. These hypothetical questions is designed to better understand the level of

comfort a researcher has with the current ownership structure in Sweden as well as how motivated they are towards commercializing their inventions.

Follow Up Questionnaire

The follow-up questionnaire was sent to all respondents with the aim of gaining a deeper understanding of their responses. Each questionnaire was tailored to the responses for each of the 21 responding participant by providing them with their answer to the specific question in the online survey. When presented with their previous responses, they were asked to “please explain your choice”, “what triggered this decision”, “how would your decision/motivation change if ...”, and “if the [factor] were to be changed, how would your motivation change?” for the various questions. The questions chosen for the follow-up questionnaire were ones which featured some of the largest variance i.e. a large number of whom responded very positively to a question while the rest responded very negatively with minimal responses in between or a high frequency of similar answers i.e. nearly all respondents answered “Very Important” for a specific factor.

3.3. Data Analysis

The data was analyzed using SPSS statistical software to show if any correlations exist between the various factors. A bivariate correlation was run on the variables from the study. Those that showed a high Person Correlation “ r ” close to a value of one with a 2-tailed correlation significance of 0.000-0.005 show that the two variables are closely related in some manner. In other words, if the “ r ” value between the two correlated variables is very close to one, then it is highly likely that as one variable increases, the other will follow in the same direction (Niven & Deutsh, 2012). Scatter plots with lines of best fit were then created to help show the relationship between the two variables visually. Data which shows no significant correlation with other variables were analyzed by looking at the average responses, percentage of responses per option and other relevant factors.

3.4. Quality Measures

The methods and measures applied in this thesis are reliable as they have been sourced through careful examination of similar studies performed over a long period of time. The calculations used to analyze the data collected were done systematically with the use of SPSS, a well-known statistical software used by researchers around the globe.

The results presented in this study are replicable and can be expanded to larger samples using the same metrics. The questionnaire used to collect the data is based on a peer-reviewed article, verified for quality, validity, replicability and reliability.

Measurement/construct validity is ensured through the careful phrasing of the survey questions so as not to lead the respondents to a specific answer. The Likert scale questions allow room for the researcher to differentiate the level of involvement or motivation a specific factor has on them without feeling obligated to answer as they believe the research expects them to answer (Brymann & Bell, 2003). The question framing is designed in such a way as to ensure a useful response which leads to a measurable data point to answer the research questions.

Internal validity, the measure of causality (Brymann & Bell, 2003) between a factor and a variable is ensured through the use of the correlation calculation capabilities of SPSS. Only responses which show a significant or highly significant result are reported. Those which are not significant do not show any statistical significance of causality between two data points (Smith, 2013).

3.5. Data Limitation

The thesis suffers from two types of limitations: sample size and a high sampling error focus on the demographics of the respondents. The collected sample resulted in 21 respondents from the original 108 contacted yielding a 21% response rate. This sample was collected from the client lists of two incubators in the Gothenburg, Sweden area surrounding Gothenburg University and Chalmers University of Technology. The limited sample size and sources of contacts makes this a convenient sample (Brymann & Bell, 2003) which was available to the writer of this thesis as the contacts were provided by educators and colleagues. Those sampled were all previously or currently engaged in commercialization stemming from research conducted at an upper education institution. Although this is the target sample for the current study, a Convenience Sample of such small size and specificity may not be applicable to the larger population of academic entrepreneurs in the rest of Sweden. Even if the sample involved higher randomization and less targeted sampling, the number of respondents is not indicative of a larger population.

The initial targeted sample of 108 was split 60% Chalmers / Encubator and 40% GU Holding / GU. Chalmers is predominantly a technology focused university while GU is geared towards the bio-sciences. The end result of participants was nearly 80% operate in medicine, chemistry and other biology-oriented fields. The sample thus suffers from strong from very high sampling error due to the focus towards the bio-science research areas. This type of sampling error reduces the generalization opportunities of this study further as the sample is very heterogeneous and a higher sample size would be required to overcome the sampling error (Brymann & Bell, 2003).

4. Literature Review

4.1. Academic Entrepreneurship

It has long been the view of both research institutions and industry that entrepreneurial activities can be seen as a threat to the integrity of universities (Etzkowitz, et al., 2000) and that the commercialization of knowledge can lead to the degradation of basic research (Fritsch & Krabel, 2012). Industry's views on universities has been more towards a source of human capital i.e. potential employees. The university as a source of knowledge for the firm was only an afterthought. Universities are the sources of knowledge, where basic research is conducted and companies are there for product or service development (Etzkowitz, 1998).

Universities have had two main goals or missions in their long history: to educate and to conduct research. In the 20th century a shift towards becoming a knowledge based economy, the universities are moving towards a third mission: to become entrepreneurial centres (Etzkowitz, et al., 2000) based on the technologies and innovations developed in-house. University utilization practices have gained in popularity over the last century because of this new mission and they have spurred a new type of entrepreneur – the academic entrepreneur.

An academic entrepreneur is a researcher who has managed to close the gap between two seemingly separate entities: conducting research and utilisation or commercialization. Etzkowitz (1998) describes this as the ability for the researcher to see their results from a dual perspective. The first being the traditional perspective in which a scientist conducts research then openly publishes their results to the scientific community. The second perspective is the ability to see commercial and intellectual use for the results and acts to commercialize them.

Scientists generally measure achievement in science through number of publications, citations and influence they have had on the scientific community (Fritsch & Krabel, 2012). The university's shift toward promoting entrepreneurship and commercial utilization of technologies has potentially added a new layer of achievement entrepreneurial success.

Researchers who engage in entrepreneurship have two main goals in mind that create a feedback loop: 1) conduct basic research and 2) commercialize that basic research (Etzkowitz, 1998). The feedback occurs when the academic entrepreneur feeds revenues and profits from their entrepreneurial activities back into funding additional basic research.

Becoming an entrepreneur has normally been seen as an act performed by someone with supreme intellect and strong will (Lundqvist & Petrusson, 2003). Although these are important qualities to possess, they are not crucial. It has led to a normative understanding of the entrepreneur being someone who possess super human entrepreneurial powers. On the contrary, unless someone is a career entrepreneur such as Elon Musk or Sir Richard Branson, entrepreneurship is not something that is chosen as a profession but more of a feat of strength (Fritsch & Krabel, 2012) for something that a person has already accomplished. In other words, entrepreneurship is not something that is learned beforehand but educated in while it is performed.

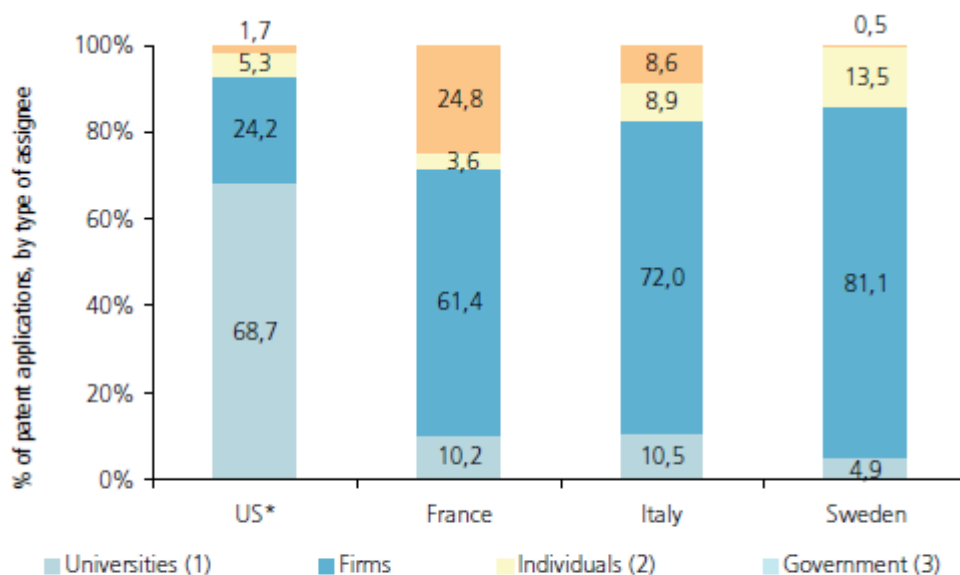
University researchers, predominantly in the sciences, engineering, information technology (Fritsch & Krabel, 2012) and medicine are those who become entrepreneurs (Åstebro, et al., 2013) as they are more likely to use the results from their research to found a company. These fields of study have

a higher chance of producing tangible and potentially consumer oriented products compared to the social sciences and humanities (Fritsch & Krabel, 2012). In other words, the research area of the scientists has a strong impact on the likelihood for commercialization and/or spin-off creation. Researchers who have had experience working on collaborative projects with industry actors have a higher likelihood of identifying potential commercial products (Fritsch & Krabel, 2012) and to pursue new paths of research which may fill identified gaps in the market.

4.2. Legislation

In this section, a look at the U.S system referred to as the Bayh-Dole act of university ownership will be compared to the Swedish system which grants an exemption for university employees to maintain ownership of their patents: Teacher's Exemption / Professor's Privilege. Employee inventions are handled differently in both legislative arenas and each has advantages and disadvantages to how the inventions are owned and utilized. One very important difference between the two systems is who owns the rights and may commercialize on the innovation. In the US, the technology transfer office (TTO) at the university assumes ownership and the right to commercialize while in Sweden, the inventor has the prerogative to pursue utilization strategies themselves as they retain ownership (Damsgaard & Thursby, 2013).

In the chart below from Fabio Montobbio, published on the World Intellectual Property Organization's webpage (Montobbio, 2013) details the ownership of patents in a Sweden, France, Italy and the US. In the US more than half of the patents are owned by universities. In stark contrast, Swedish universities are named as assignees for only 5% of the patents. The difference lies in the ownership between the two systems.



* US patent/inventor pair data from Thursby et al. (2006)

(1) US data include no-profit organizations (4,2% of tot obs); all data include co-assigned patents

(2) US data include "unassigned"

(3) European data include public laboratories

Figure 1 Ownership of Academic Patents by Domestic Inventors

4.2.1. University Ownership

The focus for this section is the United States' Bayh-Dole act of 1980 of university ownership of researcher innovations as it is the most widely known and adapted model.

Prior to the Bayh-Dole act of 1980, research generated at universities and public research organizations was automatically assigned to the government. This made the utilization and

commercialization of the knowledge and inventions from researchers very hard to reach as it was government-owned (Aldridge & Audretsch, 2011).

The Bayh-Dole Act created a patent policy in the United States which enabled the small businesses and non-profit organizations such as universities to retain the rights to their inventions (AUTM, 2014) with the intent to encourage the knowledge centres to transfer their knowledge and innovations into the public sector. Generated research would be automatically assigned to the university and the researcher would have the option to create a spin-off by licensing the technology from the university or to receive the industry standard of 1/3 of licensing revenues.

The major points of the Act are outlined below. The main goal of the legislation is to empower universities and small businesses.

- Non-profits, including universities, and small businesses may elect to retain title to innovations developed under federally-funded research programs
- Universities are expected to file patents on inventions they elect to own
- Universities are expected to give licensing preference to small businesses
- The government retains a non-exclusive license to practice the patent throughout the world
- The government retains march-in rights

Source: Adapted from the Association of University Technology Managers (AUTM, 2014)

Although technology transfer offices had been around for long before the 1980 legislation, they were not used as heavily as after the enactment. Patenting was common place prior to the introduction of the Act but did not focus on profits (Aldridge & Audretsch, 2011).

The technology transfer offices (TTO), act as an intermediaries between the university and industry. The TTO collects the intellectual property disclosed by the researchers and engages in commercialization efforts. The transfer office assumes the responsibility of searching for potential licensees/customers, marketing, networking and additional business ventures. In general, the TTO assumes most of these activities with minimal involvement of the scientist (Muscio, 2010). If the researchers were to take a more active role in the commercialization process, the speed of commercialization may increase.

Aldridge and Audretsch (2011) outline some reasons as to why not all TTOs are created equal. In the following chart, it can be seen that the primary objectives for the transfer offices vary substantially.

Technology transfer office mission statements.

Primary objectives of the UTTO	Percentage of times appeared in mission statement (%)
Licensing for royalties	78.72
IP protection/management	75.18
Facilitate disclosure process	71.63
Sponsored research and assisting inventors	56.74
Public good (disseminate information/technology)	54.61
Industry relationships	42.55
Economic development (region, state)	26.95
Entrepreneurship and new venture creation	20.57
<i>N</i> – 128 TTOS	

Figure 2 TTO Mission Statements

The most prevalent mission statement is “Licensing for royalties” while the least, with only 20% of the TTOs referenced in their study reported “Entrepreneurship and new venture creation” as part of their mission statement. Offices with higher budgets, more human capital and stronger networks can help impact entrepreneurship but it varies depending on the university (Aldridge & Audretsch, 2011). Some TTOs may prioritize licensing over entrepreneurship, as seen above which in turn may deter scientists from pursuing entrepreneurial activities. Additionally, the maturity of the TTO can have an effect on how well they are able to utilize the inventions they acquire from the researchers (Greenbaum & Scott, 2010).

TTOs missions, as evidenced above shows that the predominant goal for the university is to maximize revenue by rewarding the institution with greater revenues rather than the number of inventions which are transferred into industry (Aldridge & Audretsch, 2011). This business model stresses the need to generate revenue rather than disperse the knowledge generated by the scientists and their discoveries. The time it takes for the knowledge to reach the public or industry is increased which undermines the core reason researchers conduct research – to advance their scientific field (Morales-Gualdrón, et al., 2009). Researcher participation in the commercialization/utilization efforts can help boost the finding/acquiring of customers/licensing partners. This drive for licensing revenue has steered the majority of TTOs to search for the “Blockbuster Patent”, hoping for high returns all at the cost of other patents and inventions which may be perceived less important (Greenbaum & Scott, 2010).

4.2.2. Teacher’s Exemption / Professor’s Privilege

Sweden is one of a very few countries which still utilize the Teacher’s Exemption or Professor’s Privilege towards employee inventions. In 1949, Sweden was the first of the Nordic countries to enact rules governing the right for employers to have employee’s inventions automatically assigned to the company (Reinholdsson, 2002). Prior to this change, employers had no right to the innovations developed by their employees. Together the Nordic rule makers developed a series of rules and regulations which were incorporated into their respective countries’ patent laws over time which are similar across the borders.

In Sweden, the Patent Law is called *uppfinnarrätten*. The legislation that this thesis focuses on is *Lag (1949:345) om rätten till arbetstgares uppfinningar*, Act on the Right to Employee’s Inventions which will be referred to as LATU from here on. LATU automatically assigns the exclusive rights to utilize employee inventions worldwide. The employee has the right to be compensated for the rights that have been granted to their parent company / employer (Reinholdsson, 2002).

Shown below are the first two paragraphs of LATU which outline the Teacher’s Exemption (Kopylov, 2011)

§1. The present law relates to inventions patentable within the Kingdom, of employees in public or private employment. Instructors at universities, polytechnic institutes or other institutes which fall under the educational system shall not, by any virtue of such character, be considered employees pursuant to the present law ...

§2. All employees shall have the same right to his or her inventions as other inventors if not otherwise provided for in the present law. What is stipulated with respect to this and otherwise in the present law shall serve as criterion insofar as not otherwise expressly

agreed upon or insofar as may be deemed to result from the employment relationship form other existing circumstances.

The first section defines who falls under the teacher's exemption and the second assigns all rights to the inventor regardless if they are employed by the university/research institute (provided no agreement stating otherwise has been signed).

In the previous section, TTOs were discussed and shown to be the primary medium between the universities and industry. These institutions exist in the Teacher's Exemption environment as well but they function more towards enticing and motivating researchers towards entrepreneurship and venture creation. These institutions are Innovationskontor Väst, Research and Innovation Office at Gothenburg University, Encubator AB, Chalmers Innovation, GU Holding, various science parks, VINNOVA and others. These companies and institutions provide services and aids for researchers who choose to commercialize their inventions. Services such as: business development courses and services, finding funding, patenting and IP advice, networking and many more. Agencies such as VINNOVA, which is Sweden's Innovation agency, provides millions of Kronor in loans, grants, bursaries and other incentives yearly to researchers and entrepreneurs who wish to commercialize. The only caveat is that the researcher needs to approach them on his/her own.

Academic Entrepreneurs have much more incentive now than previously to disclose their inventions so as to reach commercialization and marketing faster. They are not just interested in licensing like TTOs as it may leave them behind in the scientific arena which may result in slowing down dissemination or even industrial competitors (Greenbaum & Scott, 2010). Looking at the figure at the beginning of this section, it was noted that roughly 5% of academics owned patents while a large proportion of these patents were owned by companies/firms. The data shown in the graph differs due to the goals of the TTOs vs the entrepreneurial researchers. In the US, the university owned patents are predominantly licensed to industry but ownership is maintained at the university while in Sweden, the researchers either sell the patents to industry or assign them to companies that they have founded (Montobbio, 2013) or the research has been conducted together with industry partners who have sponsored in whole or in part the research (Lotz, et al., 2009).

4.2.3. Denmark: From Teacher's Exemption to TTO

Denmark and Sweden had similar teacher's exemption clauses between 1956 and 2000. On January 1st, 2000, Denmark abolished the teacher's exemption for a university ownership model similar to the one in use in the United States (Lotz, et al., 2009). Denmark was the first, followed by Germany, Austria, Norway and Finland in countries who decided to change their IP ownership structures to ones which universities retain the rights to the inventions generated at universities.

The Danish government ran numerous studies on university and researcher patenting prior to making the decision to change the model. It found that from the researchers' point of view, TTOs would complicate current and future contractual obligations they had with industry. Industry actors feared that a shift towards a singular body i.e. TTO at a university maintaining and managing the innovations would result in more expensive licensing deals and harder to obtain technologies (Lotz, et al., 2009) as a third party would be involved in the negotiations.

In 1998, a proposal to change the legislation was put forward which would force researchers to disclose their inventions to the university and take over all IP rights associated with them. If the

researchers did not comply, they would be penalized in some form. (Lotz, et al., 2009). As the current law does not include this clause, it shows that the researchers were not happy about being forced to not only keep quiet about their research but also fear that they would be punished for conducting research. Additionally, if the university decided that the invention was not “worth its time” and gave up the rights to it, the researcher would have to apply for the necessary IP protection and any commercial activities which arose from the technology would have to be shared with the department. The ability for the university to decline its rights to the inventor’s IP was included in the legislation due to the latent uncertainty to whether they will commercialize the technology or simply leave it to the way side (Finn & Lund, 2006). This ensures the inventor has the opportunity to utilize their invention even if the university has no interest in it.

The years after the change, the number of patent applications by universities increased drastically as researchers were assigning their inventions to the intuitions instead of applying on their own (Lotz, et al., 2009). The graph shown previously does not include Denmark. If the data for Denmark is added, it can be broken down into: Universities – 11.2%, companies – 66.5%, Individuals – 19.7% and Government 2.6% (Lotz, et al., 2009). Compared to Sweden which showed an 81% industrial and 14% individual ownership (Montobbio, 2013). Lotz et. al expected to find that Sweden would have a larger amount of inventions owned by individuals compared to Denmark due to the Teacher’s Exemption. As noted earlier, Sweden has a strong history of partnering with industry actors who sponsor the research. Another reason could be that the research focus of the university may not yield high returns through licensing/spin-offs or other utilization methods of singular or small numbers of complimenting patents are on offer for commercialization (Lotz, et al., 2009). Pharmaceuticals and Biotechnologies have a higher propensity for revenue returns as they are more likely to focus on one specific technology innovation for commercialization. Electronics, physics and other research areas may require a “package” of technologies to be included thus making it harder for and companies to retain the property rights to these technologies (Lotz, et al., 2009).

The overall effects of the change in legislation have resulted in an increase in university patenting and a decrease in individual ownership as to be expected. The change in ownership resulted in higher licensing revenue for the Danish universities but did not create the open IP market that they were hoping to achieve. Industry ownership increased as well as companies were collaborating more actively with researchers than before thus assigning the ownership to the sponsor. When looking at only transfer of ownership between universities and researchers, the TTOs provide more aid to researchers who want to commercialize themselves but the effects were minimal (Lotz, et al., 2009).

4.2.4. Ownership Responsibility

The university ownership and teacher’s exemption acts grant ownership to either the university or the researcher respectively. Ownership means the right to possess something (Merriam-Webster, 2013). It is yours to do with as you please as it is your property regardless of what “it” is. In the context of intellectual property and assets generated by university researchers, the right to own the technology is assigned by the law either to the researcher or to the university.

For researchers, simply owning the IP rights and not utilizing them in any way i.e. publication or commercialization does not contribute to society and science which is the primary goal for researchers (Etzkowitz, 1998). Thus, a responsibility to utilize the research in some form falls to the party that owns the innovation. Responsibility is defined as the fact of having a duty to deal with

something and to be accountable for those actions (Merriam-Webster, 2013). The responsibility to act on utilizing the research falls on the owner.

Within the teacher's exemption environment, Sweden in this case, the researcher has the right to claim ownership of their research results and to utilize them as they see fit. This could be in the form of commercialization, scientific publication, creation of pedagogical material or simply choose not to utilize at all (Petrusson, 2007). In the university ownership model, the ownership is assigned to the university who then chooses how to act upon it. The issue here is who bears the responsibility of ownership (Petrusson, 2007) and who can capitalize on it.

In the teacher's exemption environment, the researchers bear the responsibility of ownership to transfer the knowledge to the public (Petrusson, 2007) through the different utilization avenues. It is up to the researcher to negotiate with industry actors on how that knowledge is transferred and on what terms. In the university ownership environment, the responsibility of ownership lies in the university. As the TTO assumes ownership, they decide, sometimes with the help of the researcher on how and when to commercialize or utilize the technologies and through what avenues. The researcher has developed the technology and transferred it to the university and may be compensated the industry standard of 30% (Petrusson, 2007) when the technology is licensed but that's where their responsibility ends. Thus the responsibility to commercially utilize the technology is much lower in the university ownership environment as compared to the teacher's exemption.

