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From Publishing to Patenting:

Survey construction of Swedish academics' motivations

Yuan Tian

Supervisor: Evangelos Bourelos
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School of Business, Economics & Law, Gothenburg University, Vasagatan 1, P.O. Box 600, SE 40530, Gothenburg, Sweden.

Contacts: Nanu.tian@gmail.com.

Abstract

This master thesis contributes to the topic of knowledge and technology transfer, by exploring the motivations for patenting in Swedish academia. Patent is a dispensable indicator to evaluate innovation output performance. As a key activity in University-Industry interaction, academic patents include not only university patents, but also patents co-invented by academics with industrial partners. It is one of the first steps to implement new knowledge created in academia into business practice, but neither all research outcomes have been patented, nor all academic patents have been commercialized.

The main objective of this paper is the construction of a survey. The focus rests on the individual perspective of academics, their perception of incentives, internal motivations, and obstacles hampering their behavior in patenting processes. By reviewing public and industry reports, and systematically searched literatures, we 1) illustrated a comprehensive understanding of academic patent topic in Swedish context, 2) identified and generalize the motives for academic patenting and related activities in eight groups: to eight variable groups: financial incentives, legislation and public policy, university supports, industry supports, group culture and networking, R & D incentives, personal rewards and intrinsic motivation; 3) proposed a framework to analyze how these motivations effect academics' preference and behavior. With the framework and summarized motivations, we constructed a survey based on these motivations in order to collect primary data in Swedish academia. Nano-science technology field is selected as the sample for the survey pilot in this research.

In further steps, an interview is planned to obtain qualitative empirical data. Motivations and survey will be modified depending on the results of the interview and survey pilot, then send to a broader scope of Swedish academia.

Key words:

Academic patenting; motivation; self-determination theory; publishing-patenting; U-I; commercialization; technology transfer; Swedish academics; academic inventor; academic entrepreneur; scientific publishing

List of Abbreviation

OECD- The Organization for Economic Co-operation and Development

WIPO - World Intellectual Property Organization

IPC- International Patent Classification

PCT- Patent Co-Operation Treaty

USPTO- US Patent and Trademark Office

JPO- Japan Patent Office

EPO - European Patent Office

EPC - European Patent Convention

GII- Global Innovation Index

TTO- Technology Transfer Office

PATENTSCOPE- database provides access to PCT applications

KEINS- database on academic inventors, produced for the EU-sponsored project on *Knowledge-based Entrepreneurship: Innovation, Networks and Systems*

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1. Introduction

Innovation drives economy and society. In the development of human society and economy, technology innovation has been playing the role of propeller. The world is evolving by innovation either radically, like invention of telephone renovated the way we communicate, the speed and quantity of information sharing expanded and accelerated unprecedentedly with the introduction of Internet; or in an incremental way, like online music with Spotify, Solar safe water system turning contaminated water into drinkable water more environmental friendly. Those pioneers who adopted and commercialized these inventions usually became leaders of the industries they belonging to, for instance, IBM, Microsoft, Spotify, etc.

In terms of Innovation system input**,** R&D expenditure and personnel are the two indicates adopted by OECD to evaluate national innovation system (OECD 2013d). According to *Science, Technology and Industry Scoreboard 2013*, investment in innovation remains a priority, largely through R&D support measures. In 2012, OECD governments on average invested the equivalent of 0.8% of GDP in direct funding of R&D. The business sector accounts for the largest share of R&D - for 67% in the OECD area. Higher education R&D accounts for nearly 17% (OECD 2013e). Government and private sectors make up for the rest expenditure. These funding are mostly focus in knowledge-incentive industries, such as biotechnology and pharmaceutics, and interdisciplinary fields for instance Nano-technology.

Then, what's the Innovation system output and who carry out them? Measurement of innovation outputs differs between agencies – such as OECD, World Bank, GII and Bloomberg, etc. - because available indicators are difficult to cover multi facets of innovation. Nevertheless, among the widely used indicators, science publications and patents are two key proxies of innovation (OECD 2013d; Cornell, INSEAD, and WIPO 2014). Universities, business, public research, private researches are identified as the four actors performing knowledge creation and technology development in the innovation system**.** While most market-pulled applied researches undertook by business companies, basic researches and some applied research are often conducted in higher education institutes[1] (OECD 2013e).

[1] Academic institutes, higher education institutes and universities are synonyms in this thesis.

The third mission and shifting institutional context

Universities, whose traditional missions are teaching and research, have long been considered as the main source of knowledge creation. However, the gap between their input and output has been criticized in 'European paradox', which implies a necessary to exploit scientific achievement in 'Ivory Tower', for commercial use in industry. With the increasing requirement of advanced technology transferring from universities to knowledge-based industries, the third mission came into being and constitutes the one of the three university pillars. In various forms of university-industry interaction, the third mission of knowledge and technology transfer to business either by collaborative or commercial activities. Meantime, academic faculties' aptitudes are polarized within this trend. Some adhere to traditional 'Mertonian' norm, some hold an inclination to academic entrepreneurism, and some others choose moderate involvement such as co-research, patent licensing and commercialization. As publications to research, the academic patent is an important outcome of the third mission (position of academic patent in figure 1). Academic patent is the key indicator of technology transfer activity university-industry interaction, for its relational information reflected both at the institutional and the academics' individual level (Lissoni 2012).