The following figure summarizes the theories discussed in this chapter in a graphical manner. It shows the process from idea to conduct specific research to the final decision as to whether to utilize the innovation commercially or to return to research and license the technology to another actor. The figure also shows the differences between the two legislations and how they affect the researcher's decision to commercialize in terms of requirements and assistance provided for the researchers if they choose to utilize. The ownership responsibility falls under the capabilities category as that is the point in which the owner of the technology has to decide how to proceed with regards to commercialization.

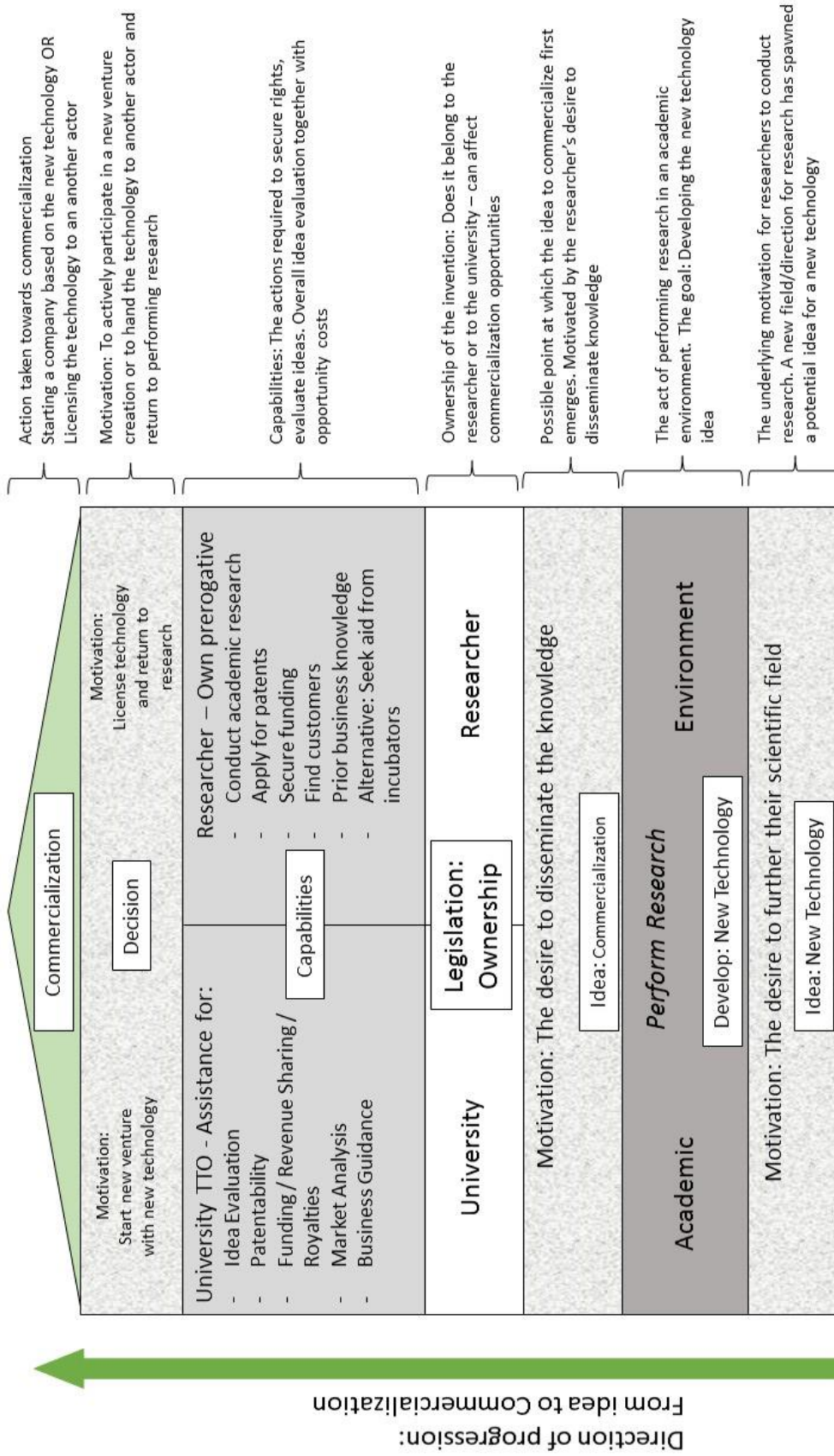


Figure 3 From Idea to Commercialization

4.3. Researcher Motivation

Motivation is the force or influence that causes someone to do something or a condition of being eager to act or work (Merriam-Webster, 2013). The most deeply held value for a scientist is to contribute and extend knowledge. Contribution to science and society is the strong desire which drives researchers to ask the hard questions and to conduct the basic research required to unearth the mysteries of science (Etzkowitz, 1998). To become an entrepreneur, the scientist must see a possible commercial application or a need to be filled with their invention and to act upon that vision.

Universities have been described as “Ivory Towers” by numerous researchers (Etzkowitz 1998; Levin and Stephan 1991; Fritsch and Krabel 2012). These towers are “safe havens” where job security, available resources such as junior researchers are a dime a dozen, a network of researchers and contacts with industry actors can be made through numerous events and conferences.

Researchers may require a singular or plurality of motivating factors to diverge from the comfort of the tower to take the risk in the business world. In the mind map/figure on the following page, aggregated from prior studies which have researched the motivational factors focused predominantly on the university ownership environments: Doutriaux and Peterman (1982) from Canada conducted interviews with 10 Canadian researchers; Samsom and Gurdon (1990) interviewed 22 Canadian and US academic entrepreneurs; and Autio and Kauranen (1994) studied entrepreneurial motivation within Finnish inventors.

A look into those studies within university ownership utilization practices reveals a plethora of potential motivating factors. The researchers from Canada, US, Finland, the UK, Italy and some additional ones have listed some of the following as their motivations for seeking commercial options:

- Boredom from the routine of their profession
- A desire for more freedom and independence
- Advancement of science
- The personal opportunity to become an entrepreneur
- The desire to make money
- The desire put the technologies into practice
- Resources such as finances and an established structure and culture for business creation
- A lack of confidence in others to commercialize their inventions
- A desire to control the uses and implementations of their inventions

List adapted from (Morales-Gualdron, et al., 2009)

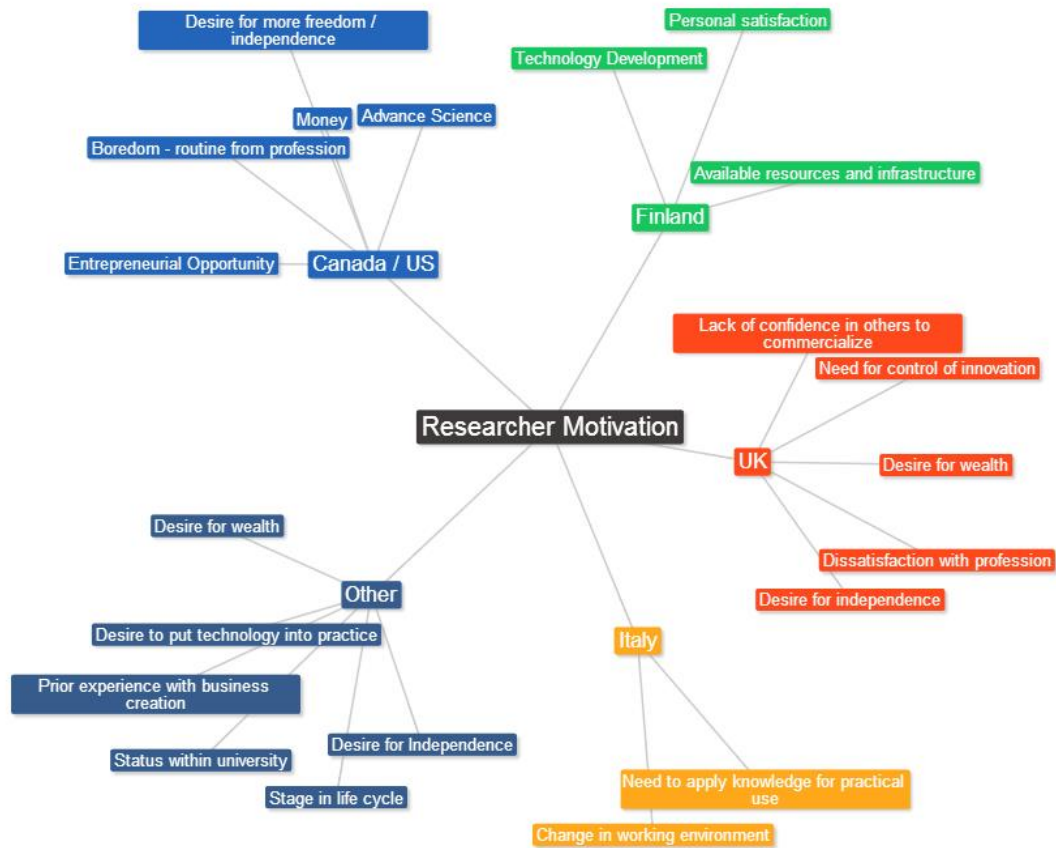


Figure 4 Researcher Motivation - Various Countries – Adapted from Morales-Gualdron et.al (2009)

A specific motivator which can be attributed to the creation of a company could arise from the fact that academic entrepreneurs are driven by the quest for knowledge (Fritsch & Krabel, 2012). The formation of a company could be a means towards that goal as it could provide additional funding for future research. Additionally, their desire to apply their knowledge to real world problems from the basic research conducted at the universities can be a motivator in the decision process as it parallels the desire to seek out new knowledge and commercialization options in industry (Greenbaum & Scott, 2010).

To alleviate some of the feeling of risk and discomfort associated with leaving the “ivory tower”, researchers may choose to commercialize only if this new route does not deviate or change the course of their quest for knowledge too drastically (Fritsch & Krabel, 2012).

4.3.1. Identification of the model and factors of research motivation

Two studies were analyzed as potentials for comparison for this thesis. The first was by Erkkö Autio and Ilkka Kauranen in 1994 titled *Technologist Entrepreneurs versus non Technologist entrepreneurial technologists: analysis of motivational triggering factors* which looked at the decision to establish a new firm in Finnish entrepreneurs. In this study, the researchers sought to understand the decisive point in time and the factor which motivates an entrepreneur to start the business. The study compares technologist-entrepreneurs (academic entrepreneurs) and non-technologist entrepreneurs (industry entrepreneurs) (Autio & Kauranen, 1994) as the two samples. Their findings indicate that personal motivations were the decisive factor for technologist entrepreneurs while non-technologist entrepreneurs preferred the environmental opportunities.

Market factors did not play any significant factor in the decisions to commercialize (Autio & Kauranen, 1994).

The second and ultimately the one chosen to compare the theories and research from this thesis to was *Entrepreneurial Motivations in Academia* by Silvia Morales-Gualdron, Antonio Gutierrez-Garcia and Salvador Dobon who conducted the research in 2009 in Spain. The research conducted by Morales-Gualdron et.al builds on the work of the Finnish study by applying similar research methods and design but focused on the Spanish research environment. Spain employs a university ownership structure similar to the one in place in the United States thus the researcher motivation model described in this section was chosen to be used as a basis for comparison for this thesis between the university ownership and the teacher's exemption structures.

They identified six major motivational factors and 12 sub-factors which influence the major ones. In Table 1 of the Methodology section, a table listing all 36 variables associated with the 18 factors was listed.

The major motivation factors proposed are: Personal, Entrepreneurial opportunity, Scientific Knowledge, Availability of Resources, Incubator Organization i.e. university/PRO, and Social Networks. The factors are detailed below and shown in the Figure on the following page.

- 1) Personal Motivations
 - a. Need for achievement: Desire to perform difficult and challenging tasks
 - b. Need for independence: The desire of the individual to be able to plan their own work and make their own decisions
 - c. The desire for wealth: the wish to make money
- 2) Entrepreneurial Opportunity: The researcher has identified an opportunity to become an entrepreneur and start a company
- 3) Motivations related to scientific knowledge
 - a. Desire to apply knowledge: the ability to apply their knowledge into real world applications
 - b. Knowledge transference: the difficulty with which their knowledge is transferred to industry
- 4) Motivations related to availability of resources
 - a. Financial: access to financial resources such as starting capital, potential investors etc.
 - b. Social networks: the connections within and without the university to industry and other potential partners and clients
 - c. Production Facilities: the availability of production facilities and staff to produce the commercial product
- 5) Incubator Organization (the university / PRO)
 - a. Organizational barriers: internal bureaucracy at the university, employment stability, promotion policies
 - b. Supporting infrastructure: established entrepreneurial culture at the university/region, traditions for spin offs, support programs for those who choose to commercialize
- 6) Social environment

- a. Role models: personal contacts in personal life and in the professional circles with successful entrepreneurs
- b. Attitudes towards entrepreneurship: society's attitudes towards entrepreneurship

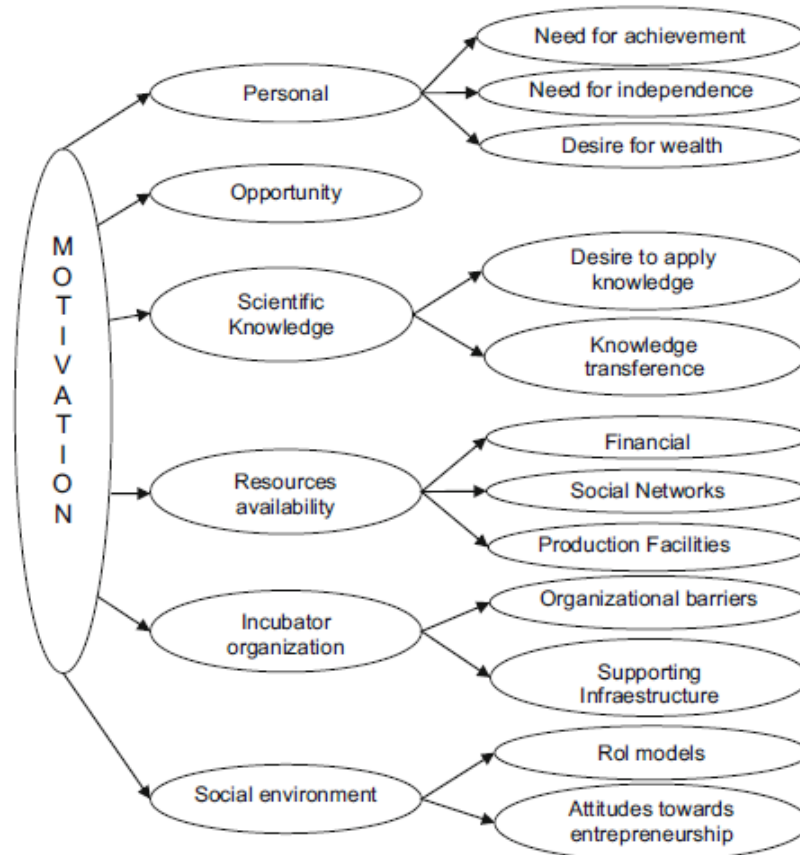


Figure 5 Model of Researcher Motivation to Utilize – Morales-Gualdron et.al (2009)

5. Results

This section describes the data collected from the survey along with the follow-up questionnaire in a concise and understandable fashion. The results closely follow the order of the questions posed in both the online questionnaire as well as the follow-up survey to maintain a level of uniformity between the data and the surveys with the exception of the demographic information which has been compiled from the various sections of the questionnaire.

5.1. Demographic information about the sample

At the time of the survey, the majority of the respondents were employed at either a university such as Gothenburg University, Chalmers University of Technology, Sahlgrenska University Hospital, Harvard or are actively working in industry. 70% of the respondents stated that they are still employed full-time at the institution while the remaining are either part time: 5%, a guest professor or industry actors no longer employed as researchers.

The areas of operation for each varied greatly in terms of research focus: Bio medicine, chemistry and molecular biology, anesthetics, nuclear physics, zoology etc. but the predominant fields of study centered on the biological and chemistry fields, 17 out of 21, which makes up 81% of the sample. All but one respondent currently holds a PhD in their respective field with the last respondent in the process of completing their PhD studies.

Twenty of the twenty-one respondents have applied for or been named an inventor for patents in the past related to the innovations developed during their university career with approximately 135 patent applications or granted patents between them. 100 of the 135 patents have been used commercially in some form.

Demographic information about current business practices

The respondents were asked to provide basic information such as current status, area of operations, their role in the creation of the business regarding any current business practices which are related to their fields of study at the university.

Figure 6 showcases the various areas of operations of the companies created by the university researchers. There are more than 21 responses as some of the companies operate in multiple areas. As can be seen below, the majority of the companies operate within the biotechnology and medicine/pharmacy areas. Within the “other” category, there are two companies within the medical imaging technology arena as well as one within energy. Nearly all respondents, 95% identified themselves as founding partners while also maintaining roles as R&D managers, scientific advisers or members of the board. Almost all the companies were founded around technology developed at universities from which 79% of the rights to the innovations have been transferred/assigned to the companies.

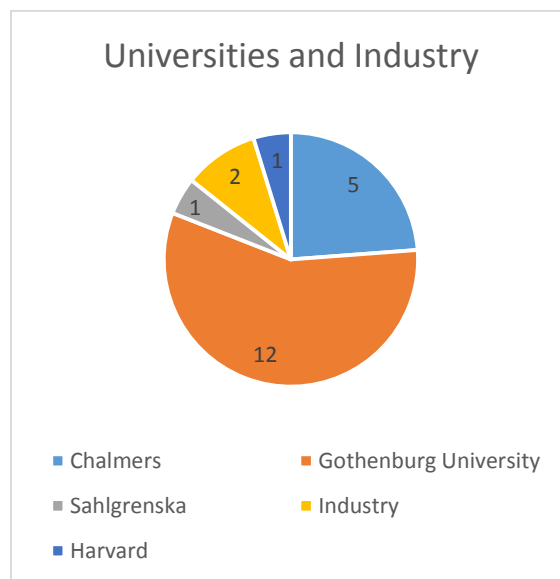
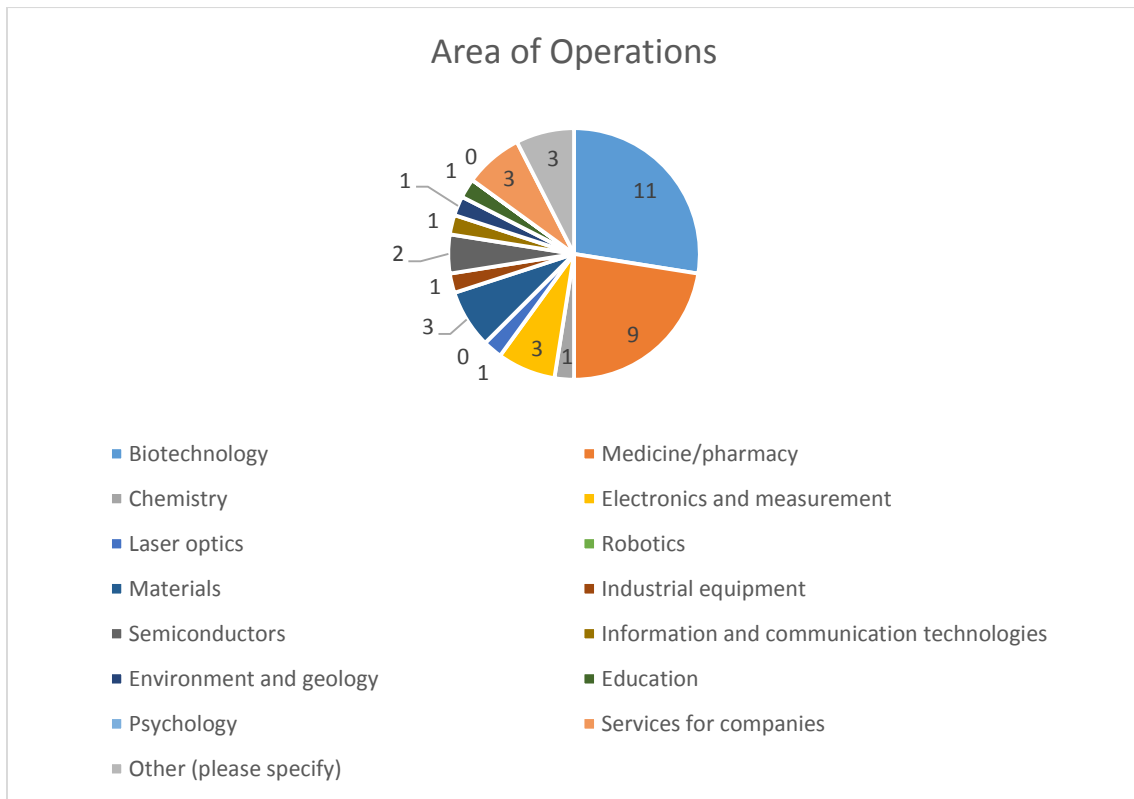


Figure 6 Demographics: Universities and Industry

Figure 7 Area of Operations



5.2. Motivations for creating a company

Decision to create a company

The original idea to start a company had to start somewhere. The respondents were asked to choose from three options: an unexpected decision, considered previously but only a remote possibility and always intended to start a company. The results showed that nearly three quarters, 73% of the respondents did not consider starting a company previously but came to the decision unexpectedly. Those who had previously considered creating a company and those who always had the intent of developing new technologies to commercialize were equally distributed.

In the follow-up questionnaire, the respondents who said that the decision to commercialize was an unexpected decision, it was a product of the circumstances shared similar views on how the decision came about: “Through academic research, we developed a ... with good properties and decided that this would be a good project to try to commercialize”; “Not a pre-set view or idea but the circumstance arose when we analyzed our academic results”. One respondent who answered “Creating a company was always my intent” stated that a family member has run their own businesses based on university research in the past. “With such background, I feel it is nature for me to create companies and job positions within the areas that I can contribute to the society”.