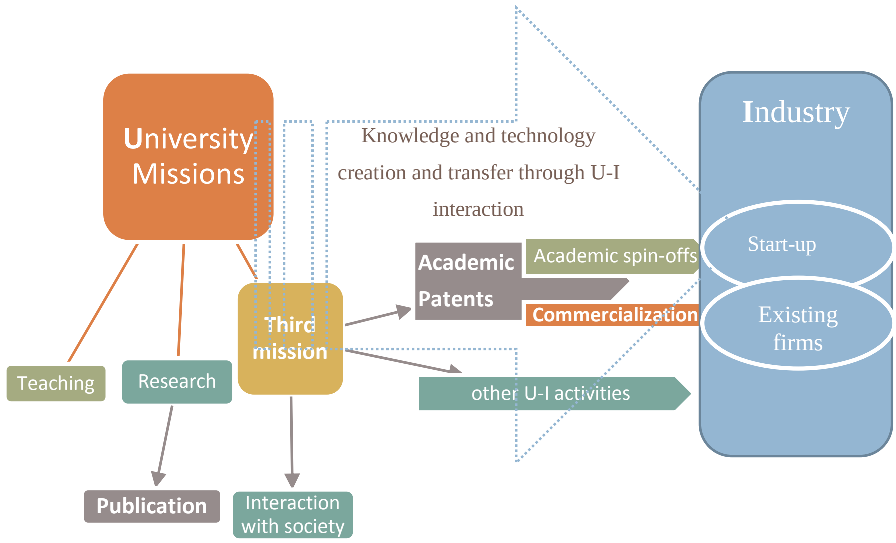

FIGURE 1 THE THIRD UNIVERSITY MISSION, AND KNOWLEDGE TRANSFER THROUGH U-I INTERACTION

The Swedish context – fact sheets

Sweden is one of the most innovative countries in the world. Stared industrialization process from a relatively poor condition, Sweden overcame its boundary limitation, is now an advanced society. Innovation is a pillar supporting its development and internationalization(OECD 2013a). Among 215 evaluated countries and sovereigns, Bloomberg ranks Sweden as the 2nd *Most Innovative Countries in the World 2014* (http://www.bloomberg.com/rank), by weighting seven factors like R&D intensity, manufacturing capability, productivity, high-tech density, tertiary efficiency, researcher concentration and patent activity. In Global Innovation Index 2014, Sweden 3rd place in the ranking, following Switzerland and United Kingdom.

Public policy and actors

Innovation is a national strategy for Sweden. Spending 3.41% of GDP on R&D, it has the world's 4th highest R&D intensity, 6th on number of researchers, and high QS University rankings (Cornell, INSEAD, and WIPO 2014). Compare with other countries, Swedish business sector has a higher investment in research, and generally the biggest sponsor for all R&D activities, investing three times more as government. But these investment are allocated to research within the business sector. For public funded research at universities, central government is the largest financer. In the *Research and Innovation Bill 2013*-16, Sweden initiatives an increase of SEK 4 billion to boost science and technology research. In 2014, the appropriations for research totaled SEK 32.87 billion. Apart from direct funding to university research, the Government also make large investments in research infrastructure, including national research facilities, libraries and archives (Research 2011). Guided by National Innovation Strategy, the government reforms regulatory and tax scheme to improve business R&D, such as tax relief of 10% reduction in the employers' social security contributions for employees engaged in R&D (OECD 2014).

Correspondingly, Sweden has a high record in knowledge and technology outputs on its high number (5th) of PCT resident patent applications (Cornell, INSEAD, and WIPO 2014). Business sector and universities are the two main actors in Swedish innovation system. For public funded research, almost 2/3 is conducted at 34 higher education institutes (31 state and 3 private), others by industrial research institutes and public agencies.

Swedish paradox

"Compared to other world-leading countries there are signs of shortcomings in the impact of scientific research as evidenced in citations and commercial outcomes"(OECD 2013c). In the aspect of academic productivity, however, the innovation performance in Sweden has been criticized as 'Swedish Paradox'. The notion was first formulated by Edquist and McKelvey (1998) to reflect the misbalance between high R&D expenditure and low share of high-tech products in Sweden. Nowadays, it has been evolved to a wide concept- the inefficiency of Swedish national innovation system on transforming input intensity to output productivity , in which university patents is a key proxy. Similarly, 'European paradox' was pointed out to indicate that compare to US, the European countries failed to transfer scientific advantage to commercialized innovations, in spite of high investment in academic institutes R & D (Lissoni et al. 2008; Bourelos 2013). Nevertheless, this kind of paradox was argued on the ground of heterogeneity of patent statistics in Europe and Sweden (McKelvey, Bourelos, and Zaring 2014). The ownership of academic patents varies among different regions. As opposed to US, where majority academic patents are owned by universities, more than 60% European academic patents are held by business companies. In Sweden, only 4.9% are assigned ownership to universities while 81.1% to companies. (Lissoni et al. 2008)

The underlying reason of this phenomenon is the Professor privilege[2] (OECD 2013c; Färnstrand Damsgaard and Thursby 2013). For US and most countries in Europe, universities have been granted the right of owning patents from public funded research since the Bayh-Dole Act of 1980[3]. Denmark legislator abolished the professor privilege in 2000 aiming to increase university patents, followed by Germany and Austria. But Sweden and Italy remain keeping the invention designating rights to faculties, on the consideration that individual scientists have more motives to

[2] Professor privilege entitles Swedish university faculty with right as an exception to the 1949 Act on the Rights to Employee's Inventions designating employer ownership, and became the policy in Italy in 2001 (Färnstrand Damsgaard and Thursby 2013).
[3] Denmark, Finland, Germany, and Norway all changed to university ownership models similar to the Bayh–Dole Act of 1980 (Färnstrand Damsgaard and Thursby 2013).

patent than their affiliated universities (Lissoni et al. 2008). In spite of not as large patent portfolio as their US counterparts, European universities do contribute remarkably to countries patenting record by academic scientists' invention efforts (Lissoni 2010). Nowadays, in Sweden, most academic inventors are professors, whose academic patents are owned by firms or individuals, not universities (see figure 2).

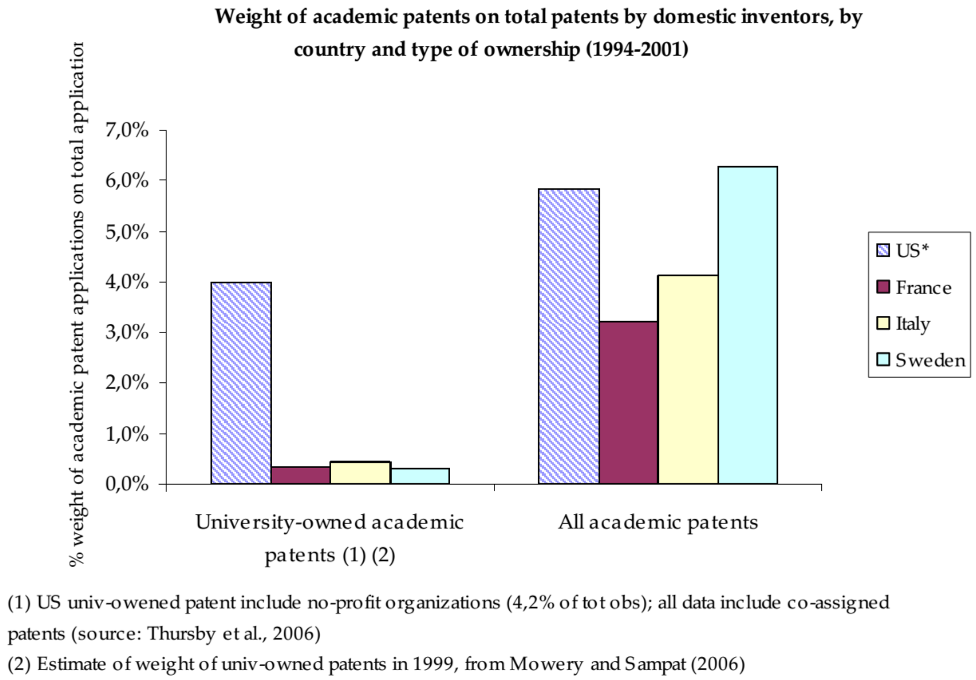

FIGURE 2 COMPARISON OF UNIVERSITY-OWNED PATENTS AND ACADEMIC PATENTS. SOURCE: (LISSONI ET AL. 2008)