Figure 8 Decision to commercialize

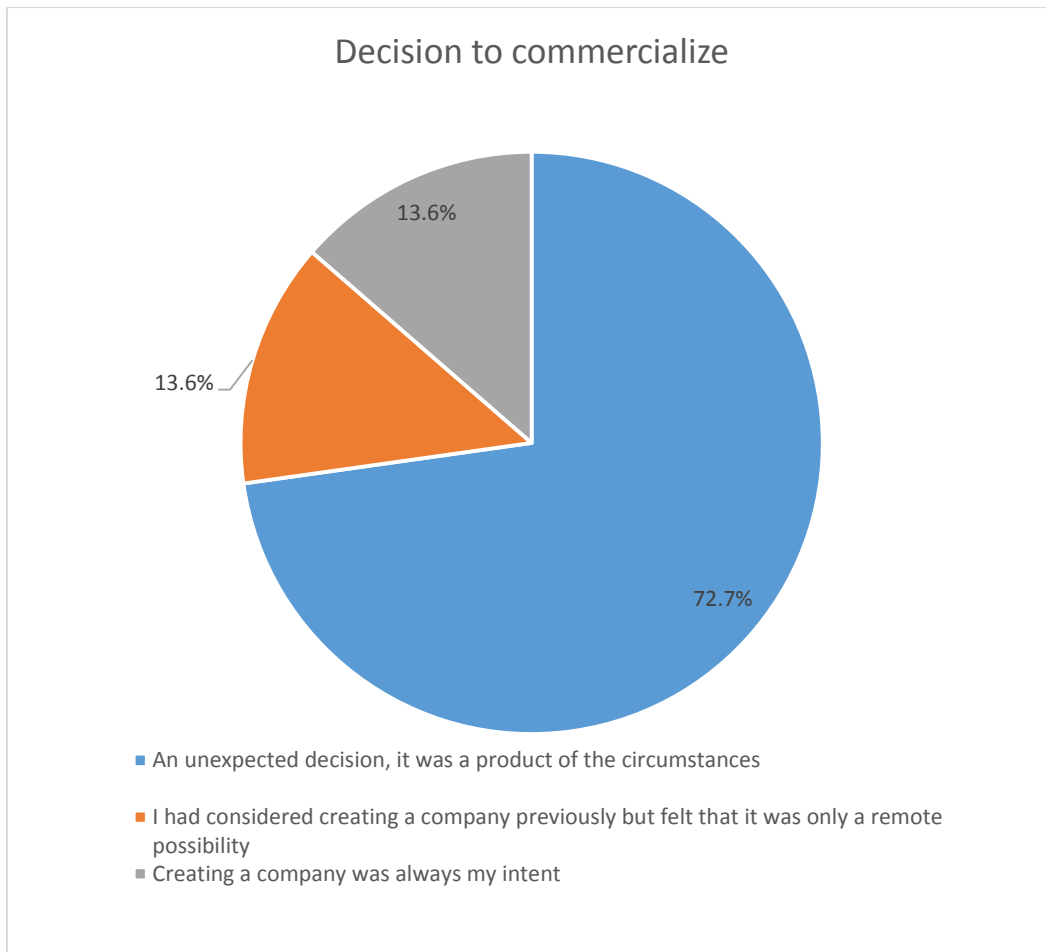


Figure 8 shows the point in their career in which the researchers first considered the possibility of creating a company out of research conducted at the universities. Half of all respondents reported the possibility as occurring either during their tenure as an established researcher or at the start of their professional research careers. PhD students and post-doctorate researchers followed at 20% and 15% respectively. The final 15% is distributed between Master's students and researchers nearing the end of their university careers.

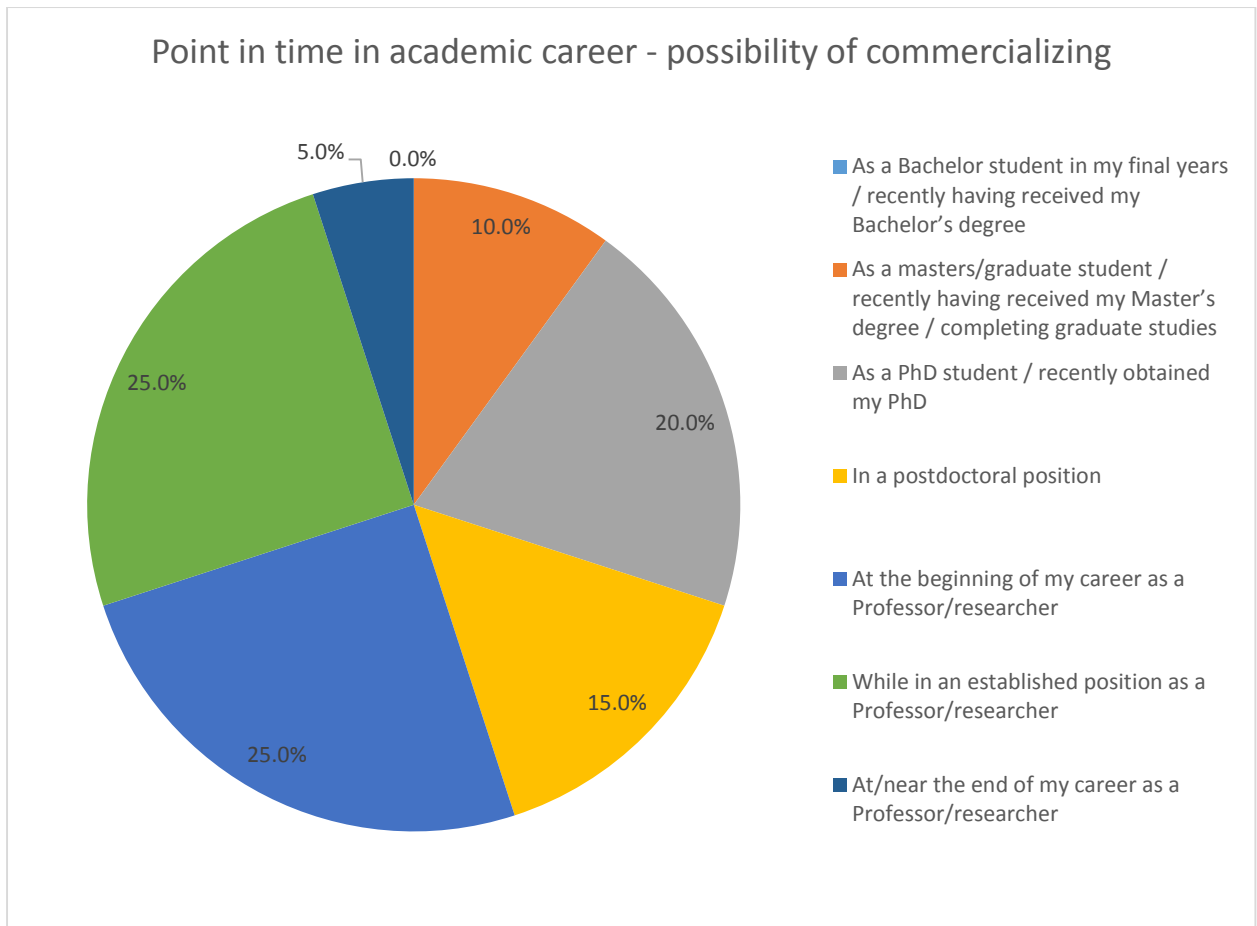


Figure 9 Possibility of Commercialization

Motivations for creating a company

Figure 9 shows the importance each potential motivational factor plays on the researcher's desire to commercialize. The factors are the desire to: build and own my own company, develop my own ideas, be independent, make lots of money, improve my personal work environment, growth and freedom in the work environment, new personal challenges, advance my scientific/technological field, have cutting edge technical knowledge and the desire to apply my knowledge in practice. In the figure, the results are shown by level of importance for the researcher.

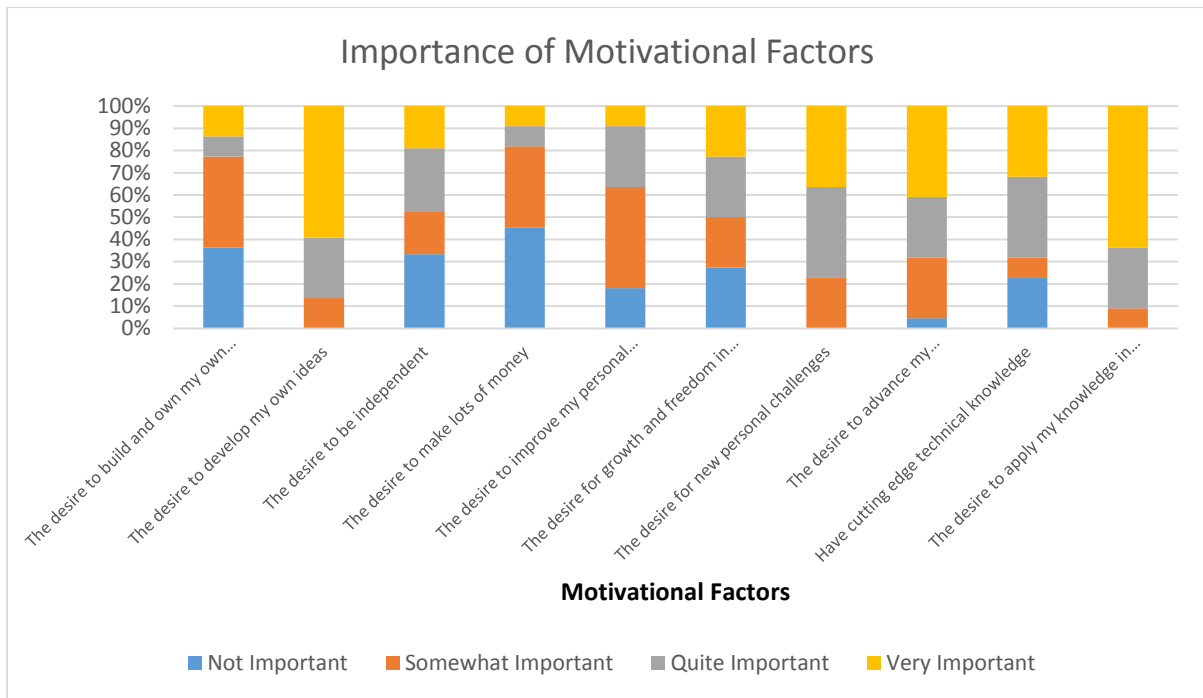


Figure 10 Personal Motivations to commercialize

The average responses for this factor show that nearly 80% of respondents do not consider building and owning their own company a factor in what motivates them. The desire to apply the knowledge as well as the freedom to develop their own ideas were the two highest rated factors in this section. “It is stimulating to see what we study at a basic research level actually makes its way into [practical applications]...” was the overarching sentiment in the follow up questions regarding the motivation to advance the scientific fields and apply the knowledge in practice. The least important factors were the desire to make lots of money and a wish to improve the work environment.

When asked to elaborate on their choices, the respondents who said that the desire to create or own a company responded with “a means to become financially independent” and “to build my own company and grow it from an idea to an organization that makes lots of people find their own value in it”. Those who did not find it important simply stated that they “do not have the desire to [run a company]”.

Looking at the data from a statistical point, three strongly significant Pearson product-moment correlation coefficients stand out:

- 1) The desire to be independent correlates positively with the desire for growth and freedom in the work environment: $r = 0.590$, $n = 21$, $p = 0.006$.
- 2) The desire for growth and freedom in the work environment and the desire to improve my personal work environment: $r = 0.686$, $n = 21$, $p = 0.001$
- 3) Have cutting edge technical knowledge and the desire to advance my scientific/technical field: $r = 0.873$, $n = 21$, $p = 0.000$

The desire to make lots of money and the desire to apply my knowledge in practice was the only correlation to produce a significant negative (opposite) correlation: $r = -0.443$, $n = 21$, $p = 0.044$. This is a mild negative correlation which it shows that as one factor increases, the other decreases. The

scatterplot, Figure 8, below shows this effect. In other words, as the desire to make money increases, the desire to apply knowledge decreases.

Overall there is strong positive correlation between cutting edge technical knowledge and the desire to advance my scientific/technical field which is summarized in the figure below.

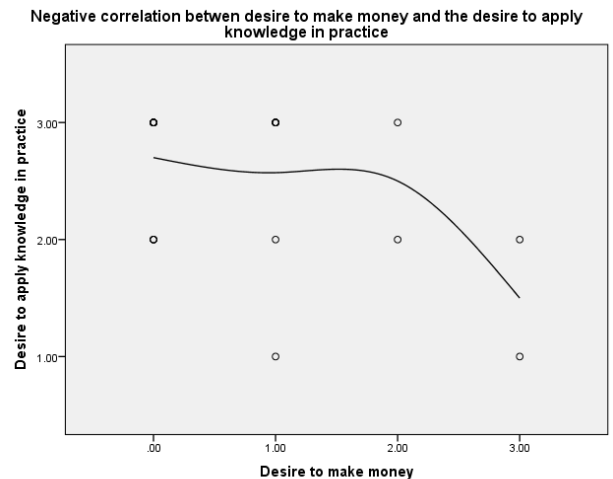
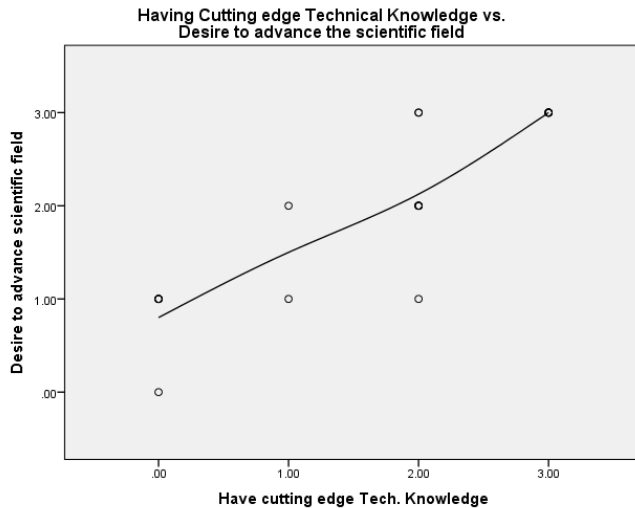


Figure 11 Desire to make money vs Desire to apply knowledge

Figure 12 Cutting edge technology vs. Desire to advance scientific field scatter plot

Leveraging a business idea

Businesses require an idea to use as leverage when starting a new company. The respondents were asked to rank the importance of the following factors when they were in the process of identifying the core competencies for the future businesses. The factors are: difficulties in exploitation or commercialization of your own patent, a business opportunity developed by a third party such as an incubator or a technology transfer office, a new production method, the identification of a new product/service and the perceived needs of potential clients and/or deficiencies in existing products.

A new product/service idea and identifying the perceived needs of potential clients with innovations developed at the university were the most important factors which help in leveraging business opportunities and motivating the researchers to push towards commercialization. The perceived needs of potential clients factor received the strongest average result and is the most important factor for the researchers receiving with 58% of the researchers stating that it was very important. Factors such as identification of a new production method and leveraging a business idea developed by/together with an incubator organization were the next most important. The chart can be seen in Figure 10.

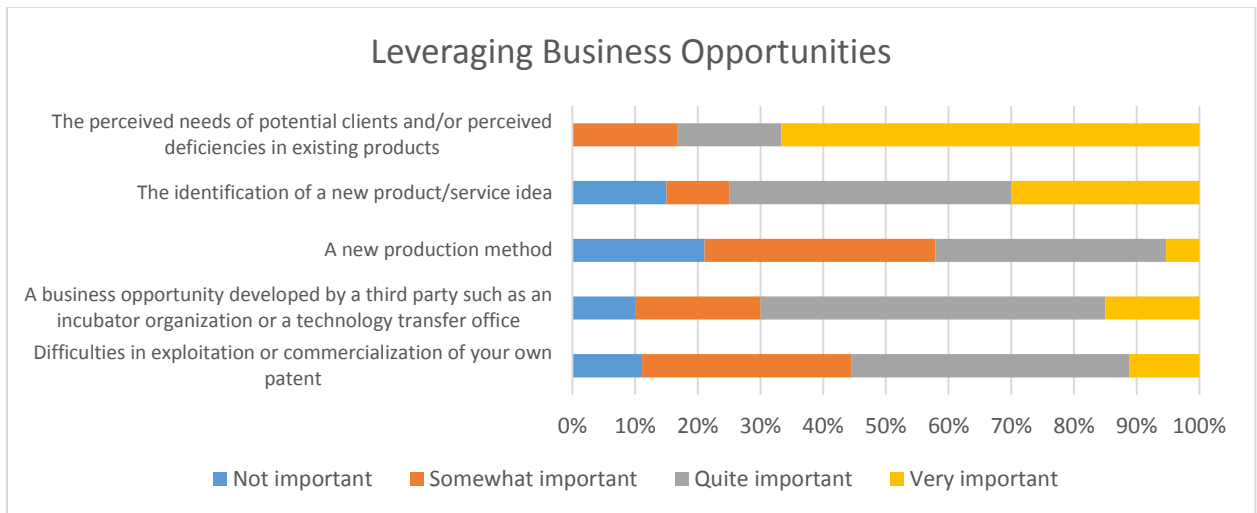


Figure 13 Leveraging a Business Idea

Availability of Resources

Resources such as knowledge, economic, human capital and professional contacts can help motivate a person to start a company if they are available. The following factors played important roles in the commercialization process for the respondents: availability of funding, opportunity to invest personal funds, opportunity to manage the company, availability of contacts (potential partners), good network of contacts in the target market, nearby science park, nearby business incubator, available production facility, existing knowledge base for the company, the difficulty in transferring knowledge to the market and the exclusivity of the knowledge the company can provide.

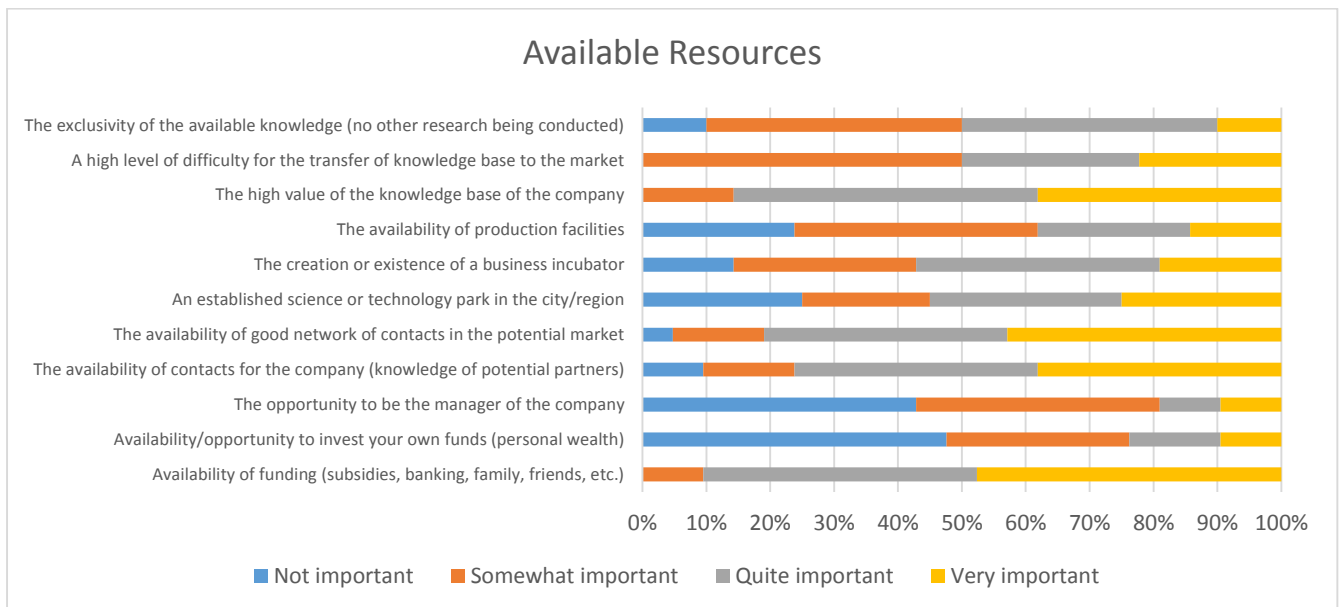


Figure 14 Available Resources

The factor that garnered the highest importance in both the quite important and very important scales was the availability of funding followed closely behind by the high value of the knowledge base within the company and the availability of a good network of contacts in the potential markets respectively. The least important factors were the opportunity to invest personal funds, which had

the lowest importance level followed by the opportunity to be a manager or part of the management team in the company.

Respondents ranked the high level of difficulty to transfer knowledge base into the market as only somewhat important as well as the availability of production facilities.

When analyzing the data through SPSS, a number of significant correlations within this line of questioning emerged as well as a number of factors which correlated with a number of the other questions.

Researchers found a lot of difficulty with commercialization if they had to invest their own funds. The Pearson correlation of $r = -0.606$, $n = 21$, $p = 0.010$ and scatterplot below shows the downward trend. The researchers had ranked the opportunity to invest their own funds as their least important factor while they had significant difficulty with the exploitation and commercialization of the technologies.

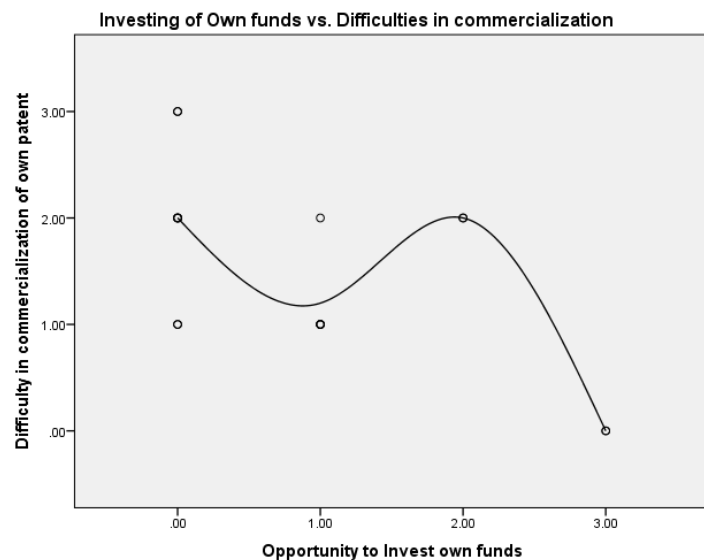


Figure 15 investing own funds vs. Difficulty Commercializing

The desire to build and own their own company correlated positively with the opportunity to be the manager at said company: $r = 0.667$, $n = 21$, $p = 0.001$.