Supportive agencies

Government appropriations for research in universities are allocated through four major research-funding agencies. The largest one is the Swedish Research Council, which in 2014 shared out about SEK 5.5 billion to basic research in natural sciences, technology, medicine, humanities and social sciences (Research 2011).

The Swedish Governmental Agency for Innovation Systems (VINNOVA) is the second largest agency in terms of capital, distributing about SEK 2.4 billion in 2014. But it plays the most important role in supporting innovations by funding need-driven research and improving conditions. The supported research and innovation projects each year are in around 2400, with a focus on advanced applied fields: Health and healthcare, Transportation, Environment, Services, ICT, Manufacturing and

Innovation Management (Eriksson et al. 2010). Besides, VINNOVA is the leader of other agencies to monitor the implication of Swedish innovation policy. Together with the Swedish Research Council, they explore ways to reform the incentive structures for university management and researcher, by creating criteria and procedure for funding distribution. To address social challenges with innovation, closer collaboration between industry and academia is important for technology transfer and commercialization. VINNOVA launched or co-initiated several programs, for instance SIA, CDI, VINNVAXT and VINN Excellence Centers, seeking to create excellent academic research environment with industry participating (OECD 2014).

Other two agencies are The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) and Swedish Research Council for Health, Working Life and Welfare (Forte), respectively supporting basic and needs-driven research in the fields of environment, land-based industries and spatial planning, and in the fields of the labor market, work organization, work and health, public health, welfare, the social services and social relations. Additionally, Research foundations, the EU, municipalities, county councils and a number of private foundations also provide funding sources for research at universities.

Research purpose and scope

Given the role of academia in Swedish Innovation system, academic patent and its commercialization is important for technology transfer. However, from the perspective of academic individuals, some prefer doing scientific research and publish their findings, some rather patenting their innovations and even get them commercialized. To publish or go to patent? Issues regarding scientific publishing and academic patenting have been discussed for a couple of years, but lack of evidences in factors that driving or impeding Swedish academics getting involved in patenting activities. As a result, it is necessary to conduct such a research to investigate reasons behind this phenomenon.

The purpose of this research is to investigate factors affecting Swedish academics patenting behavior, with a main work of survey construction. First objective is to review public and industry reports and data, as well as systematically searched literatures, to illustrate a comprehensive understanding of academic patent and

Swedish context; the second goal is to identify and generalize the motives for academic patenting and related activities; and finally to construct a survey in order to collect primary data. In the following steps of survey conducting, the survey is to be sent out to Swedish academics in nanoscience technology field as a pilot, on the background of previous study *Academic Inventors and Knowledge Technology Transfer in nanoscience in Sweden* (Bourelos, Beyhan, and McKelvey 2013). In further step, it will be sent to a broader scope of the Swedish academia to investigate these factors.

Thesis structure

This paper is a survey construction work to investigate why some academics only have scientific publications while others go further, to patent inventions. The paper mainly contains four parts. The first section introduces the role of academic patenting in the innovation system and third mission of universities; outlines the Swedish background, research motivation and thesis structure. In the second section, relevant literatures have been reviewed to illustrate concepts and definitions, and examine what have been done on the topic of academics' motivation for patenting and other relevant activities. A theoretical framework is formulated in this chapter based on Self-determination Theory. The third section is about the survey construction methods, explaining research question and survey design, data collection, methods, variables and sampling. The final part concludes the findings and addresses further steps.