Additionally the availability of contacts for the company i.e. potential partners correlated strongly with the desire for growth and freedom ($r = 0.667$, $n = 21$, $p = 0.001$) showing that when as more contacts become available for the researcher, their willingness to connect with potential partners increases.

This sentiment is mirrored by a strong correlation ($r = 0.657$, $n = 21$, $p = 0.002$) between the availability of a good network of contacts in the potential market and having an established science or technology park in the area from which the company can seek potential partners as well as grow their knowledge base.

University culture and the decision making process

The culture surrounding the business creation process can have an effect on the motivation for the researchers to seek commercialization. The factors in this section seek to understand these factors and what effect they have on the motivation and its effects on the researchers. They are as follows: an established tradition of spin-off creation at the university, difficulty in climbing the professional ranks, a high level of bureaucracy at the institution, a low risk research environment, a difficulty in the development of entrepreneurial activities due to other engagements i.e. conferences, courses, publications, etc. , positive attitudes towards start-up creation and support from colleagues.

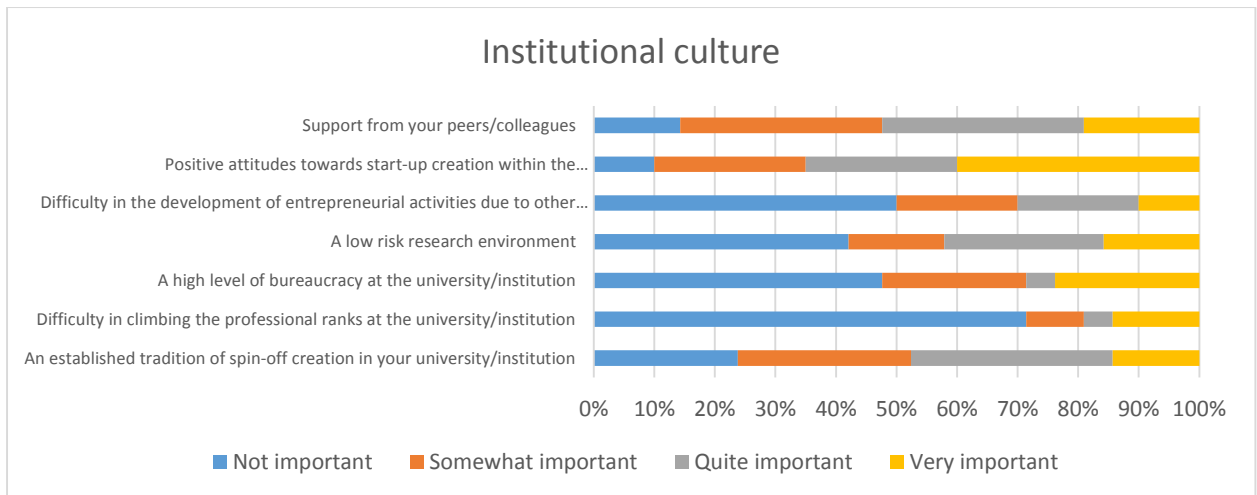


Figure 16 Institutional culture and the decision making process

The average results for all factors in this section were below average. The respondents predominantly answered that the culture had no influence or only somewhat of an influence on their decision making process.

Difficulty climbing the ranks within the institution, the existence of a high level of bureaucracy and a difficulty in the development of entrepreneurial activities all scored very low. The majority of the respondents stated that these factors were of no importance to them whatsoever.

The only significant correlation was between the positive attitudes towards start-ups and support from peers and colleagues in the institution: $r = 0.625$, $n = 21$, $p = 0.004$. In other words, the respondents said that when their peers viewed the entrepreneurial activities positively, so did the university.

Attitudes and impressions from Colleagues

The respondents were asked to identify the attitudes and impressions they have received from colleagues and peers upon commercializing their innovations to gain a better understand of the culture and how those attitudes may have affected the researchers.

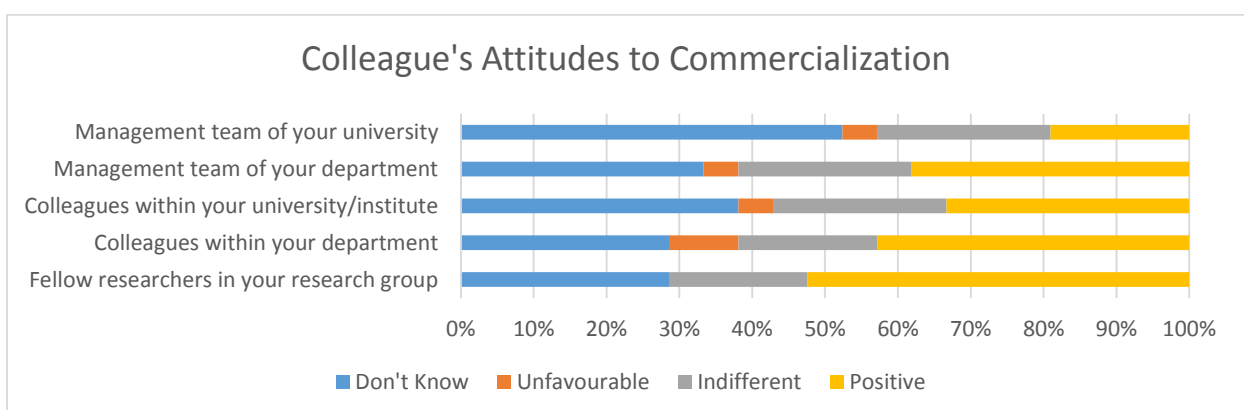


Figure 17 Colleague's Attitudes to Commercialization

The overall impression the respondents have had regarding their colleagues' impressions on their commercialization activities is positive. There are minimal unfavourable responses and a large portion of unknown.

External factors affecting motivation

In addition to the university culture, external factors such as influence from family members with prior entrepreneurial experience, advice from friends, examples of successful companies, advice from other organization, campaigns promoting entrepreneurship and society's attitude towards the creation of spin offs.

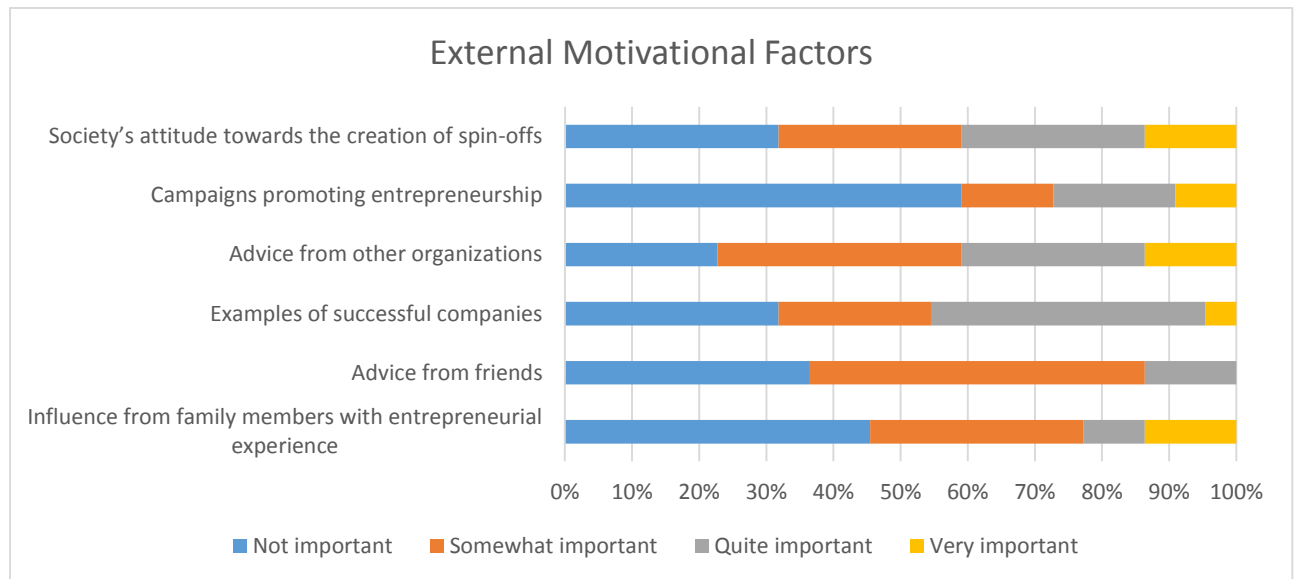


Figure 18 External Motivational Factors

As in the previous section, the responses regarding the effects of external (non-internal) motivational factors was pretty low. The average was even lower than within the university culture. The respondents did not feel that external factors played a major role in their decision making / motivational process although there were a number of significant correlations between both the university culture and other external factors.

- 1) Influence from family members and advice from friends have a strong positive correlation: $r = 0.623$, $n = 21$, $p = 0.004$
- 2) Influence from family members and examples of successful companies: $r = 0.565$, $n = 21$, $p = 0.003$

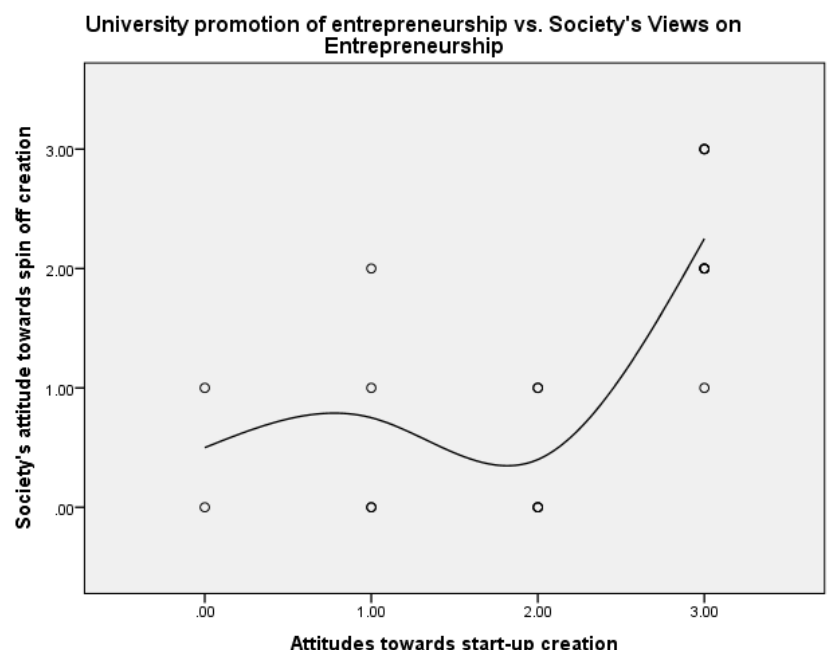


Figure 19 Attitudes

- 3) A positive attitude towards start-up creation at universities correlated strongly with society's views on entrepreneurship: $r = 0.624$, $n = 21$, $p = 0.004$

The strongest correlation appears between campaigns promoting entrepreneurship and society's attitudes towards the creation of spin offs: $r = 0.709$, $n = 21$, $p = 0.004$. Thus, universities promoting entrepreneurship have an overall positive effect on society's attitudes towards start-ups.

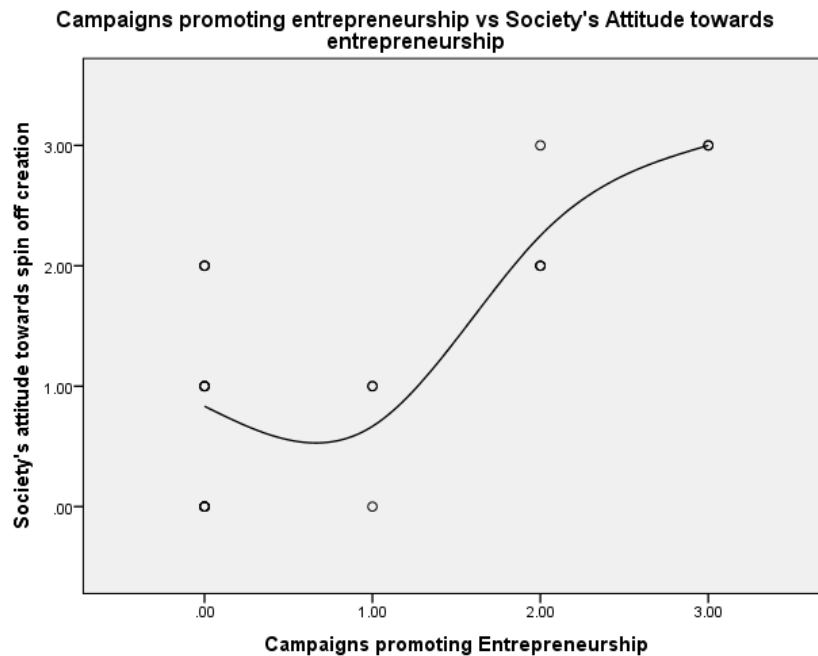


Figure 20 Promoting Entrepreneurship and Society's attitude

External licensing and Collaborative efforts

In addition to the external motivational factors, the respondents were asked a number of questions regarding their experience with receiving government funds for research, whether they had licensed technologies from other companies for use in research or commercialization, if they had received monetary compensation from licensing and how often they or their research groups were involved in collaborative efforts with other research groups.

Nearly 82% of the researchers either solely or with their research group had received external funding either through government grants or subsidies or from industry actors. Only one respondent disclosed that they had licensed technology during the research efforts and over 90% of the sample had not received monetary compensation from licensing.

In the chart on the right, it can be seen that collaboration between research groups does happen and it is common but not very frequent. The majority of the responses fall within the “A few times” and “Frequently” for each of the options. The least amount of collaboration happens with autonomous research groups which can include industry partners. Internally, within the university collaboration appears to be low as well. Working with groups from across or outside the country appears to be the most common practice.

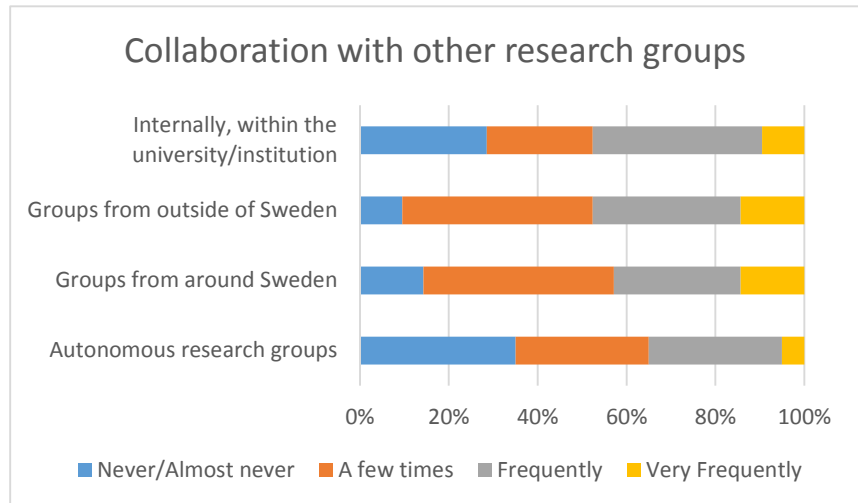


Figure 21 External Collaboration

Prior Entrepreneurial Activities

Respondents were asked to choose from a number of potential activities which relate to management and work experience. The most prominent response was the researchers have known colleagues or others within academic research who have started their own companies based on their innovations. Prior experience with management of research groups in the academic setting was also very popular choice.

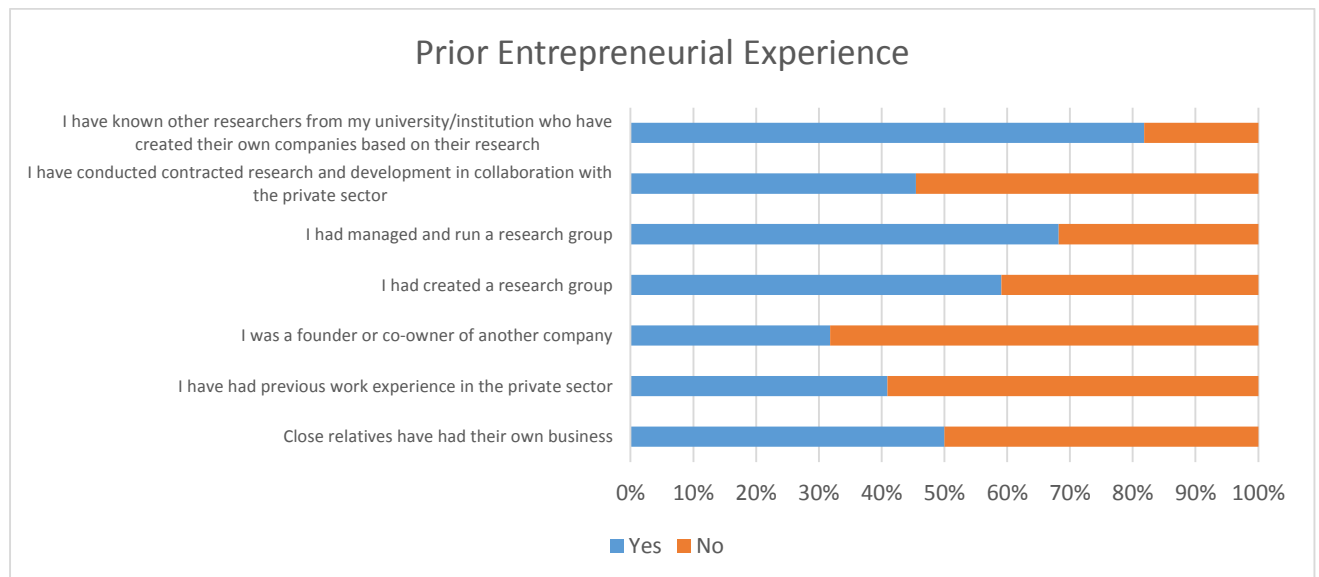


Figure 22 Prior Experience

Company Creation Process

The idea to start the business originated somewhere. The respondents were asked about where or how the idea to commercialize was finally made and who/what helped them decide.

The respondents predominantly reported that the final decision or the moment when they chose to seek commercialization came from either conversations or dealings with an incubator which may have explored various options or from another researcher from outside their own research groups. One respondent mentioned that the idea to commercialize originated from contacts with a potential customer who had been following their research, “The business idea came from the perceived need after being contacted by an industry actor who saw a solution in the research to an internal technical problem. That contact became the company’s first customer.” Another respondent said that the incubator company did not help set up the business but it “tried to encapsulate a business around the technology”.

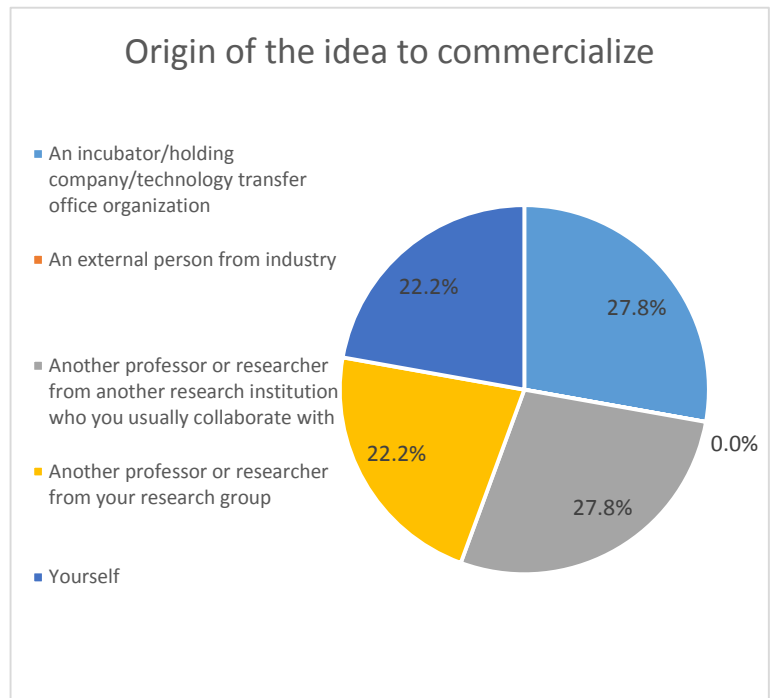


Figure 23 Trigger to Commercialize

External factors contributing to the Company Creation Process

Prior work experience in the private sector, participation in business development projects, the systematic study of potential business ideas, a change in the regulations of the state, major progress in basic research and participation in R&D work for an industrial partner are additional factors which can help spark the idea to start a business.