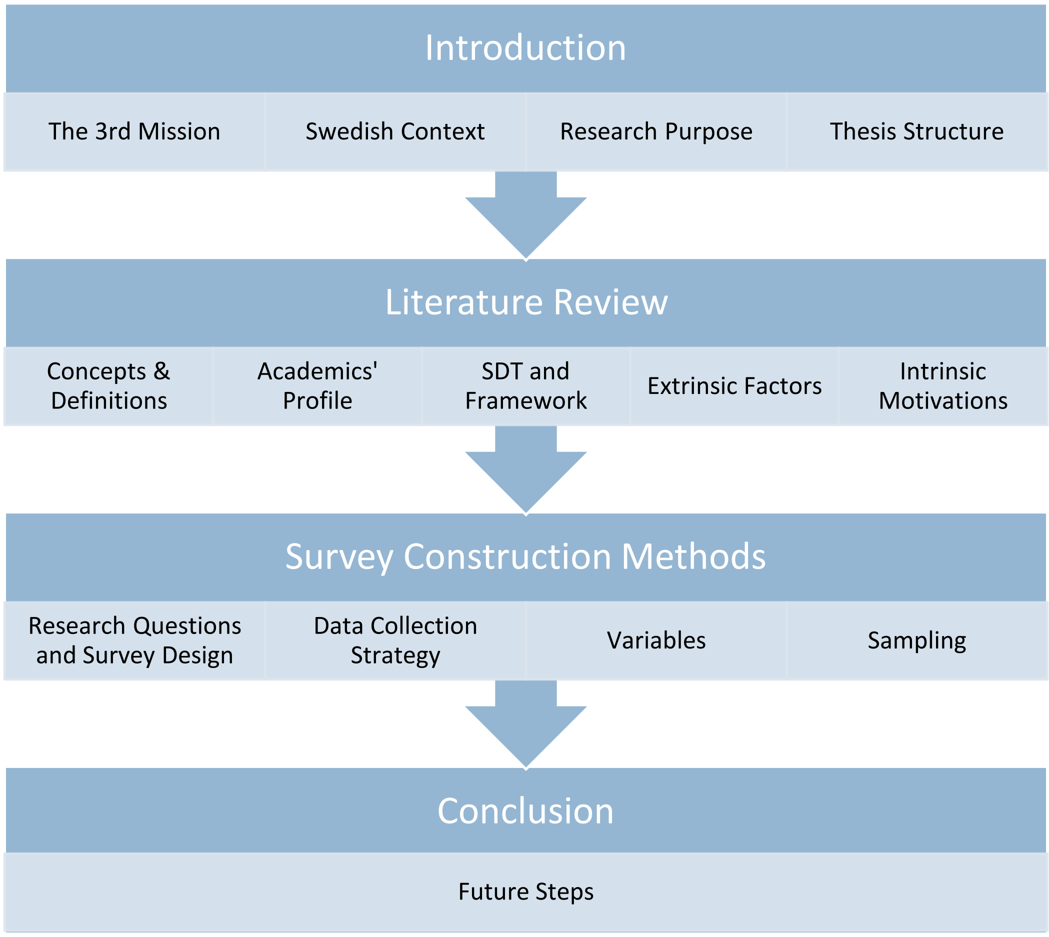

FIGURE 3 THESIS STRUCTURE

2. Literature Review

This section reviews and synthesizes the existing findings on academic patenting motives. First it introduce the purpose and procedure of the literature review. Then, it explains the definitions and concepts discussed in this thesis, and the profiles of academics. The major part is the selected literatures synthesized and generalized in three blocks: relationship between publishing and patenting, extrinsic factors affecting patenting/ U-I interaction/ academic entrepreneur/ research commercialization, and psychological motivations.

The purposes of conducting the systematic literature review are:

- To identify concepts and boundary for this research
- To find the relationship between publishing and patenting
- To address academics profiles
- To explore the psychological theory on motivation and behavior
- To generalize and compare factors in academic patenting related activities

Literature compass– A systematic research

In light of the heterogeneous of innovation system settings across countries, factors affecting academics' patenting behavior are diversified and controversial. In order to generate unbiased and comprehensive accounts of the literature, a systematic review is feasible and needed. But there are some elements of systematic review unable to be used in this research, such as the difficulties to reach unpublished literatures.

The systematic literature research is conducted with the following steps:

- Identified keywords based on research question and relevant readings recommended by professor and researchers.
- An initial search on Web of Science was analyzed in Endnote but only 20 papers were found with search strings academic patent* AND motiv *.
- Selected literatures were scanned and generated modified keywords for further search, such as motiv*AND university-industry, motiv* AND commercialization, motiv* AND patent*-publish*,
- Extend search in seven engines: Web of science, Springer Link, Science Direct, ProQuest, Wiley online library, Emerald and EBSCO.

- Papers from the second search were filtered manually by going through abstract and discarding duplicates.
- This procedure was repeated across the whole research process.

Because this research work has an emphasis on individual motivation level, psychological factors are indispensable elements. However, from the literature research result, there is not much studies about academic patenting motives, among which cover analysis from psychological perspective are even less. Therefore, we look up into literatures in a broader scope, including not only patenting motivations, but also about academic entrepreneurism, research commercialization and U-I interaction as complement. Additionally, another method used to find literature is to select the most relevant articles from references lists.

Concepts and definitions

The definition of 'Patent' by WIPO is "an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem". To get a patent, technical information about the invention must be disclosed to the public in the patent application documents.

Triadic patent families refer to patents applied for at the European Patent Office (EPO), the Japan Patent Office (JPO) and the US Patent and Trademark Office (USPTO) referring to the same invention. It is an index for quality, typically of higher value and lessen biases introduced by the geographical coverage of individual patenting offices (OECD 2013d). The process of patent filing contains two phases – international phase and national phase. Priority date is the date to state inventors' right of the invention at the beginning of international phase.

'Academic patent' is defined as "any patent signed at least by one academic scientist, while working at his or her university", regardless of ownership to universities or not (Lissoni 2012). In other words, the university or the individual academics are involved with the invention either as patent owner or as co-inventors (Bourelos 2013). Another term 'university-invented patent' shares the same meaning. Accordingly, these academic scientists are 'academic inventors', and 'academic authors' refer to those who are not involved in patenting activities but have publications in specific scientific fields. Academic inventors and authors are not limited to professors. Researchers, research fellows, associate professors, lecturers, PhD students and post doctors are included. Academic patent contains data in two dimensions, ownership and inventorship which can be used as proxy variables for elaborating U-I interactions (Bourelos 2013). With this explanation, the definition of 'academic patenting' is distinguished from 'university-owned patenting'.

Scientific publication refers to 'Publication of codified scientific knowledge transferred in the pool of open science' (Landry et al. 2010). It is a channel for scientists to expose their research findings to public, in forms of papers or articles in science magazines. 'The number of top-cited publications is an indicator of research excellence and represents the 10% most-cited papers in each scientific field.' (OECD 2013b). Scientific excellence, similarly, is measured by publication and citation patterns.

'Citation' links patents and publications in two dimensions: in time series and cross literatures. A patent can cite prior art contained in other patent documents and non-patent literature describing similar technologies published previously, which is the traditional definition 'backward citation'. In turn, it can be cited by others. The citations received by it are 'forward citation'. 'The link between patents and scientific literature is based on the non-patent literature (NPL) listed as relevant references in patent documents in *the Thomson Reuters Derwent World Patents Index and Derwent Patents Citation Index databases*' (OECD 2013e). NPL are "backward citations to peer-reviewed scientific papers, conference proceedings, databases and other relevant literature, with the exception of patent abstracts and commercial patent databases" (OECD 2013b).

Knowledge and technology transfer from academia to industry is carried out via various forms of U-I interaction. U-I interaction refers to all activities involving personnel from universities and firms, from university perspective. Landry et al. (2010) classified six categories of the interaction activities: publication, academic patenting, spin-off, consulting, teaching and informal knowledge transfer. Perkmann et al. (2013) identify U-I activities in two broad classes: academic engagement-collaborative research, contract research, consulting and informal relationships for university-industry knowledge transfer; and commercialization - defined as intellectual property creation, such as patenting, and academic entrepreneurship, such as spinoff. In that not all patents have been turned to product or service in practice, in this paper, we define patent commercialization as activities bring patented technology to industry, like patent licensing from an individual to a firm.

Spinoff is the process and outcome of generating a startup company with technology developed by academics, or with co-inventors from universities. Academic entrepreneur are those academics who worked for or studied at the very technology and found the new venture. Research and patent commercialization is the activities to bring technology developed in universities to market, by cooperating with existing firms.

The profile of the academic inventors

In general, academic inventors' character differs in terms of gender, age, experience, discipline, network, propensity, etc.

Academic inventor distributes differently across scientific fields. In Italian universities, 301 inventors made up 10.2% of the total 2957 professors active in the year of 2000. But the distribution differs across fields. The scientists from Chemical-, Pharma- and Electro- areas share a higher percentage, highest 18.5% in Chemical Engineering & Material Technology, while only 5.7% work in Biology field (Lissoni 2010; Breschi, Lissoni, and Montobbio 2008).

When it comes to the reason academics participating in patenting, there is also a **discipline feature**. While pecuniary motives predict patenting in the **physical** sciences, the desire to contribute to society is the key motive predicting patenting in the **life** sciences. In **engineering**, patenting is predicted by the motives of challenge and advancement. Scientists with a strong desire to contribute to society are more likely to work on **applied questions** while those with a strong desire for intellectual challenge tend to be engaged in **basic research**. Patent Licensing incentives tend to be positively associated with applied research in the physical sciences (Sauermann, Cohen, and Stephan 2010). Academic inventors' entrepreneurship propensities also have a large difference across gender (Goel, Göktepe-Hultén, and Ram 2015)

Regarding the network, academic inventors share the similar one with their non-inventors counterpart in terms of dimension and structure prior patenting, but have a denser ego-network after patenting (Forti, Franzoni, and Sobrero 2013).

In the process of reviewing papers on the scientists' behavior of patenting inventions, we found that most of them have a geographic feature, such as academics in US, Italy, France, Germany, etc.(Baldini, Grimaldi, and Sobrero 2007; Blind et al. 2006; Blumenthal et al. 1997; Breschi, Lissoni, and Montobbio 2008; D'Este and Patel 2007; Klitkou and Gulbrandsen 2010; Wang, Lin, and Lo 2012). When the patents scientists from France, Italy and Sweden are assigned to industry firms, in a span of 64% to 82%, US faculties prefer keep the ownership to their univeristy (McKelvey, Bourelos, and Zaring 2014).

Characters of Swedish academic inventors

The characteristics of the academic patenting in Sweden have been studied and concluded by McKelvey, Bourelos, and Zaring (2014). The male academics outperform their female colleagues, dominating 86% of the patents. These scientists are gathered in few main universities and in the fields of electrical engineering and electronics, pharmaceuticals, biotechnology and nanotechnology and medicine. More than half of them are professors, as introduced in previous section, and most reach this achievement at a late stage of their career, in age 40s to 70s (McKelvey, Bourelos, and Zaring 2014).

Furthermore, about 82% of patented inventions are owned by firms. Swedish university faculties are quite active in connection with firms. However, the majority engage with industry in channel of consulting, sponsored research and contract research. Only about 12% involve with patenting, which is equivalent with the portion of academic entrepreneurs. The figures 4 indicates the percentage of academics involvement in the specified U-I activities.

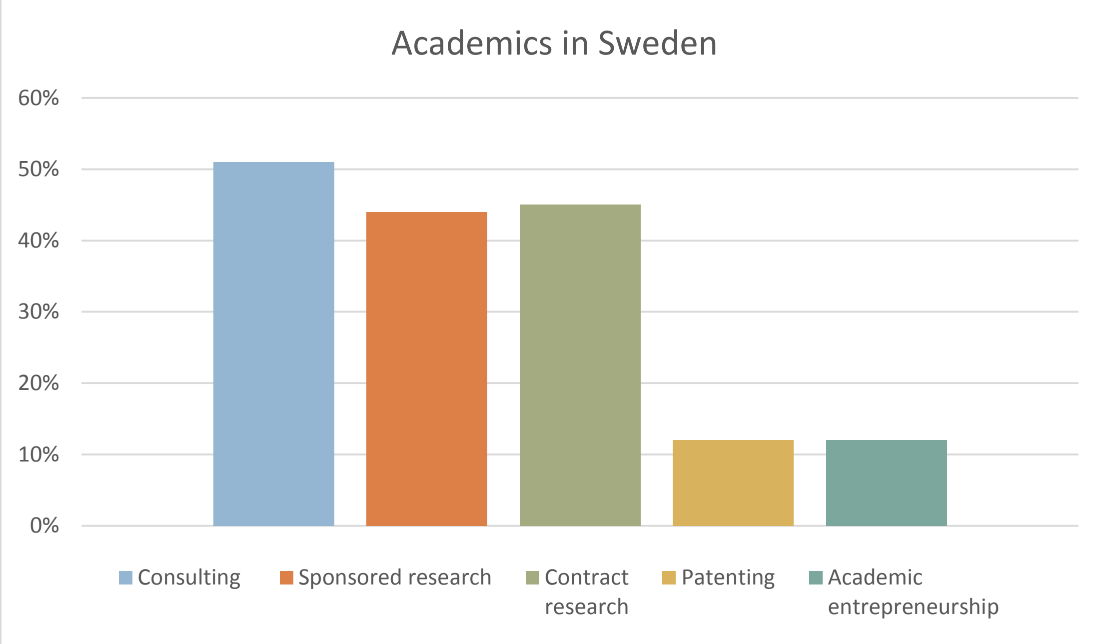

FIGURE 4 SWEDISH ACADEMICS U-I ENGAGEMENT. DARA SOURCE: (KLOFSTEN AND JONES-EVANS 2000)

SDT and theoretical framework

Individuals' preferences are shaped by external factors in the environment surrounding him/her, and their behavior motivated by the external determinants and intrinsic preferences. To illustrate how the diversified factors affecting academics patenting behavior, we use Self-determination theory (SDT), the social psychology theory of human motivation, and generate a conceptual framework (figure 6).