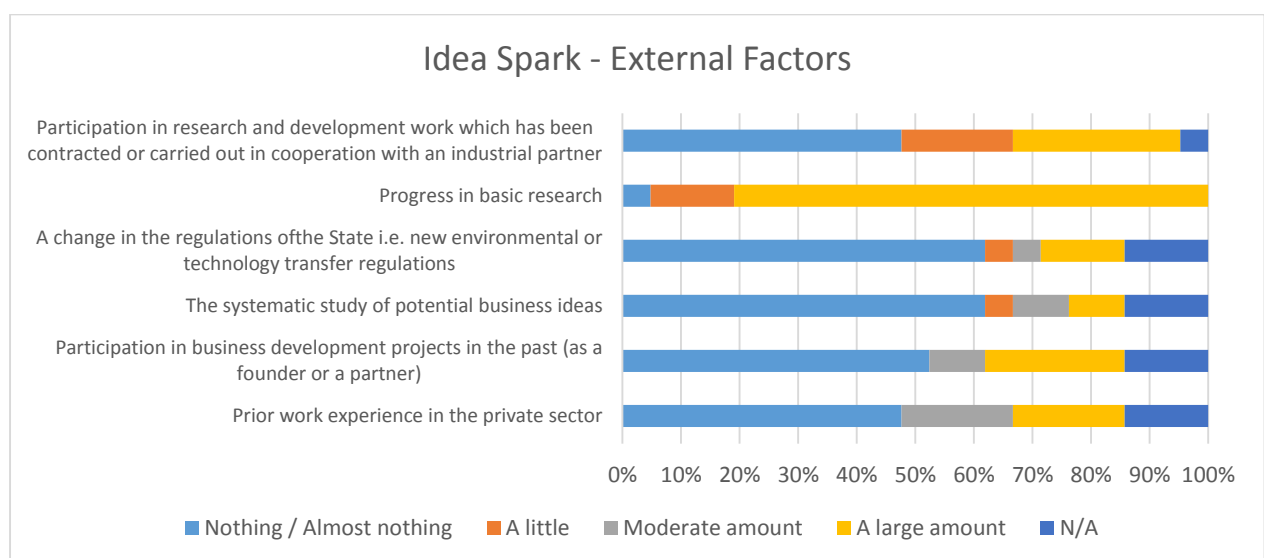


Figure 24 Idea Spark - External Factors

The researchers were asked how each of these factors have or could affect their decision to commercialize. The large majority of respondents claimed that the progress in basic research is their most important and strongest motivator as it “could lead to additional funds to conduction

additional research”. The predominant response as can be seen in the chart above is that the majority of these factors have little to no effect on the researchers. One respondent claimed, in response to changes in the legislative environment that “our business idea was based upon legislative regulations and its effect on certain products” but the majority claim that legislative changes would not affect their motivations too much. Those who have worked in collaboration with industrial partners state that most partnerships or joint projects have given them insights into how the businesses operate thus allowing them to learn from industry and apply the practices and policies into their own businesses. Participation in business development projects and the systematic study of potential business ideas were ranked as least important.

The most notable correlation in this section is the negative correlation between conducting basic research and participating in industrial R&D projects: $r = 0.709$, $n = 21$, $p = 0.000$. The researchers seem to be less interested in participating in industry projects the more they want to work on basic research. This can be seen in the following scatterplot.

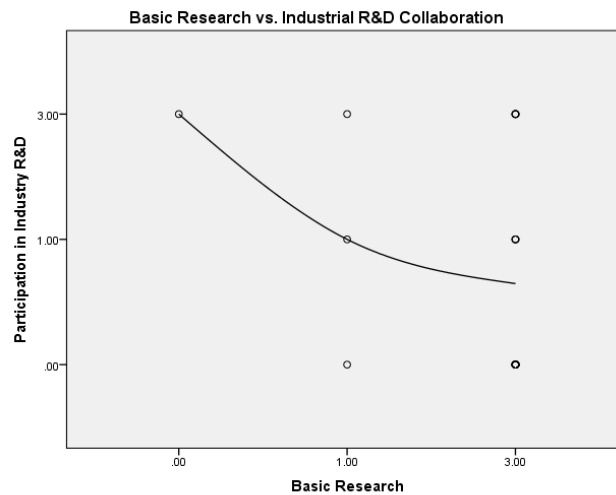


Figure 25 Basic Research vs Industrial R&D

Risk

Risk is a natural feature of business creation. The respondents were first asked if they felt that a potential failure in the business plans would have any effect on their personal assets, their careers and their personal lives. They were then asked if they felt any risk in economic risk for the company, personal economic risk and risk in the continuity of their careers.

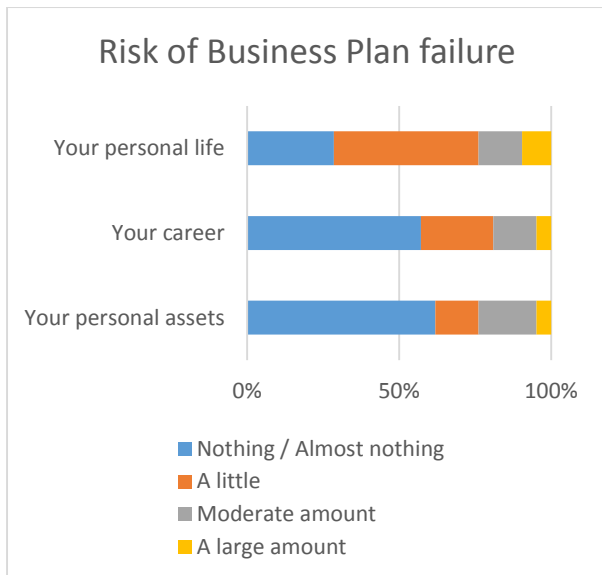


Figure 26 Business Risk

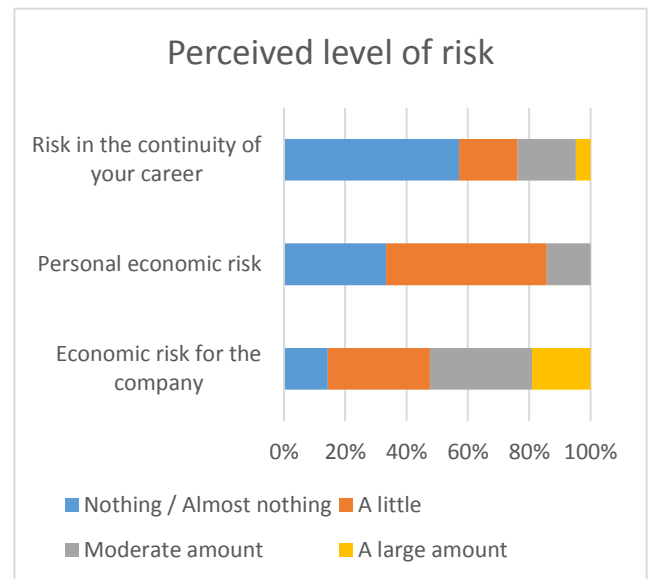


Figure 27 Perceived Risk

The researchers found that the highest risk was in the continuity of their career. This sentiment was paralleled by correlated data which showed that the risk in the continuity of the career correlated strongly with their personal life ($r = 0.641$, $n = 21$, $p = 0.002$), their career ($r = 0.687$, $n = 21$, $p = 0.001$) and their personal assets ($r = 0.595$, $n = 21$, $p = 0.014$) and personal economic risk ($r = 0.684$, $n = 21$, $p = 0.009$).

Business and personal Objectives

The respondents were asked to rank the importance of the following personal and business objectives: to become a great company, to become an international company, to become the best, the leader in a technology area, the best in a specialized market, to be able to serve multiple markets with a wide range of products, to generate an income level sufficient to continue R&D efforts, create job opportunities for fellow researchers and to become personally wealthy.

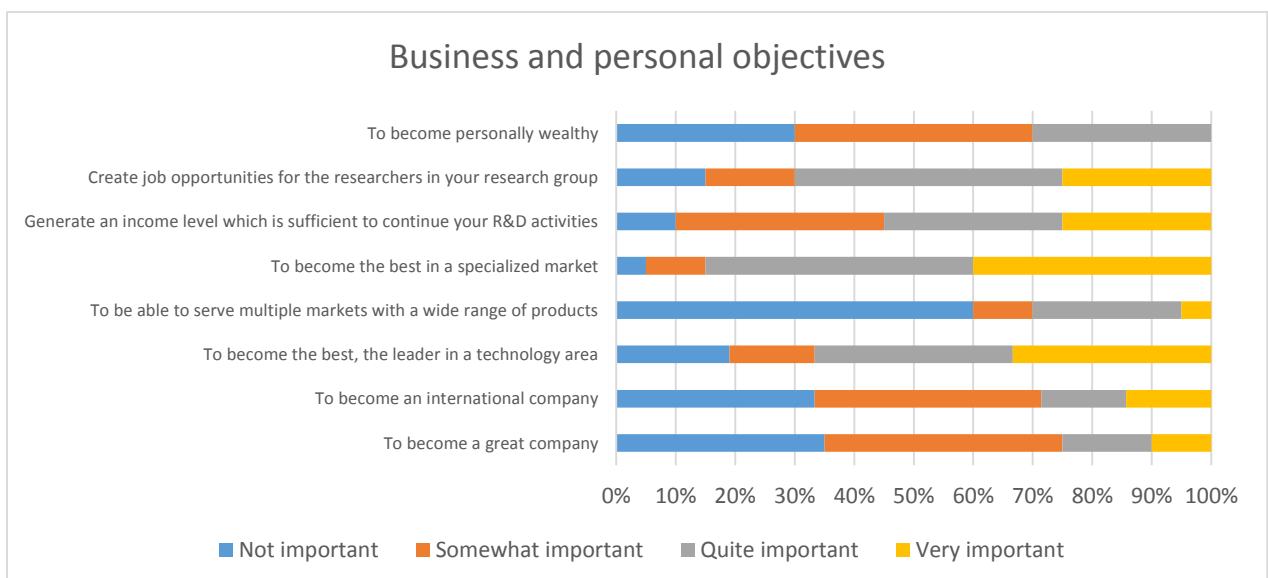


Figure 28 Business and Personal Objectives

The objective with 60% of respondents reporting it as least important was the ability to serve multiple markets with a wide range of products. On the contrary, the 85% of researchers place strong importance on specialization in a specific market. The ability to provide job opportunities for fellow researchers was reinforced in the follow-up responses as all those interviewed stated that they wanted to provide junior researchers in their teams with future positions if they so wished. Personal wealth is not a strong priority or objective neither is the wish to become an international company. The strongest correlation was between becoming the best in a specialized market and becoming leaders in the technology area with a moderately significant correlation of $r = 0.537$, $n = 21$, $p = 0.015$.

Difficulties in commercialization

The respondents were asked to rank the issues they faced during the star-up process of their respective companies. As the respondents are at varying stages of commercialization, some issues may not be encountered or not applicable to their businesses. The difficulties faced by the researchers include: securing financing, application / granting of patents, negotiating rights for commercialization, developing a commercial product, sales and distribution networks, suppliers, market demand estimations, other competitors, production and production equipment availability, finding a management team, legal issues, disputes with partners, and personal issues.

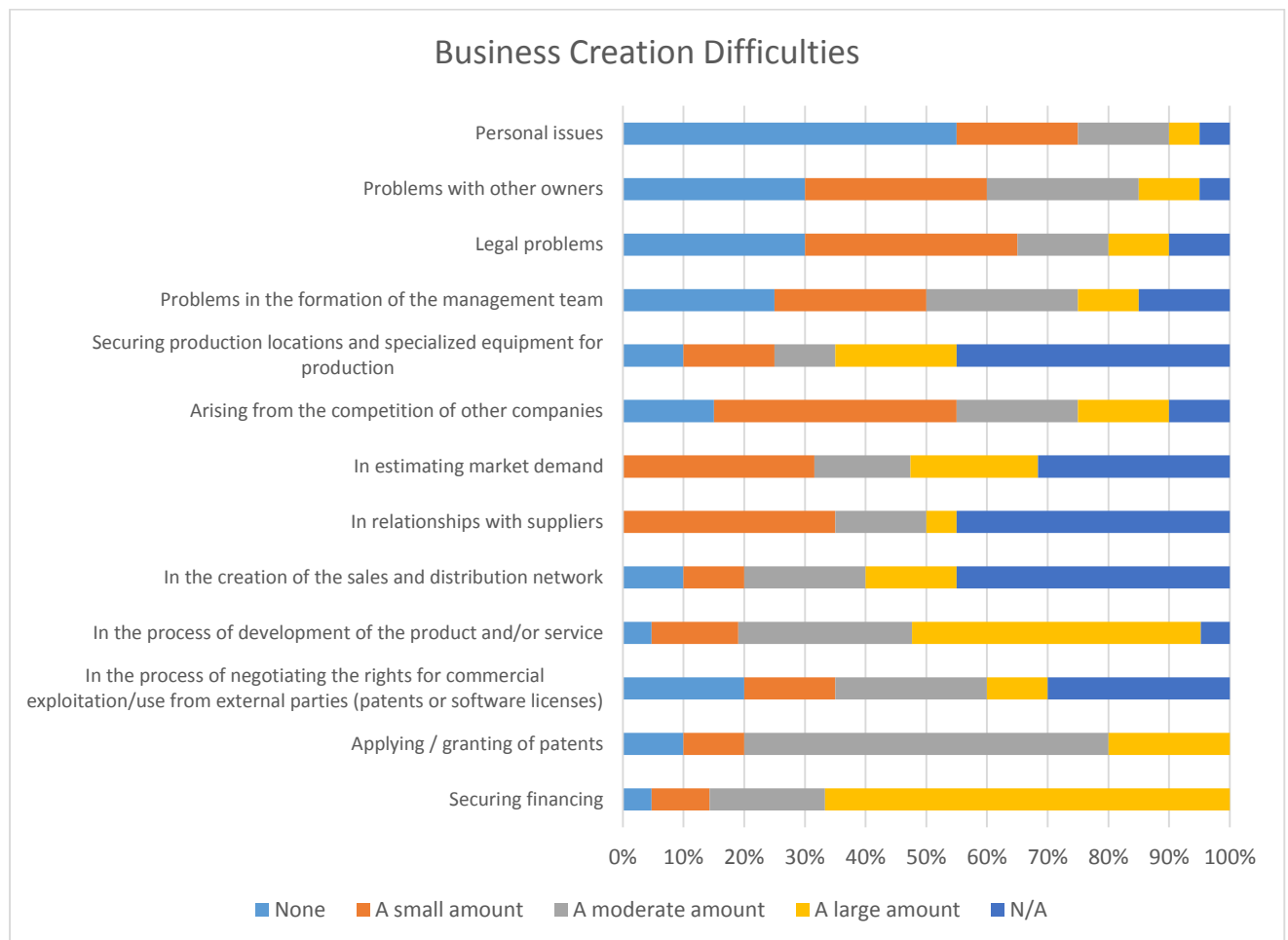


Figure 29 Start-up creation issues

Securing financing is the most difficult process during business creation according to the researchers followed by the application and granting of patents. The respondents shared the same sentiment when asked about the difficulties in patenting: “Patent application and acceptance is a very time consuming process. The application takes many days, weeks and months with multiple revisions on top of conducting research while the potential granted patent may take years if it happens at all”.

Product and service development also saw a large level of difficulty as researchers struggled to apply their innovations into consumer products. As one respondent says “Even with experienced engineers product development is a very hard task. There are lots of unforeseen problems such as customers asking for different things and the requirements are set out too late to make changes.”

Looking at the correlations within this section, there is a very strong positive correlation between Securing production equipment or facilities and maintaining relationships with suppliers: $r = 0.706$, $n = 21$, $p = 0.001$. The scatter plot shows this relationship very well. The higher the difficulty in securing a manufacturing facility / equipment, the more difficult it is to maintain a relationship with suppliers.

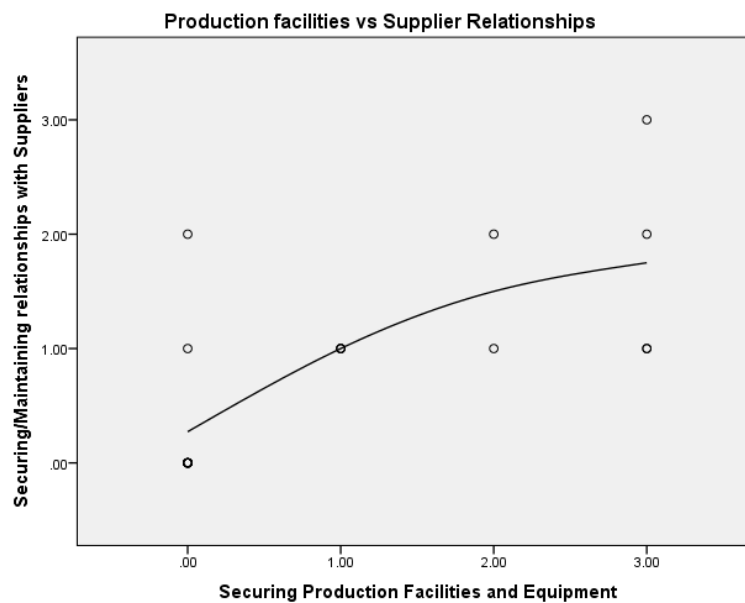


Figure 30 Production facilities vs Supplier Relationships

Securing a strong management team correlated strongly with both the difficulties in the creation of sales and distribution networks ($r = 0.633$, $n = 21$, $p = 0.003$) and maintaining the relationships with suppliers ($r = 0.684$, $n = 21$, $p = 0.001$) showing the difficulties faced and the importance of a strong management team. The scatter plots are shown below.

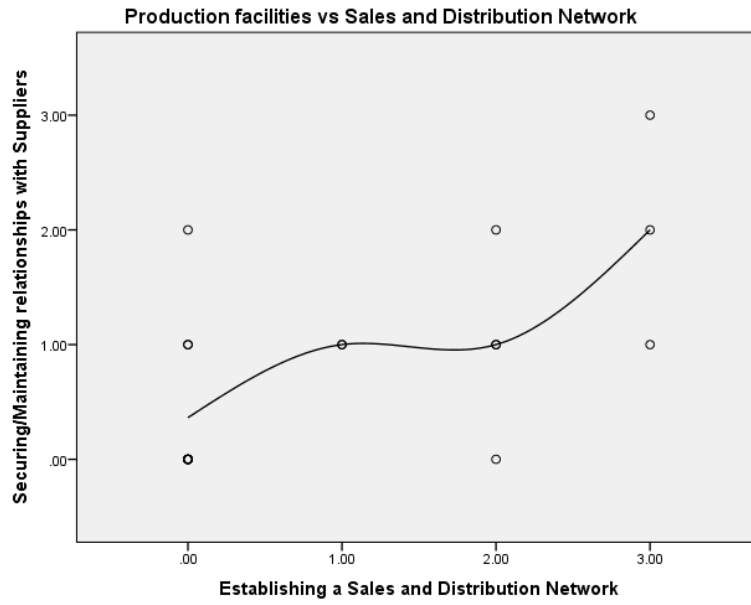


Figure 31 Production vs Sales

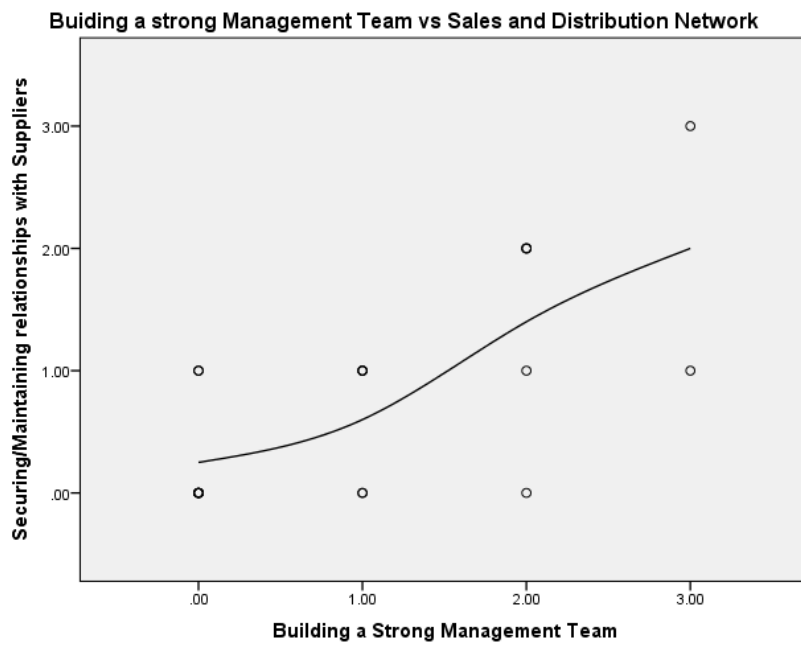


Figure 32 Suppliers vs Management Team

Entrepreneurial services available at the home university

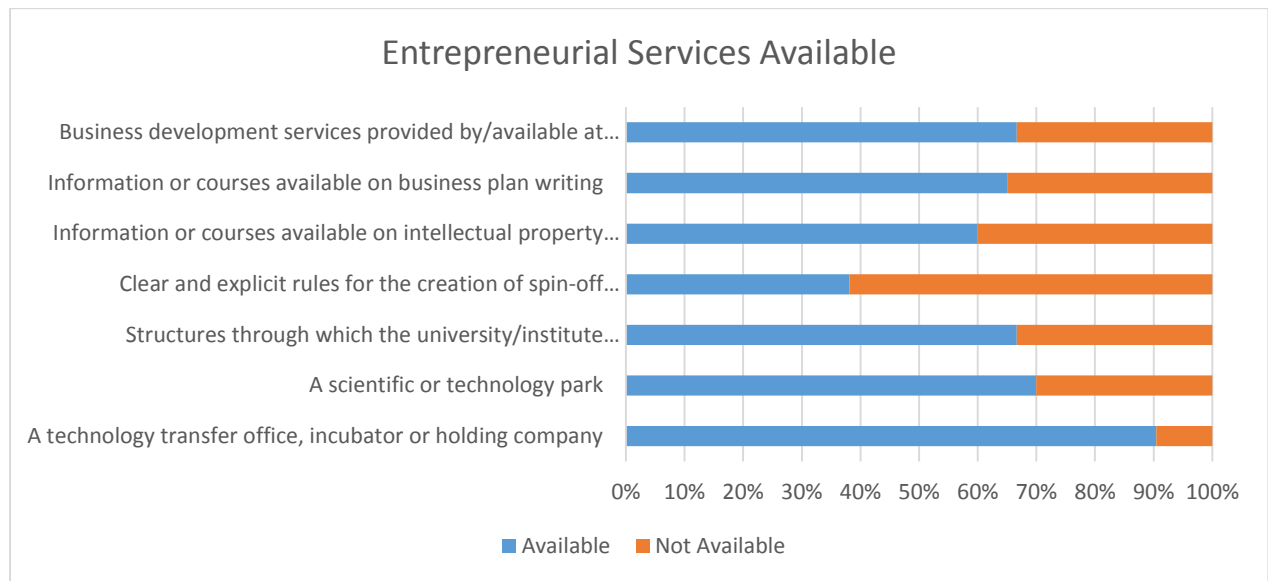


Figure 33 Entrepreneurial Services Available

With the exception of clear and explicit rules for start-up/spin-off creation which came in at just under 40% of universities, all other respondents reported that their institutions have almost all of the listed entrepreneurial services. These services include: a technology transfer office, incubator or holding company, a science and technology park, established structures for finding capital investment, information or courses on intellectual property rights, business plan writing courses and assistance and business development services.

Even though these services are available, the respondents were asked about the extent to which their university/institution was involved in helping set up their business.

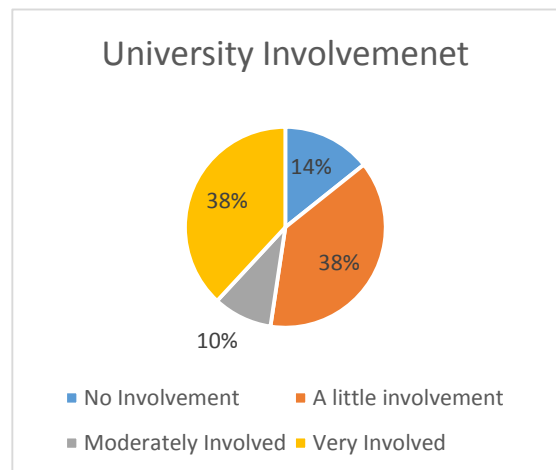


Figure 34 University Involvement

Comparing the results from the entrepreneurial services available at the universities with the level of involvement in this section, a number of interesting correlations arise.

All of the correlations in this data set are significantly negative signifying an opposite correlation between all the factors. The strongest negative correlation is between the level of involvement of the university and the structures through which the university/institute participate in the search for capital funding of spin-offs. The resulting correlation can be seen in the scatter plot below: $r = -0.722$, $n = 21$, $p = 0.000$.

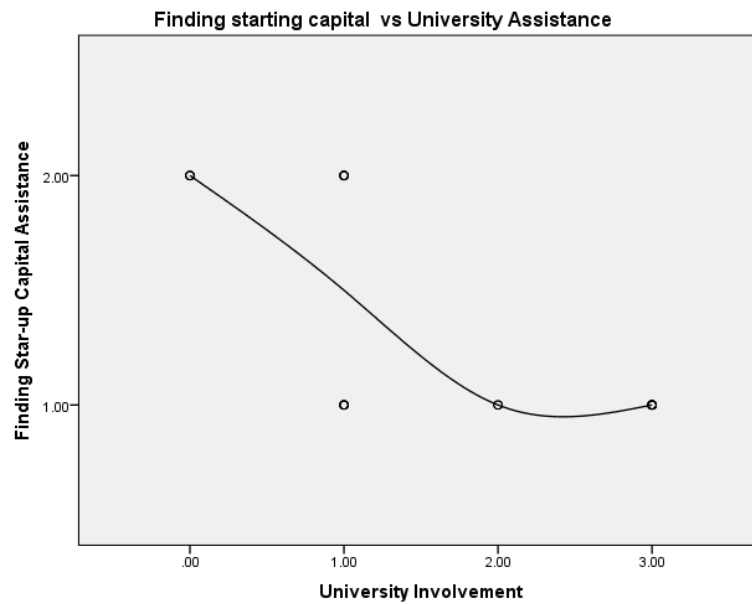


Figure 35 University assistance vs. Finding Capital

Specific involvement by the university

To expand on the services and level of involvement, the researchers were asked about how much of each of the following services they received during the business creation process. The choices were: advice on how to build a business plan, legal advice, administrative support for setup procedures, contacting venture capital firms, help finding customers, information on possible funding sources, payment of patenting fees, transfer of usage rights for the patents, rights of use and exploitation of software licensing, production or product/service delivery facilities available for use/rent, right to use high cost departmental equipment and labs, decrease of academic load for the researcher, qualified lab staff, training in business management, seed capital.

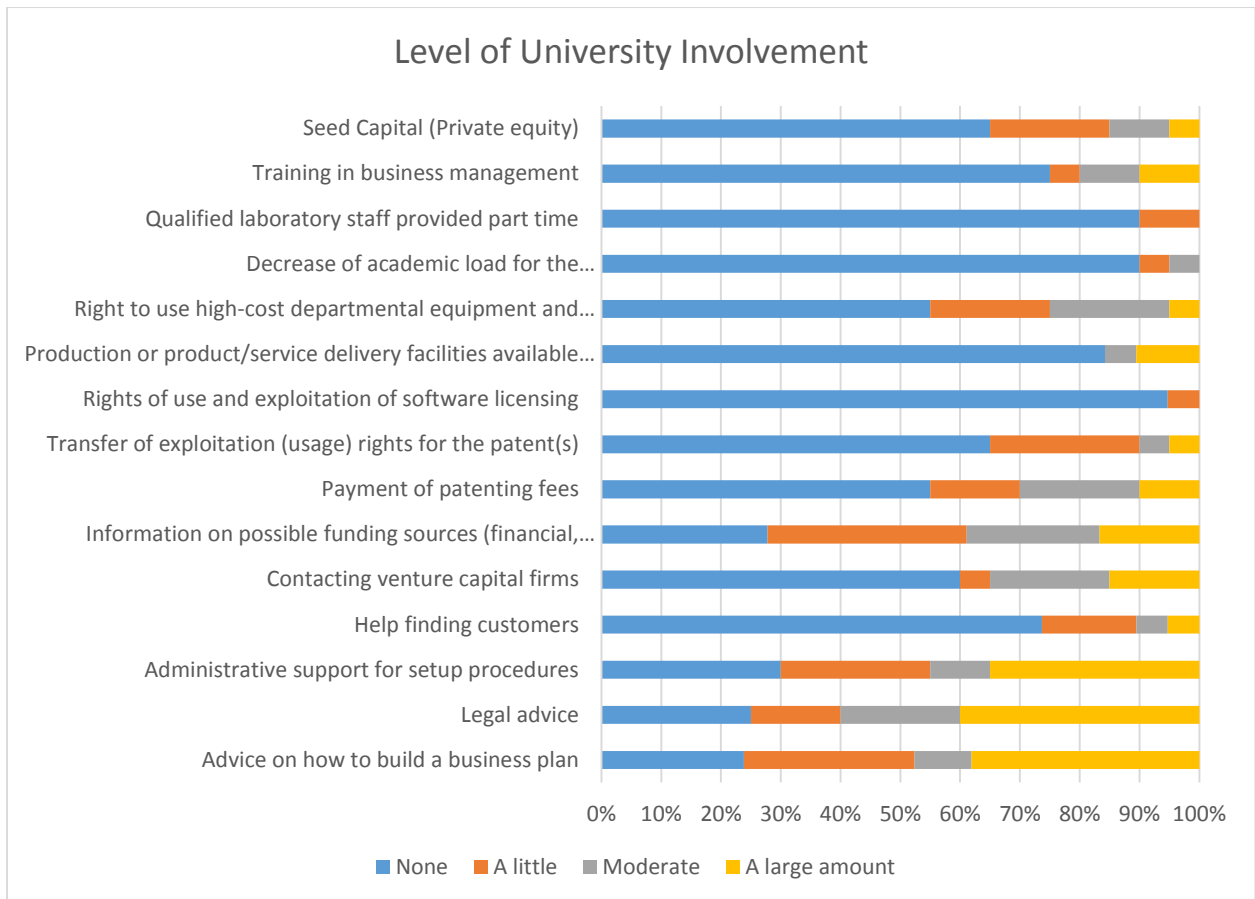


Figure 36 University Involvement

Although the researchers reported previously that their respective institutions provided various services to assist in the entrepreneurial ventures, the average rate of involvement was fairly low. In the chart above, it can be seen that the highest level of involvement appears within the legal advice, business plan building and information on how to find sources of funding.

The following two graphs show the average rate of responses for the level of university involvement. The scale was: None (0) to A large amount (3). The first graph shows the average while for the second, the respondents were asked if they would like to see a change in the level of involvement. The data is represented using arbitrary numbers to signify a difference between the results.

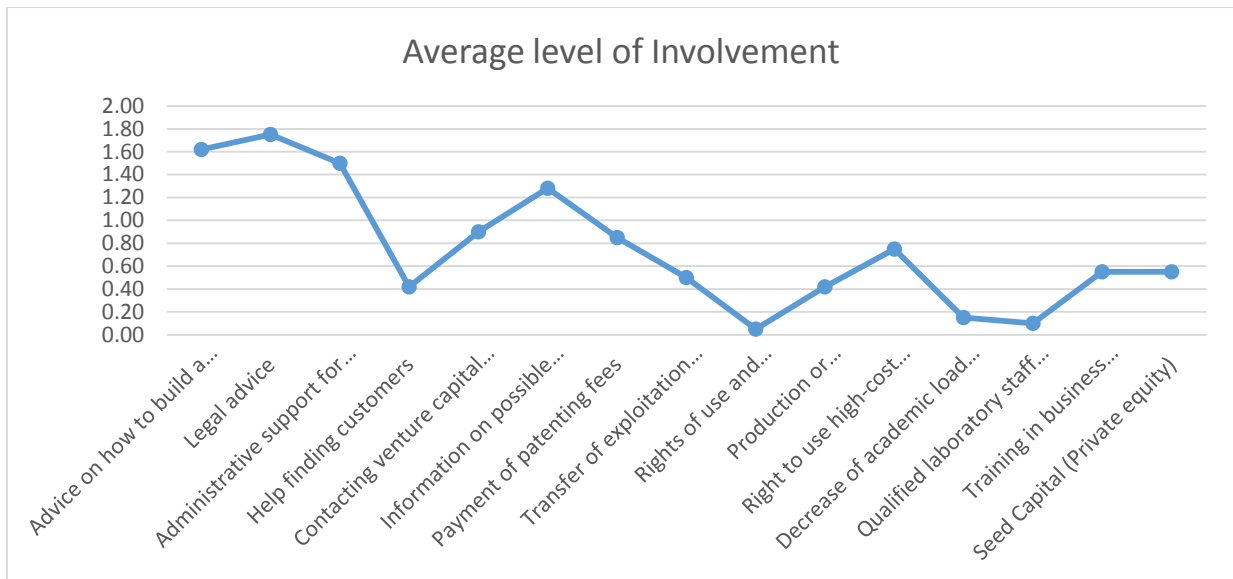


Figure 37 Average level of University involvement

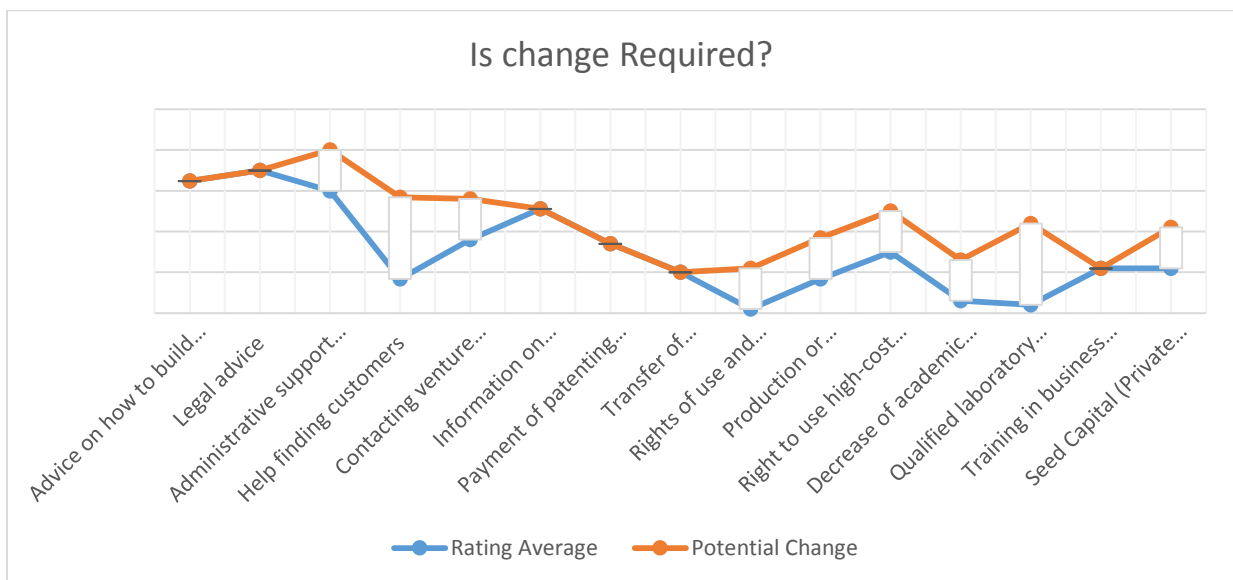


Figure 38 Change in Involvement

The difference between the data is the direction in which the change should happen. If the change is higher than the average, there should be more of subsequent involvement. If there is no difference, the level of involvement is adequate according to the researchers who responded to the follow up survey.

Preferences relating to researcher/university ownership and delays on publication

The respondents were posed three final questions which them to choose between two hypothetical scenarios as well as how long they are willing to wait to delay publication to ensure their intellectual assets and properties are protected adequately.

The first question asked the researchers to choose between: researcher owns the rights to their inventions and manages commercialization privately or the university owns the technical inventions, manages commercial activities and gives a share of the generated revenues to the researcher.

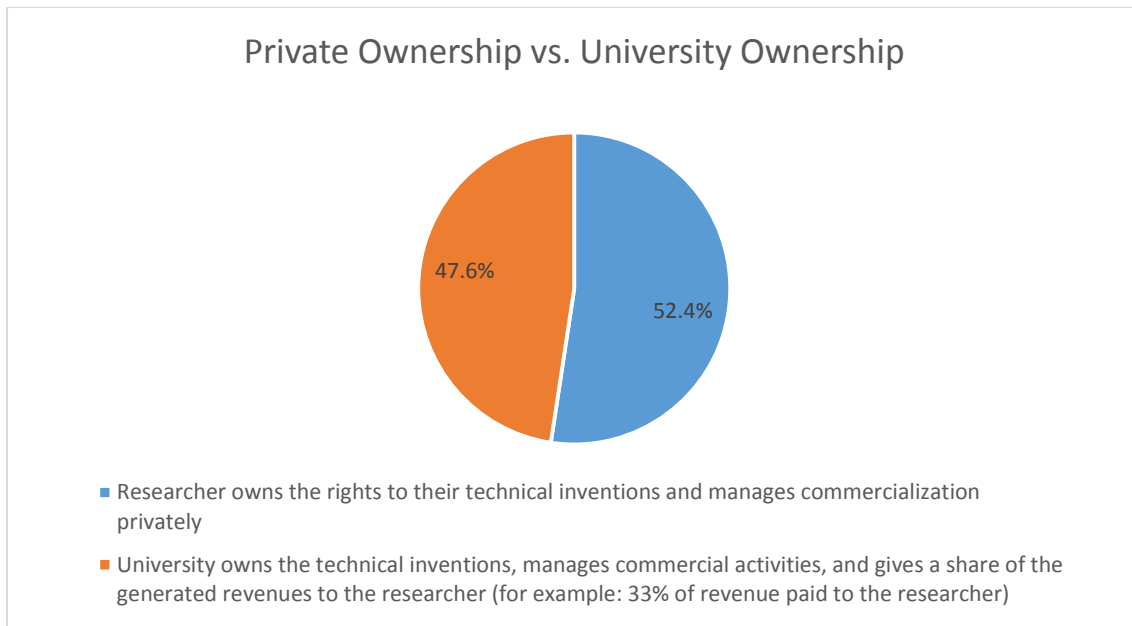


Figure 39 Private vs University ownership

More than half of the respondents chose to maintain private ownership of their innovations. When asked why they chose private ownership, the answers varied from “If I own the rights, I can interact with whomever I choose” and “the business development team should keep the IP in house as they have a deeper understanding of the technology” to “These issues are not interesting but agreements can be made”.

The second question asked how long they would delay publication to allow enough time to protect the IP.

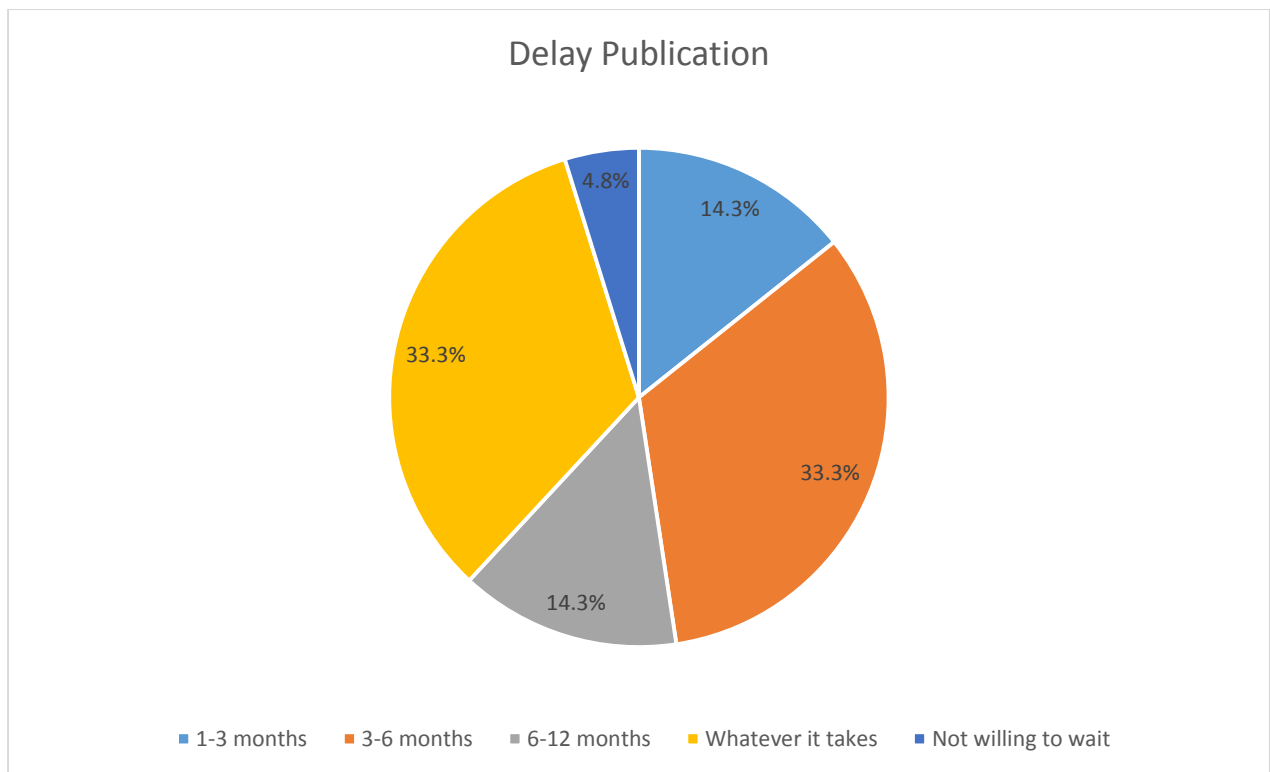


Figure 40 Delay Publication

Whatever it takes and three to six months are the two most popular responses totaling two thirds of the sample. Six to twelve months and one to three months were the next most popular and a less than 5% reporting they were not willing to wait publication.

The time delay before publication varies between the respondents. Some state that “it depends on the situation” while others feel that “3-6 months is adequate/standard for the department”.

The last question asked whether the researchers would prefer to continue conducting research while allowing the university to handle the commercialization or if they would like the institution to allow them time off from their academic responsibilities so they can focus on utilization on their own.

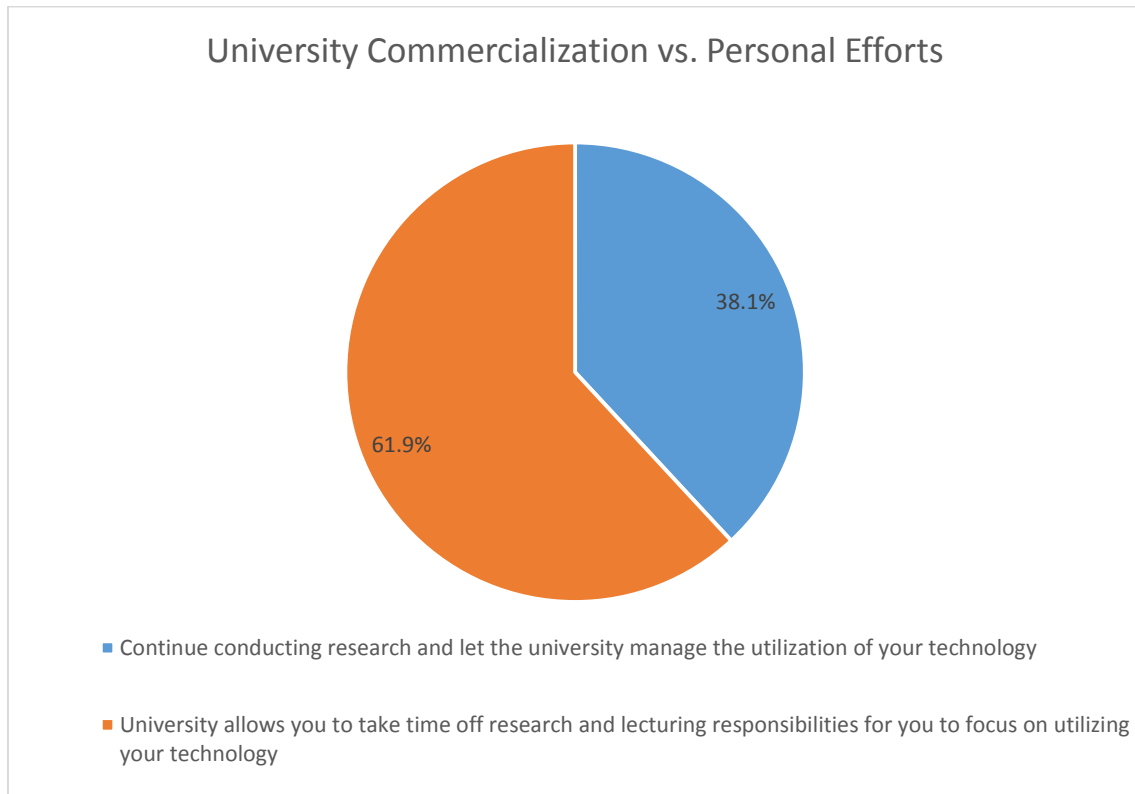


Figure 41 Commercialization vs Personal Efforts

The large majority of respondents indicated that they would prefer to take time off so they can focus on the commercialization of their innovations.