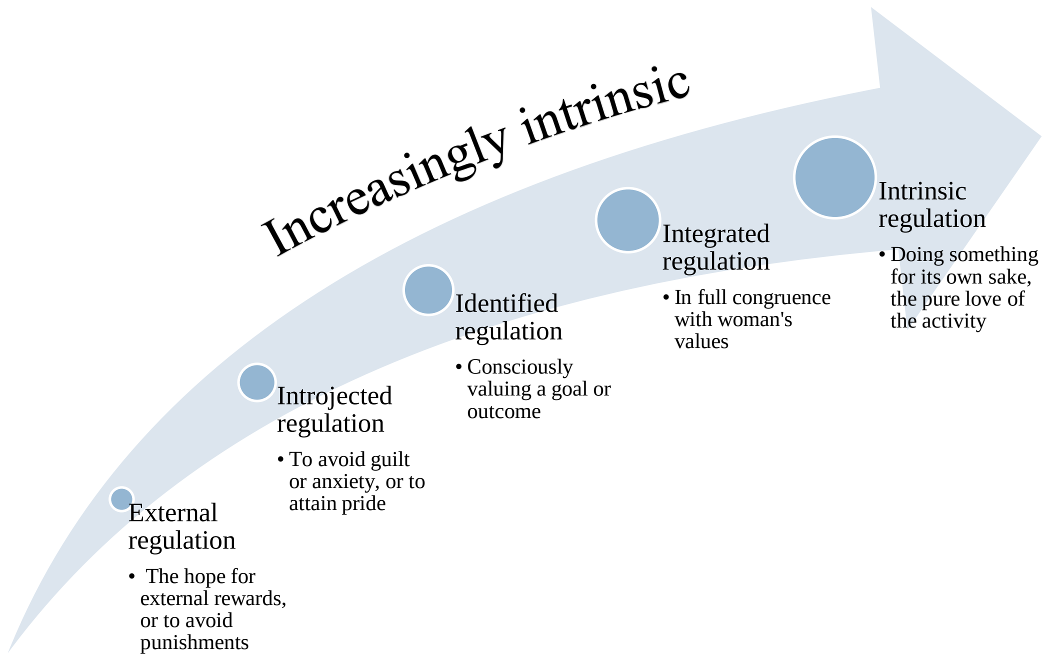

FIGURE 5 SELF-DETERMINATION THEORY. SOURCE: UNDERSTANDING MOTIVATION AND EMOTION (REEVE 2014)

Founded by psychologists Edward Deci and Richard Ryan, SDT distinguishes between different types of motivations, on a scale from extrinsic - motivations from outside of a person, such as the hope for external rewards, or to avoid punishments, etc., to intrinsic, such as personal value attributes and interests (Reeve 2014). SDT and its sub-theory CET (Cognitive evaluation theory) are designed to explain the effects of external forces on internal motivation, stating that individuals' behavior is an outcome inter-motivated by external regulatory process and psychological needs. SDT suggests that intrinsic motivation promotes creativity by encouraging persistence. The more intrinsically motivated someone is to do a particular behavior, the more long-term success someone will have with that behavior. When individuals are intrinsically motivated, their curiosity and interest in knowledge will expand their openness to risks and complexity, and enhance ability to generate ideas and solutions (Grant and Berry 2011). In this way, we can assume that scientists' passion for invention, invention commercialization itself has positive effect on his/her research excellence. There would be a persistence in inventors' experience and patent filing. This is the reason why we use SDT to build the theoretical framework.

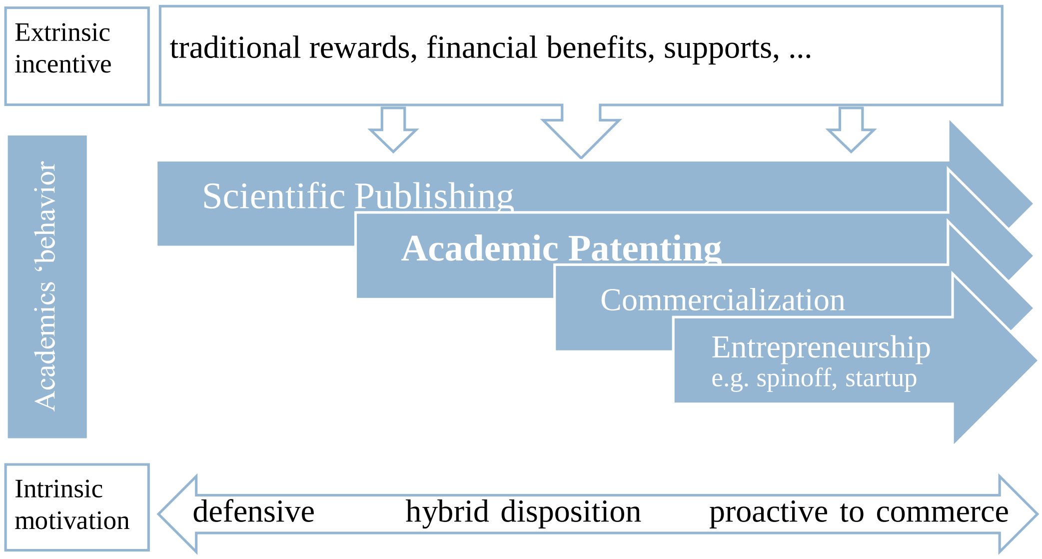

FIGURE 6 SDT BASED THEORETICAL FRAMEWORK

This framework incorporates both positive and negative driving forces affecting academics' patent-related behavior in two folds- extrinsic incentives and intrinsic motivations. Extrinsic incentives include traditional rewards like career promotion and prestige, financial factors like funding and costs, supportive structures, etc. Intrinsic motivation refers to academics' disposition on an axis, the inherent qualities and inclination to research or proactive to commerce.

Extrinsic factors affecting academic patenting

The relationship between scientific publishing and academic patenting

First, we have a look at the mutual effect of publishing and patenting, because in traditional perspective, publishing is a key factor shaping academic scientists patenting preference.

For a specific invention, previous publishing has an exclusive effect on later patenting. It is stated in Patent Law that only "new and nonobvious" inventions can be patented, the ones "in the public domain" not patentable. As a result, Once the knowledge of a specific technology is disclosed to the public in any form of publication, not only others but also the scientist himself, will be precluded from granting the patent of this invention (Levi-Mazloum and von Ungern-Sternberg 1990).

On the other hand, a large number of empirical evidence demonstrated that there is a positive correlation between scientific publications and academic patents, both in quantity and quality. Highly productive academic scientists, also named as 'Star scientists', are more likely to turn into inventors. Vice-versa, Academic inventors have significantly higher publication volume than their peers (Lissoni 2012; Azoulay, Ding, and Stuart 2007; Breschi, Lissoni, and Montobbio 2008; Breschi, Montobbio, and Lissoni 2005). Basing on data from all Norwegian universities, Klitkou and Gulbrandsen (2010) matched patent inventors to their peers without patents by controlling comparable disciplinary profile, age and position, coming to the same conclusion. Paper citations of these inventors have a positive correlation with their patent counts, implicating a research excellence. Apart from that, Breschi, Lissoni, and Montobbio (2008) pointed out that the positive effect of patenting on scientific productivity largely differs across scientific fields, with particularly stronger results in pharmaceuticals and electronics.