With regards to the management of the commercialization, those who responded that they would prefer to manage their own utilization activities explained that "I see great academic value from the network I have developed via my companies. The feedback from the market gives the academic studies a solid application background. Sometimes this kind of feedback is very hard to obtain for a person who stays in the university." Another notable explanation was "bureaucracy has never been successful in fulfilling targets. I like to hold the reigns myself." A respondent who prefers the university management option explains that they are "more interested in my research and teaching than management of business ideas".

The statistical analysis reveals that there are no significant correlations regarding the ownership, how long researchers are willing to wait for publication and who they would prefer to manage the innovations.

Note: The values in the charts are as follows

- 1) Ownership of innovation: 1 = Researcher ownership, 2 = University ownership
- 2) Time delay: 1 = 1-3 months, 2 = 3-6 months, 3 = 6-12 months, 4 = whatever it takes, 5 = not willing to wait
- 3) Management of innovation: 1 = University management, 2 = personal management

Ownership of the invention correlates negatively with the time delay: $r = -0.250$, $n = 21$, $p = 0.274$

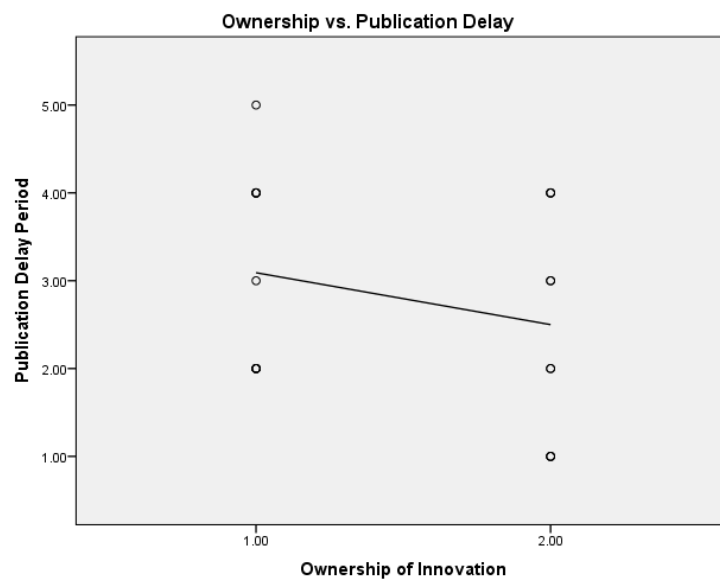


Figure 42 Ownership vs Delay

Ownership of the invention correlates negatively with the management of the invention: $r = -0.430$, $n = 21$, $p = 0.052$

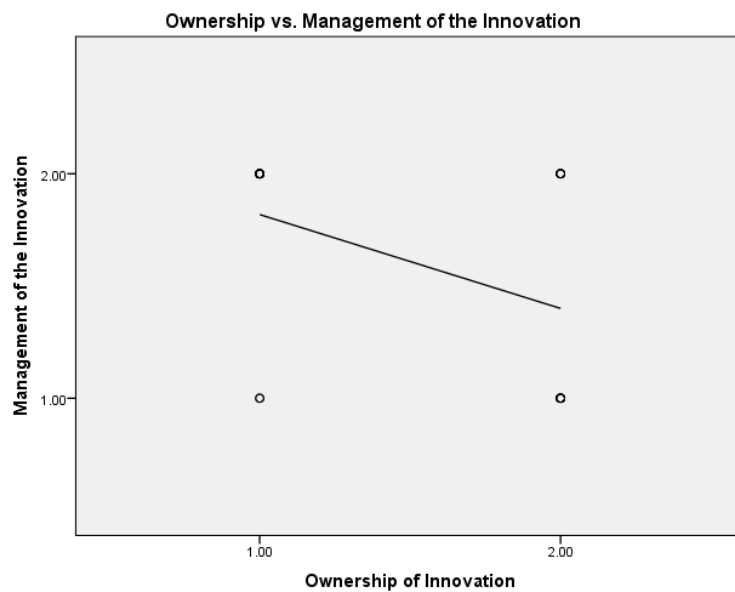


Figure 43 Ownership vs Management

Time delay and management of the invention experience no correlation: $r = 0.206$, $n = 21$, $p = 0.371$

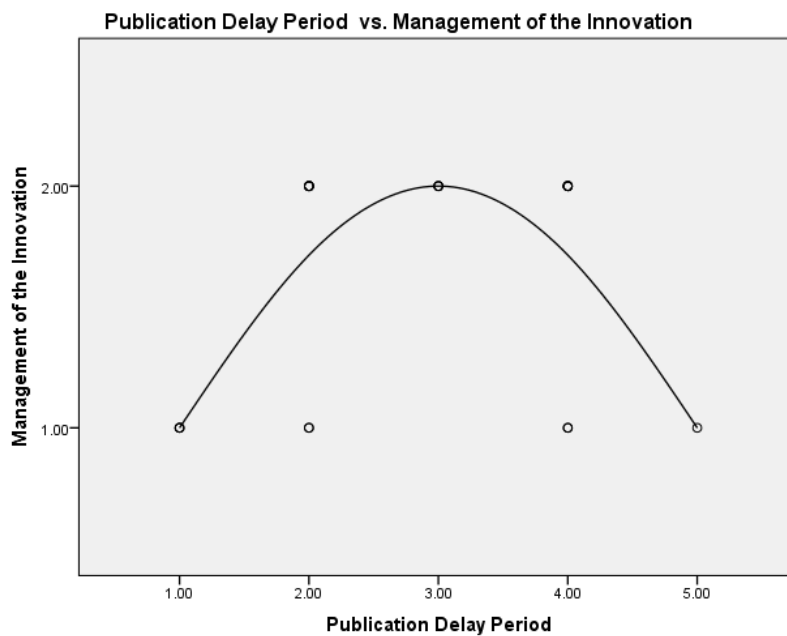


Figure 44 Publication delay vs Management

Summary of the results

The quest for new knowledge and the ability to disseminate it was the most important factor for the Swedish researchers. Entrepreneurial opportunity: the identification of a new product or service was just marginally lower in importance but served as a strong motivator for researchers to commercialize. Resource availability averaged quite important for the researchers as financial, social, business and human capital requirements are crucial to the start-up and continued success of a company. Personal motivations such as the need to make money, social approval and promotion of entrepreneurship within the university were the least important factors for researchers overall.

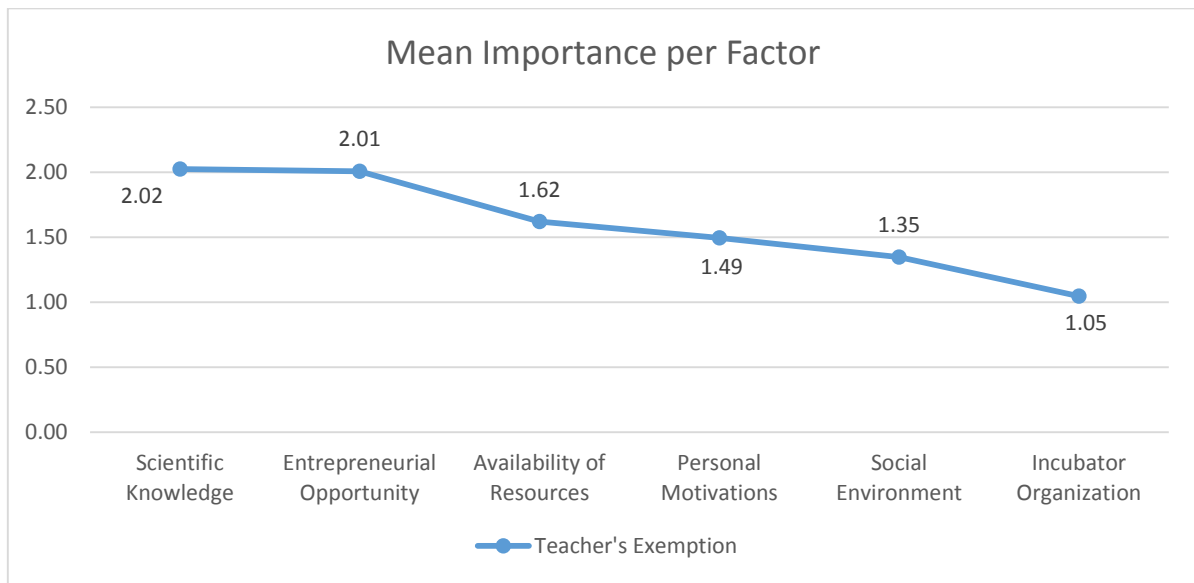


Figure 45 Importance factors

Overall, Swedish researchers are content with the private ownership model and would prefer to manage their own innovations. The majority of respondents are willing to wait to publicize their results to allow adequate time to secure IP rights.

6. Discussion

In this section, the discussion will revolve around the results of the data: what it means and how it compares to the study conducted in Spain. Additionally, the data from the hypothetical questions at the end of the questionnaire will be analyzed and discussed.

6.1. Motivational and Important Factors

Motivations and experiences for commercialization vary between individual researchers. Analyzing the data collected revealed the most and least important factors which may contribute to their reason to commercialize. Not all variables produced clear “high” or “low” importance. In Appendix 1, a chart summarizing the deviation of the variables can be seen. Two of the 36 factors had nearly an even spread in terms of answers on importance. The first is “V5 – Lack of work prospects” which addressed the desire for growth and freedom in the work environment and the second is “V22 – science or technology parks in the area”. V5 stems from the personal motivations factor (need for independence sub dimension) while V22 is from the availability of resources factor (available production facilities sub dimension). Both of these variables had nearly identical spread in terms of importance rating thus neither variable can be deemed important or not important overall as there is no clear consensus between the surveyed populations.

In similar fashion, the variables V6 – desire for independence, 11 – having cutting edge technological knowledge, 14 – difficulties in transferring knowledge to the immediate environment, 15 – exclusivity of available knowledge, 23 – business incubator in the vicinity, 29 – tradition of spin-off creation at the university, 30 – attitude towards spin-off creation at the university, 33 – examples of successful companies, 34 – advice received from external organizations and 36 – society’s attitudes towards entrepreneurship each experience a high deviation between the responses. There were no variables which had “Not important” and “Very important” as a response gap, but the majority of the aforementioned variables had conflicting responses.

The entrepreneurial opportunity, need for achievement, financial resource availability, social networks, and organizational barriers sub dimensions had the least amount of disparity between the responses. The respondents seemed to agree on the rest of the variables and factors were important thus allowing for this researcher to deduce that the following are the most important factors for commercialization of university inventions for Swedish researchers:

- 1) Personal motivations
 - a. High need for personal achievement
 - b. A desire to develop one’s own ideas
- 2) Entrepreneurial opportunity
 - a. The identification of a business opportunity developed by an incubator
 - b. Identification of products or services and perceived customer needs
- 3) Scientific knowledge
 - a. The desire to apply knowledge to practice
 - b. To develop cutting edge technologies
- 4) Availability of resources
 - a. Having contacts in the market for potential customers/partners beforehand
 - b. Contacts for managers able to manage the company
 - c. Close proximity to a science or technology park

There is no one specific motivating factor which stands out as most important or as the deciding factor in the push to utilize university technology. Instead a variety of factors within 4 of the 6 identified dimensions combined together can help trigger the drive to establish a company around technology developed at the university. As Fritsch and Krabel (2012), Etzkowitz (1998), Morales-Gualdron (2009) and other research studies have shown, a combination of the above factors working together can motivate the researchers. Across all the studies, the single most important factor was the quest for knowledge (Fritsch & Krabel, 2012) and the desire to put it into practice. Additionally, entrepreneurial opportunity, resource availability, a need for control of the innovation and a desire for independence were factors shared by nearly all researchers across the various studies. Monetary gains was the least important motivator for researchers which is in line with the studies conducted in Finland by Autio and Kauranen (1994) and Chiesa and Piccagula (2006) while those who performed similar research in Canada, the UK and the US found that monetary gain does play a part in motivation (Morales-Gualdron, et al., 2009). The motivations for researchers vary from region to region and with experience, but the end goal is the same, generate knowledge and disseminate it.

6.2. Motivational factors: Comparison with Spain

In the study by Silvia T. Morales-Gualdron et. Al (2009) in Spain, the study revealed the 18 factors and 36 variables to entrepreneurial motivation. Those variables and associated values are listed in the table in Appendix 2 together with their standardized loading results from the study: 0 (not important) to 1 (very important). The teacher's exemption (mean score) column displays the mean score of all values between 0 (not important) and 3 (very important).

The Spanish study revealed that entrepreneurial opportunity is not a significant factor for researchers in the decision to commercialize. The same applies for V7 – desire for wealth, V17 - Available personal assets to invest, V25 – Difficulty promoting professionally within the university, V26 – Low risk orientation of the research environment, V28 – Existence of specific rules for the creation of spin offs in the university, V29 – Existence of a tradition of spin-off generation in the incubator organization, V30 Attitude towards new business creation within the incubator organization and V31 Relatives or family members act as entrepreneurs. Although these variables do show some influence they are not significant thus are excluded from their calculations.

Comparison of results

In this section, the analysis will compare the relative results of the variables between the work performed in this thesis and that with the work by Morales-Gualdron et.al (2009). To conduct the analysis, the results are normalized for both sets of data using the equation below then graphed. Figure 47 shows the 36 variables side by side. The names correspond to the variable factors listed in Appendix 2.

The normalized values provide equal ground from which to compare the results on a 0 – 1 scale. The number are divided into the four importance levels: 0 – 0.25 Not important, 0.25 – 0.5 somewhat important, 0.5 – 0.75 quite important and 0.75 – 1 very important.

$$\text{Normalized } (e_i) = \frac{e_i - E_{\min}}{E_{\max} - E_{\min}}$$

where

E_{\min} = the minimum value for variable E

E_{\max} = the maximum value for variable E

Equation 2 Normalization of Two Sets of Data

It is important to note that as discussed in the limitations chapter previously, the sample size for this thesis is not only very small, but biased towards a homogenous biotech sample. Additionally, the analysis and comparison between the Spanish study and Sweden faces an additional challenge. The Spanish study had a much larger sample size, nearly 150 respondents from universities and research groups all around the country while the current study focused only on the Gothenburg, Sweden geographic area. The results from this section can only be compared and interpreted on a very basic level as the two samples are not of comparable size (Brymann & Bell, 2003) and a direct comparison is not possible. The analysis provides a glimpse into the motivations for Swedish researchers but does not paint a clear picture of the differences between the two environments. Further research with a much larger sample is required to perform a more accurate and applicable comparison.

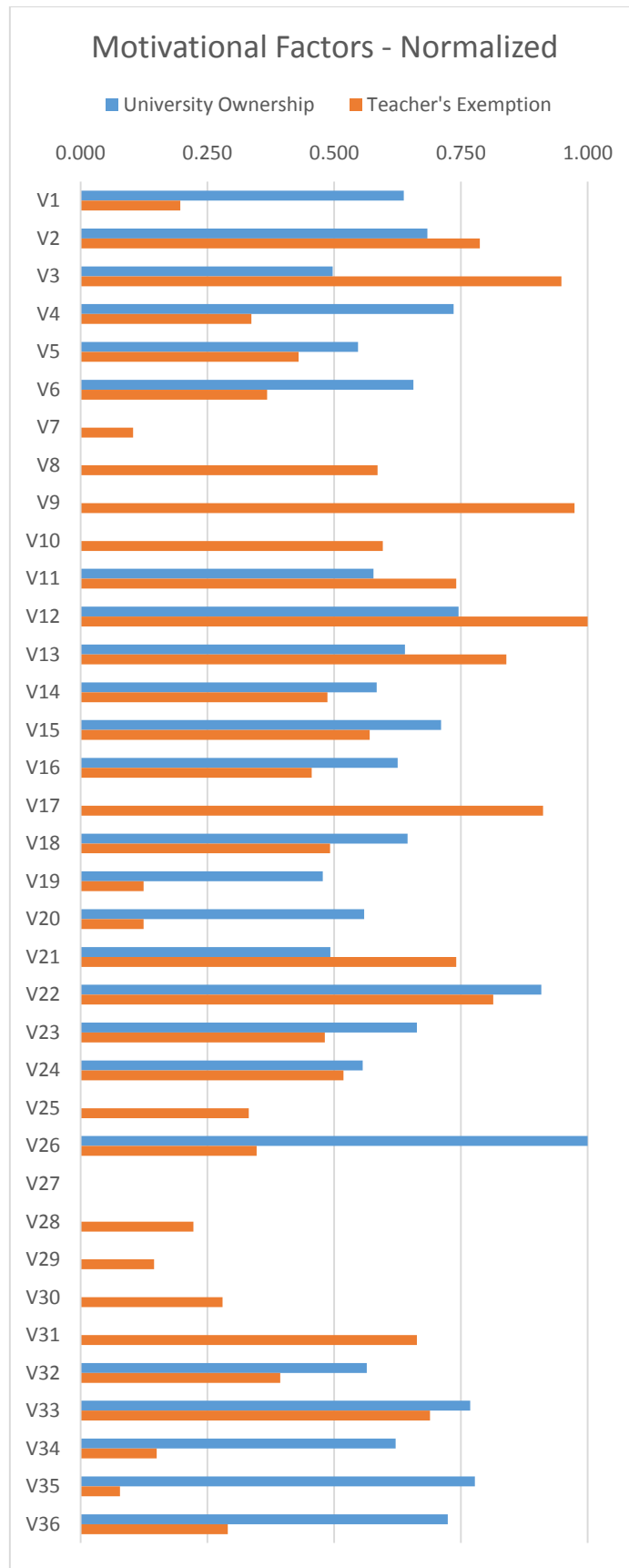


Figure 46 Results Normalized for comparison

6.2.1. Personal Motivations

Need for Achievement

The need for achievement dimension looks at the desire to perform tasks which are challenging (Morales-Gualdron, et al., 2009). Boredom with the current status quo and a lack of an intellectual challenge can contribute to the motivation for researchers to search out new avenues for stimulation.

Creating a company is one such motivator thus the desire to prove one's ability to establish a new firm was evaluated. Spanish and Swedish researchers differ by a large amount. In Spain, the researchers find that the need to create a company to provide a new stimulant for personal achievement is "quite important" on average. Swedish researchers do not find this factor to be a motivator overall. When asked how the idea to create a company came about, nearly 73% of the respondents said that it was an unexpected decision and the desire to build and own their own company was unimportant to nearly 80% of the entrepreneurs

As a motivator towards personal achievement, the desire for personal challenges was "quite important" and "very important" on average for Spain and Sweden respectively. The desire to develop one's own ideas is very important to Swedish researchers but only somewhat important to the sample from Spain. This can be attributed to the higher frequency and stronger interaction between Swedish researchers and industry actors as they have a much higher rate of collaboration with industry (Montobbio, 2013) as established companies are more likely to sponsor research into specific products.

Need for Independence

The need for independence dimension is a personality trait of entrepreneurs (Etzkowitz, 1998) which emphasizes the need for an individual to have more control and impact on the decisions to plan and coordinate their own work (Morales-Gualdron, et al., 2009).

The desire to achieve a better working atmosphere together with the desire to be more independent are much more prominent/important in the Spanish universities as opposed to the Swedish institutions which may be indicative of higher bureaucracy at the home university.

Desire for Wealth

The desire for wealth was deemed not important for both Swedish and Spanish researchers. This in line with other studies conducted in this area which concluded that researchers are not influenced by monetary gains (Etzkowitz, 1998) (Laredo, 2007) (Fritsch & Krabel, 2012) , instead they seek to contribute to the advancement of science and knowledge.

6.2.2. Entrepreneurial Opportunity

This section analyzes a series of variables and their effects on motivation from different parts of the data. The results show that the individual variables differ drastically from between the two sample groups and they showcase the differences in the environments.

The identification of an entrepreneurial opportunity through analysis of business opportunities, development of new products/services and perceived customer needs in current product offerings are thought to be significant motivators for commercialization (Morales-Gualdron, et al., 2009). In the study conducted in Spain, Morales-Gualdron et.al concluded that the Entrepreneurial

Opportunity factor was not a significant motivator for researchers which contrasts the findings by previous studies. The discovery of an opportunity and the decision to exploit that opportunity are two separate factors and must be treated as such (Autio & Kauranen, 1994). Those researchers who can identify new products/services during the research and development phase are ones who will proceed with entrepreneurial activities.

The Swedish entrepreneurs see the opportunity to commercialize as very important. The strongest of the three factors is the identification of the product or service which coincidentally received one of the highest importance ratings in the entire study. Business opportunities developed by the various incubators and the identification of perceived needs of customers were also quite important. The reason behind this large difference could be attested to the dissimilarity in the legislation. As a TTO based environment, Spanish researchers may not feel compelled to seek out commercialization strategies on their own as the university owns the rights to their inventions and the option to utilize falls predominantly on the institution. The Swedish legislation is much more conducive to the identification of the entrepreneurial opportunity as the researchers own the rights themselves and work more actively to identify or conduct research geared towards commercialization as a way to not only get their products to market but as a way to sponsor further research (Fritsch & Krabel, 2012).

6.2.3. Scientific Knowledge

Developing their scientific fields, basic knowledge and understanding, and society are the main motivators for researchers to consider careers in universities (Etzkowitz, 1998). The extension of these goals can be through creating spin-offs based around their innovations as it could serve as the basis for the advancement of science and its applicability in the “real world”.

The results from both studies share nearly identical results for all factors in this category. As expected, the strongest motivator for researchers to commercialize their innovations is to apply the knowledge in practice. The difference in legislation does not affect the core passion of researchers to extend knowledge and science (Etzkowitz, et al., 2000).