However, evidence from both US and UK suggest that, in traditional basic research area, patent volume does not predict publication volume. Agrawal and Henderson (2002) found that majority scientists in the Departments of Mechanical and Electrical Engineering of MIT never patent, but their publication rates far outstrip patenting rates. Additionally, (Crespi et al. 2011) found a U-shaped relationship between faculties' patenting and publishing in engineering and physical sciences. Patenting complementary to publishing, as well as other technology transfer channels, to a certain level- about 10 patents, but has a substitution effect beyond that point.

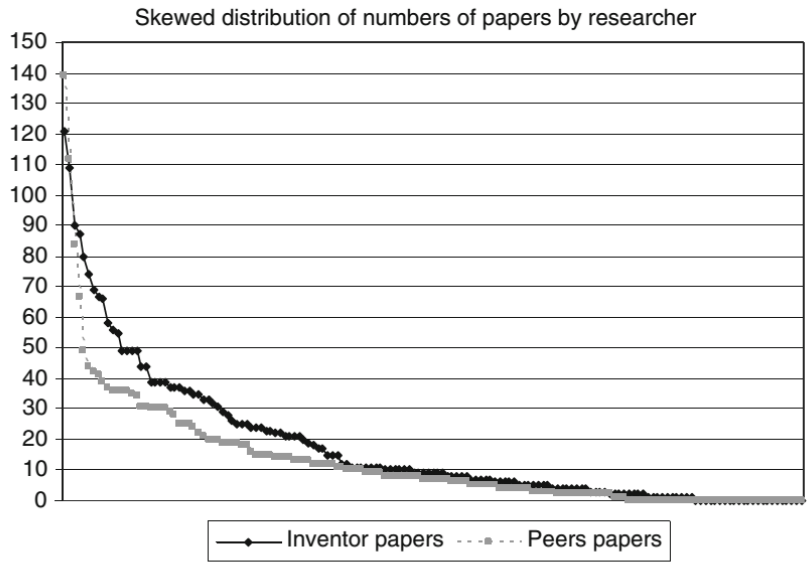

FIGURE 7 DISTRIBUTION OF NUMBERS OF PAPERS BY RESEARCHER. SOURCE: ***(KLITKOU, A. AND M. GULBRANDSEN, THE RELATIONSHIP BETWEEN ACADEMIC PATENTING AND SCIENTIFIC PUBLISHING IN NORWAY, 2010.)***

External motivations for patenting and other U-I activities

Although papers discussing Swedish academics' involvement in patenting are limited, there are a bunch of studies about university patenting in other countries. The reason we take these literatures for reference is the different settings across countries but similar nature of academic patent in Sweden and university patent in other countries. As presented in Swedish context, most academic invented or co-invented patents are designated to firms but in other countries are owned by universities, namely university patents. Here we synthesis the factors from these literatures in two folds: from industry side and from academics side. Whether those factors are applicable to Swedish academics will be tested in this research.

From the industrial side, studies on firms' academic patens and non-academic patent (Ljungberg, Bourelos, and McKelvey 2013; Ljungberg and McKelvey 2012) found that academic patents have less importance on firms' core technology, but much contribute to firms' margin technology, and usually have long term advantage compared to non-academic patents. Firms have academic inventors involving in their inventions for technology development or to assist problem-solving activities. For companies, U-I interaction is an indispensable channel of open innovation. In order to enhance internal innovation capability, licensing-in of academics' patents is one component of expertise and technology acquisition during the inbound resource flow (Melkas and Harmaakorpi 2012).

Levi-Mazloum and von Ungern-Sternberg (1990) raised three determinations affecting industrial innovators' behavior to patent or to publish - costs, imitations and competitors. By building models, they found both the time lag between the original invention and the product introduction to market, and easiness to imitate has negative effect on motivating innovators to patent. Blind et al. (2006), basing on sample of German companies, suggested company size as another motive to patent.

Nevertheless, the incentives drew from business sector not necessarily have the same effect on academic scientists. Veer and Jell (2012) found differences among applicant types by comparing patenting motives of individual inventors, small firms, universities and large firms. Preventing imitation is highly valued by firms but inventors from universities do not mind such technology diffusion. The same as another factor – patenting as secure access to capital for business- does not work on academics.

Despite of these facts, for some academics, **intellectual protection** is an important force driving them pursues patent filing. If an inventor intends to commercialize his/her invention, obtaining a patent is dispensable in that the holding of intellectual property is legally required activity when transfer the technology to industry. It endows the right to inventor to gain benefits from technology transfer and commercialization. Owen-Smith and Powell (2001) argue that academics' perceptions of the benefits of patent protection affect their decisions to patent invention or not.

More conventionally, engagement with U-I interaction activities in turn enhance the academics' knowledge and skills, quality of teaching and research. As research and teaching are original missions for academics, traditional purpose and personal rewards cannot be neglected. For non-commercial U-I activities like contract research and consulting, there is a feature of close alignment with traditional academic research activities. Findings show that academics' engagement in these knowledge transfer activities are inspired by practical consideration- to access resources supporting their research agendas (Perkmann et al. 2013). By participating in cooperative activities with industrial partners, they can get more funds for research, access to laboratory equipment, obtaining applicable insights to their research and inventions, etc. D'Este and Perkmann (2011) suggest that most academics engage with industry **to further their research** rather than to commercialize their knowledge. When academics perceived that patents increase scientific productivity and research excellence both in quantity and citation of publications (Breschi, Lissoni, and Montobbio 2008), patenting will act as a substitute or a complement to their research (Agrawal and Henderson 2002). A survey of Italian inventors shows that Italian professors involved in patenting activities are motivated by stimuli for new researches, reputation and prestige (Baldini, Grimaldi, and Sobrero 2007).

With the **status** becoming more and more important, some scientists go for patenting on the ground that patent records add value to their CVs, which boost possibility for better career promotion. Göktepe-Hulten and Mahagaonkar (2010) asserts that German faculty scientists file patent and disclose their invention is more correlated to gain and increase reputation through commercial activities than other motivations. It happens to UK academics in the similar case. Reputation and career rewards are the main extrinsic motivation for commercial engagement (Lam 2011).