The factor which the researchers claim to have the most importance in their decision making process is the difficulty on transferring their knowledge to the industry. This could involve anything from product design issues, to IPR transfers.

6.2.4. Available Resources

Business creation, whether it is an academic spin-off or starting a company requires assets. Knowledge, finance, social capital, intellectual property and organizational capital are just a short list of requirements (Morales-Gualdrón, et al., 2009). Lacking these resources, a researcher may not attempt to realize an entrepreneurial opportunity as the resources are unavailable to be exploited. The proximity to incubator organizations, technology parks, potential venture capital, social networks, and managerial talent can help motivate the researchers to commercialize (Morales-Gualdrón, et al., 2009).

Financial

Securing financial support is one of the most challenging tasks the researcher encounters during the entrepreneurial process (Åstebro, et al., 2013) thus it is mildly surprising to see that for both cases this factor is only somewhat important. The reason for this could be that in Sweden, the researchers

find it very important to have the ability to invest their own funds to start the company. This can be attributed to a sense of accomplishment achieved in bringing a product to market on your own (Autio & Kauranen, 1994). In Spain, this factor is non-existent which may be attributed to the poor financial state the country is undergoing.

In both scenarios, the respondents claimed that the availability of public funds for financing the start-up process is of moderate importance. It is less in Sweden as there are many established public institutions, government subsidies and venture capital firms surrounding the research institutions.

Social Networks and Production Facilities

Acquiring strong and experienced management personnel and securing partnerships with which to start the company is very important to Spanish researchers but not important for the Swedish sample as the entrepreneurial culture is very strong (Åstebro, et al., 2013). The start-up infrastructure such as available production facilities, business incubators and the proximity to science parks has allowed the Swedish entrepreneurs to grow and evolve. The situation with the TTOs, production facilities and science parks in Spain is not as well developed as those in the Sweden, the US or other countries and have left the Spanish researchers feeling unsupported and without good connections (Morales-Gualdron, et al., 2009). These factors are very important to the Spanish researchers and may motivate them more if they were improved.

6.2.5. Incubator organization / Home University

The home university can play a large factor in the entrepreneurial motivation for researchers to consider starting a business. Reward systems such as promotions based on scientific systems, bureaucratic barriers to entrepreneurial development, and job security are some of the motivations which act as push factors (Morales-Gualdron, et al., 2009). Support programs, business development classes, the existence of a spin off tradition and peer attitude towards spin off creation can help motivate and act as pull factors

For all but one factor, the Spanish researchers stated that the incubator organization has no motivational effect on their decisions to commercialize. The only important point is a very high level of bureaucracy at the university. The high rate of bureaucracy and a low risk environments push the Spanish researchers to leave the home university (Morales-Gualdron, et al., 2009) to create a company. The freedom of working without red tape was the single most important motivation for these researchers.

The Swedish sample were also fairly indifferent to the effects of the home university. The level of bureaucracy at the home institution was only “somewhat important” to them. This leads to the same conclusion: the home university has minimal effect on the motivations for researchers to commercialize.

6.2.6. Social Environment

The attitudes towards entrepreneurship and role models such as family and colleagues with prior experience in entrepreneurship are factors that affect the perceptions of researchers. The proximity to successful family members or star companies has the potential to influence the researchers.

Attitudes towards entrepreneurship

Surprisingly, the Swedish researchers scored very low on the importance of advice from external organizations, campaigns aimed at encouraging entrepreneurship and society's attitudes towards entrepreneurship. This may be attributed to the fact that the Swedish entrepreneurship eco-system is already very mature and established as the home institutions have programs and resources in place to encourage commercialization and are surrounded by incubators and technology parks.

The Spanish researchers on the other hand valued these three variables as very important. It can be assumed that external motivators are very important for the decision making process for these researchers.

Role Models

Advice from friends and examples of successful companies were seen as relatively important for both groups of respondents. "My father is also a researcher and has created companies based on those results, I figured I had the obligation/mission to do it as well", a sentiment from one respondent to the research conducted for this thesis is shared by the majority of Swedish researchers. It shows that they are somewhat motivated by the advice relatives who have had prior experience as entrepreneurs while the Spanish group did not find this factor of any relevance.

In Sweden, the advice from friends and examples of successful companies were the most important factors for this group which is on par with the research conducted in Germany by Fritsch and Kabel (2012), which is a university ownership environment. They conclude that researchers are more likely to be influenced by their friends and peers if they have had prior success with entrepreneurial activities. In a study in the US, a similar ownership structure to Germany, Ding and Stuart (2006) also concluded that role models can influence the motivations of academic entrepreneurs. In Finland and in Spain, these factors were not important as shown by Autio and Kauranen (1994) and Morales-Gualdron et.al (2009). The results in this section contradict previous studies which have not reached a consensus on role model motivation thus they prevents a conclusive result.

The tables below summarise the results described above. The first table details the key differences between the two countries and the second, the key similarities.

Table 2 Key Differences between Sweden and Spain

	SWEDEN – TEACHER'S EXEMPTION	SPAIN – UNIVERSITY OWNERSHIP
KEY DIFFERENCES	Desire to develop my own ideas	Desire to prove own ability to establish a new firm
	Analysis of business opportunity developed by an incubator	Very high levels of bureaucracy
	New idea for product/service	Seeking a better working atmosphere
	Need for contacts for management and partnerships	Advice from external organizations
		Campaigns encouraging entrepreneurship Society's attitude towards entrepreneurship

Table 3 Key Similarities between Sweden and Spain

KEY SIMILARITIES	HIGH IMPORTANCE	LOW IMPORTANCE
	Apply knowledge for practical use	Strong spin off tradition
	Firm to be founded with a strong knowledge base / portfolio	Attitudes towards business creation from society or peers
	Resource availability	No desire for wealth

6.2.7. Motivational Factors ranked by importance

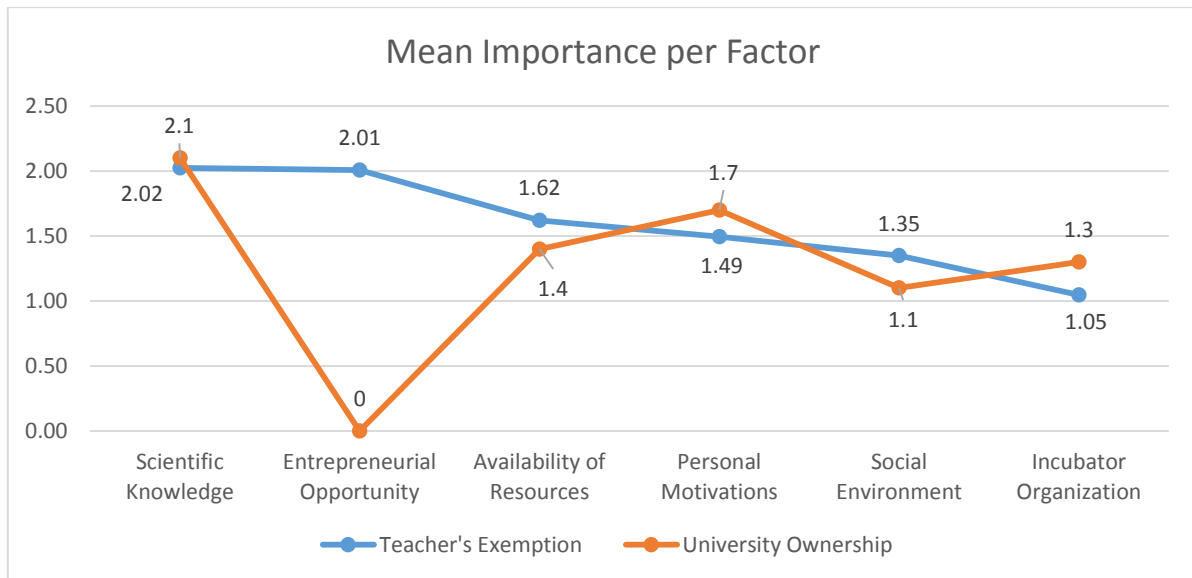


Figure 47 Mean Importance Per Factor – Teacher's Exemption vs. University Ownership

The average values for each factor was calculated for the Swedish sample while data for the Spanish sample was added to gain a better understanding where the two countries differ. In both the Spanish study and the research conducted here, the respondents placed the highest importance on scientific knowledge. The next most important factor for the Swedish researchers was the entrepreneurial opportunity. This is contrary to the Spanish study in which the opportunity to start a business ranked below the significant threshold thus it was excluded and deemed not to be a motivating factor for the sample. The availability of resources was third highest for Sweden and ranked slightly more important than in Spain. Personal motivations in Spain were higher than in Sweden. The social environment was of higher importance in Sweden than in Spain and the opposite applies for the incubator organization (home university).

Overall, with the exception of the identification of the entrepreneurial opportunity which is negligible in Spain, both countries have similar motivational factors despite the legislative differences.

6.3. TTO vs. TE – Hypothetical change in ownership

To gain a better understanding of the difference between the two legislative arenas, the researchers in Sweden were asked which they would prefer.

The questions were designed to give only two options for the researchers. They were indirectly asked to choose between the University Ownership model and the Teacher's exemption models and which they would prefer.

When asked whether they would prefer to own the rights to their technical inventions and manage commercialization privately or to pass the rights to the university and let it manage the commercial activities, the researchers chose to maintain ownership. The results were split 52% to 48% thus there was not a strong divide between the respondents.

When asked whether they would prefer to continue conducting research while the university / TTO manages commercialization or for the university to allow them time off to commercialize their innovations on their own, the researchers chose to be entrepreneurs. The results were more decisive for this question with 62% commercializing on their own and the remaining 38% choosing to stay at the university.

To gain a better understanding into how willing the researchers are to commercialize vs waiting to release their findings to the public, two thirds of the respondents said that they are either willing to wait 3-6 months or whatever it takes. This shows that the researchers value entrepreneurship and delaying publication while securing the proper IPRs for their invention is worth the wait.

The majority of researchers understand that it takes time and effort to acquire the right IPRs to secure protection for their inventions. Strong intellectual property rights and protection can be key to the maintaining a competitive advantage over their future competitors but the responsibility of ownership is not very clear. The majority of researchers chose the option to maintain ownership of their inventions and to commercialize them on their own. Thus the researchers in Sweden are satisfied with the Teacher's Exemption ownership environment. To further test this, a set of additional correlations were run to determine if the legislative environment had any effect had any effect on the motivating factors.

Of the 36 factors, only a very small number had any significant correlations with both the ownership of the invention and the management of the technology. When looking at the desire to build and own my own company, there was no correlation ($r = -0.093$, $p = 0.688$) with ownership relating to the legislation. Ownership in terms of personal desire and management of that business correlated with a strong positive significance of $r = 0.575$, $p = 0.006$ showing that even though the legislation does not influence the personal desire to own a company, the need to maintain control of it's use is very important to researchers. This sentiment is shared with the desire to develop my own ideas. Again, the legislation has no effect on the motivation ($r = 0.093$, $p = 0.687$) but the need to maintain that idea ($r = 0.462$, $p = 0.035$) is moderately significant/important.

Ownership of the technology played a strong factor on putting the knowledge into practice, $r = 0.541$, $p = 0.011$ as researchers felt that they would prefer the ownership. The correlation between putting knowledge into practice and personal management of the technology paints a different picture though, it shows the disparity between ownership and responsibility. The slightly negative

correlation $r = -0.268$, $p = 0.241$ may not be significant, but it lends itself towards the proposal that ownership and the responsibility of management of that intellectual property do not go hand in hand. Ownership responsibility requires the person(s) to act on what they own (Petrusson, 2007) but in this case, the researchers seem to prefer to own, but not to maintain. Thus they do not feel the responsibility to put that knowledge into practice.

Another strange and significant correlation is between the desires to manage their own company. Researchers, as shown earlier, do not want to be managers, they want to find managers. In the management of own invention question, the correlation is significant at $r=0.615$, $p = 0.004$ thus they want to have the control to choose their managers but do not want the responsibility of management themselves.

Overall, the correlations listed above were the only significant ones when comparing the legislative environment with the motivational factors. The teacher's exemption environment does not have any effect on the personal motivations of researchers to commercialize their innovations nor does it affect the importance of the other factors such as entrepreneurial opportunity, scientific knowledge, social environment, resource availability or even the home university. The main issue for the researchers is who manages their innovations, they prefer to do it themselves.

7. Conclusions

The goal of this thesis was to gain a better understanding of the motivational factors which affect the decision to commercialize innovations developed at Swedish universities. The focus on Swedish universities was chosen as Sweden is one of the few countries which still employ the Teacher's Exemption to Employees Inventions. As such, a model of researcher motivation was chosen from a study conducted in Spain to compare two different legislative arenas and how they may affect the decision making process.

Researchers in Sweden are motivated by a number of factors such as the desire to utilize their innovations in practice, whether that is through commercialization or through publications, their goals to disseminate the knowledge are the same. The academic entrepreneurs have a very high need to prove to themselves that they can achieve something new, coupled with a strong desire to develop their own ideas more freely, the entrepreneurial path can help achieve these goals. Although researchers want to commercialize their knowledge, the management of the business is not a motivator for them. They would prefer to have good contacts within industry who can take the reins and perform the daily management tasks. What was interesting, though not surprising was the lack of desire for personal financial gains. Monetary gain is of minimal importance to researchers unless it can be used to conduct additional research. Surprisingly, the social environment and the efforts undertaken by the Swedish universities in promoting entrepreneurship within the academic environment have a minimal effect on researchers' motivations to commercialize. That motivator usually comes from an off chance idea which has usually been developed by a business incubator or a peer.

The research found that there are many similarities and a few differences between the teacher's exemption in Sweden and university ownership environment in Spain. In both cases, the most important motivating factor for researchers was the desire to apply their knowledge in a practice. Whether this meant through commercialization or through publication, scientific advancement was the runaway motivator for researchers. In Sweden, the second strongest motivator was the identification of an entrepreneurial opportunity whether it be from a systematic analysis of potential business methods, an identification of a product or service that can fill a commercial gap or simply what they perceived as a gap in customer needs / products offered on the market. Researchers in Spain did not find the identification of an entrepreneurial opportunity a big enough motivator for commercialization.

Resource availability was a very important factor for both areas as intellectual capital, human resources, production facilities, financial resources and social networks are key to establishing a strong business. Although, the Swedish respondents would like to see a change in the amount of effort that their universities exert when the researcher decides to commercialize. The services offered by the universities feel lack-luster to the researchers thus slight changes could help foster an even stronger entrepreneurial environment which is contrary to the rules and regulations of the exemption. Additional support, courses on IPRs, business training and additional campaigns educating researchers on the benefits of spin-offs and entrepreneurship could prove beneficial.

When the motivational factors were correlated with a potential change in legislation from teacher's exemption to university ownership, a surprising result emerged: there was minimal effect on motivation. Ownership and responsibility to act upon that ownership is the same, regardless of who

is the owner. It is the responsibility of the researcher or the university to disseminate the knowledge to the public as per the first and second missions of the universities.

University Ownership and Teacher's Exemption environments, although different, both foster entrepreneurship and commercialization of university research. Both systems are effective even if their motives and executions differ between countries. For the moment, the Swedish researchers are content with the system but their main idea discovery occurs from the incubators around the universities. The researchers are not trained to identify commercial applications for their innovations. They want to commercialize as has been shown in this study, but they want additional help from the universities. Courses in product development, idea evaluation, business methods and other business related issues can help the researchers in Sweden take a more proactive approach to entrepreneurship. Teach them to take the reins and they will.

Future research into entrepreneurial motivation in Sweden can be performed by expanding the reach of this study to all universities and science parks across the country. A much larger sample will provide a better understanding as to how the motivations in this study differ between the various universities and research areas. It would be interesting to look into the possibility of additional motivational factors which affect the decision to commercialize that were not included in this study i.e. cultural, geographic and demographics: age, gender.

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9. Appendix

Appendix 1: Motivational Factors – Deviations and Importance

MOTIVATIONAL DIMENSIONS	MOTIVATIONAL FACTORS	VARIABLE FACTORS	DEVIATION (HIGH/LOW)	IMPORTANCE (HIGH/LOW)
PERSONAL MOTIVATIONS (F14)	F1 Need for Achievement	V1 Desire to prove own ability to establish a new firm	Low	Low
		V2 Personal achievement motivation	Low	High
		V3 Desire to develop one's own ideas	Low	High
	F2 Need for Independence	V4 Attempt to achieve a better working atmosphere	Low	Low
		V5 Lack of work prospects	High	All
		V6 Desire to be more independent	High	Low/high
	F3 Desire for Wealth	V7 Desire for wealth	Low	Low
ENTREPRENEURIAL OPPORTUNITY (F4)		V8 Analysis of business opportunity developed by TTO	Low	High
		V9 New idea for product/service	Low	High
		V10 Perceived customer needs/deficiencies in existing products	Low	High
SCIENTIFIC KNOWLEDGE (F15)	F5 Desire to apply knowledge	V11 Cutting edge technological knowledge	High	Low/High
		V12 Desire to apply knowledge into a practical use	Low	High
		V13 High value added knowledge – base of new firm	Low	High
	F6 Knowledge Transference	V14 Difficulties in transferring knowledge to the immediate environment	High	Low/High
		V15 Exclusivity of available knowledge	High	Low/High
AVAILABILITY OF RESOURCES (F16)	F7 Financial	V16 Available finances	Low	High
		V17 Available personal assets to invest	Low	Low
		V18 Available public support – loans	Low	High
	F8 Social Networks	V19 Availability of a person suitable to be manager	Low	High
		V20 Good contacts for establishing a company (partners)	Low	High
		V21 Contacts in the market	Low	High
	F9 Production Facilities	V22 Science or technology park in the city/area	High	All
		V23 Business incubator in the area	High	Low/High
V24 Available production facilities		Low	Low	

INCUBATOR ORGANIZATION (F17)		V25 DIFFICULTY OF PROMOTING PROFESSIONALLY WITHIN THE INCUBATOR ORGANIZATION	LOW	LOW
	F10 ORGANIZATIONAL BARRIERS	V26 High level of bureaucracy in the incubator organization	Low	Low
		V27 Low risk orientation of the research environment	Low	Low
		V28 Existence of specific rules for the creation of spin-offs in the incubator organization	Low	High
	F11 Supporting Infrastructure	V29 Existence of a tradition of spin-off generation in the incubator organization	High	Low/High
		V30 Attitude towards new business creation within the incubator organization	High	Low/High
SOCIAL ENVIRONMENT (F18)	F12 Role Models	V31 Relatives or family members act as entrepreneurs	Low	Low
		V32 Advice received from friends	Low	Low
		V33 Examples of successful companies	High	Low/High
	F13 Attitudes towards entrepreneurship	V34 Advice received from external organizations	High	Low/High
		V35 Campaigns aimed at encouraging entrepreneurship	Low	Low
		V36 Society's attitudes towards entrepreneurship	High	Low/High

Appendix 2: Factors for Motivation: University Ownership vs. Teacher's Exemption

MOTIVATIONAL DIMENSIONS	MOTIVATIONAL FACTORS	VARIABLE FACTORS	UNIVERSITY OWNERSHIP (STANDARDIZED LOADING)	TEACHER'S EXEMPTION (MEAN SCORE)
PERSONAL MOTIVATIONS (F14)	F1 Need for Achievement	V1 Desire to prove own ability to establish a new firm	0.619	1
		V2 Personal achievement motivation	0.664	2.14
		V3 Desire to develop one's own ideas	0.483	2.45
	F2 Need for Independence	V4 Attempt to achieve a better working atmosphere	0.714	1.27
		V5 Lack of work prospects	0.531	1.45
		V6 Desire to be more independent	0.637	1.33
	F3 Desire for Wealth	V7 Desire for wealth	N/A	0.82
ENTREPRENEURIAL OPPORTUNITY (F4)	V8 Analysis of business opportunity developed by TTO	N/A	1.75	
	V9 New idea for product/service	N/A	2.5	
	V10 Perceived customer needs/deficiencies in existing products	N/A	1.77	
SCIENTIFIC KNOWLEDGE (F15)	F5 Desire to apply knowledge	V11 Cutting edge technological knowledge	0.561	2.05
		V12 Desire to apply knowledge into a practical use	0.724	2.55
	F6 Knowledge Transference	V13 High value added knowledge – base of new firm	0.621	2.24
		V14 Difficulties in transferring knowledge to the immediate environment	0.567	1.56
		V15 Exclusivity of available knowledge	0.690	1.72
AVAILABILITY OF RESOURCES (F16)	F7 Financial	V16 Available finances	0.607	1.5
		V17 Available personal assets to invest	N/A	2.38
		V18 Available public support – loans	0.626	1.57
	F8 Social Networks	V19 Availability of a person suitable to be manager	0.464	0.86
		V20 Good contacts for establishing a company (partners)	0.543	0.86
		V21 Contacts in the market	0.478	2.05
	F9 Production Facilities	V22 Science or technology park in the city/area	0.882	2.19
		V23 Business incubator in the area	0.644	1.55

		V24 Available production facilities	0.540	1.62
INCUBATOR ORGANIZATION (F17)	F10 Organizational Barriers	V25 Difficulty of promoting professionally within the incubator organization	N/A	1.26
		V26 High level of bureaucracy in the incubator organization	0.971	1.29
		V27 Low risk orientation of the research environment	N/A	0.62
		V28 Existence of specific rules for the creation of spin-offs in the incubator organization	N/A	1.05
	F11 Supporting Infrastructure	V29 Existence of a tradition of spin-off generation in the incubator organization	N/A	0.9
		V30 Attitude towards new business creation within the incubator organization	N/A	1.16
SOCIAL ENVIRONMENT (F18)	F12 Role Models	V31 Relatives or family members act as entrepreneurs	N/A	1.9
		V32 Advice received from friends	0.548	1.38
		V33 Examples of successful companies	0.746	1.95
	F13 Attitudes towards entrepreneurship	V34 Advice received from external organizations	0.603	0.91
		V35 Campaigns aimed at encouraging entrepreneurship	0.755	0.77
		V36 Society's attitudes towards entrepreneurship	0.703	1.18