In a general level, Bourelos, Magnusson, and McKelvery (2012) investigated factors in three categories that influencing academics on commercialization, both academic patents and start-ups as proxy. The survey revealed significant importance of research performance, namely publication excellence, and **support structures** which include technology transfer offices (TTOs), courses and incubators, but networks not positive. Support mechanism, from university level to society level, appears to be a positive factor (Baldini, Grimaldi, and Sobrero 2007). How effective are these incentive mechanism is another issue to examine. The time and efforts spent on patenting process, filing life span and costs also shape their decision for patenting. Evidence shows that other incentives to patent are magnified or minimized by the interacting process with TTOs and licensing professionals (Owen-Smith and Powell 2001).

Furthermore, financial benefit is an indispensable consideration when draft public policy to impel scientists for innovation. **Financial factor** has been disputed among relevant topics for a long time. Lam (2011) states that financial rewards play a relative small part for UK academics' research commercialization. Sauermann, Cohen, and Stephan (2010) concluded financial incentives in the form of licensing royalty shares have no systematic relationship with patenting activity in UK academia. Similarly, personal earnings, has not much importance for Italian academics (Baldini, Grimaldi, and Sobrero 2007). However, the influence of financial incentives differs across technology fields (D'Este and Perkmann 2011; Sauermann, Cohen, and Stephan 2010). In high monetary valued fields like life sciences, researchers patent for incomes purpose, but in other fields like physical sciences, patenting is less attractive and their motivation have less relation with pecuniary.

Additionally, the gregariousness- **group** culture is a possible factor motivating academics for patenting. US academic entrepreneurs in a large extent are influenced by relationships with other entrepreneurs at their university or within their region (Hayter 2011). Similarly, academics are somehow motivated by their peers- other inventors or patent assignees in their **networks**. In a paired control investigation of academic inventors and non-inventors, the former appear to have a more cohesive ego-network. Such a denser network is more likely to convey fine-grained information and facilitate a greater climate of trust, long-term relationships and learning for inventors (Forti, Franzoni, and Sobrero 2013).

Industry **experience**, in terms of various kinds of channels, especially industrial cooperation rather than consulting, results in a greater probability of patenting and continuous U-I engagement. Goel and Göktepe-Hultén (2013a) explained this fact due to cooperation allows researchers greater and broader insights into industrial research secrets. Furthermore, the persistence of patenting experience, is a force driving inventor for patenting. Life-cycle and trend make inventors more productive over time (Forti, Franzoni, and Sobrero 2013). Those scientists who have previously patent their inventions are more likely to continue, and to be more inclination to industry activity, and also have a greater chance of being an entrepreneur (Goel and Göktepe-Hultén 2013b).

Intrinsic motivations - Psychological factors

Apart from the external factor and motivations, scientists' behavior of innovation activities are influenced by intrinsic motivations. In this paper, we adopt a broad concept for intrinsic motivation to explain academics' propensity for patenting. It therefore covers elements from Maslow Needs' Theory, including individuals' interests, value orientation, and satisfaction.

The influence of academics' personal value and beliefs about science-business relationship has been examined by Lam (2011). The intrinsic **satisfaction** derived from commercial engagement itself, emerges as a central motivation shared by many of the scientists in UK academia. Evidence from UK academia shows that satisfaction is a crucial intrinsic factor of scientists' motivation for pursuing commercial activities (Lam 2011). For the academics with traditional belief toward research, commercial activity is a means to obtain more supports for their research. But for those who have propensity to academic entrepreneurship, they are more intrinsically motivated and have a long-term engagement.

Survey data from 64 US universities present that university faculties' **propensity** to engage in research commercialization constitute the main reason of the growth in university licensing, rather than the reason of innovation incentive schemes (Thursby and Thursby 2002). By investigating the effect of nascent entrepreneurship on inventive activities of German researchers, Goel and Göktepe-Hultén (2013b) found a significant positive effect of start-up business propensity, by increasing the likelihood for patenting.

In addition, this disposition differs across gender. Goel, Göktepe-Hultén, and Ram (2015) examined academic scientists' entrepreneurship propensities in a survey study of German researchers. The results demonstrate a positive correlation between patenting and entrepreneurship inclination. However, in terms of gender, coefficient of patenting and propensities toward entrepreneurship differs significantly between male and female. The association is much higher for male than that for female.

Compare to industry researcher, academic scientists' appear less mind of imitation. It is largely because of the faculties' traditional mindset of **open science.** A distinguish character between patenting and publishing is that publishing is aiming for **technology diffusion** while patenting is believed in purpose of commercial exploitation. Even the third mission of university introduced academic scientists to business activities, knowledge sharing is still a popular belief. Evidence shows US academic entrepreneurs run spinoffs because it is a way to disseminate the results of their research and diffuse new technologies out of academia (Hayter 2011). This kind of desire to contribute to society and benefit others is called 'Prosocial motivation' in psychology science (Grant and Berry 2011). While pecuniary motives predict patenting in the physical sciences, the desire to contribute to society is the key motive predicting patenting in the life sciences (Sauermann, Cohen, and Stephan 2010).

In spite of the discrepancy in extrinsic factors between industry and university groups, common points exist. In case studies of UK Faraday Partnerships, Ankrah et al. (2013) found **stability-seeking** taken as a key determinant of engagement in knowledge transfer activities by both groups. For inventors' choices whether to commercialize their inventions, Simons and Astebro (2010) confirmed a consistence with profit-seeking motives and risk aversion.

Intrinsic motivation fuels creativity, but it does not work independently. Grant and Berry (2011) found that prosocial motivation- the desire to benefit society, strengthens the association between intrinsic motivation and independent creativity ratings. It guides academics to take markets' perspectives, and invent technology that are not only novel, but also useful, thereby achieving higher creativity.

Sauermann, Cohen, and Stephan (2010) argues that intrinsic motives related to patenting also vary across fields. In engineering, patenting is predicted by the motives of **challenge and advancement**. Scientists with a strong desire to contribute to society are more likely to work on applied science area while those with a strong desire for intellectual challenge tend to be engaged in basic research.

3. Survey Construction Methods

Research questions and survey design

The research questions are inspired by a former study of *Academic Inventors and Knowledge Technology Transfer in nanoscience in Sweden* (Bourelos, Beyhan, and McKelvey 2013). In that research, 114 Swedish academic scientists are identified and matched in 57 pair 'twins' of academic inventor and academic author, on the condition of similar individual characteristics, disciplines and positions in the university, etc., but distinguished by patent filing or not. Academic inventors are those who have both patents and publications in nanoscience field; academic authors are those academics who only publishing without patenting activities. Their findings, again, lead to the questions we raised in the first chapter: why some academics are active in both publishing and patenting while others are not? Since the "twins" share similar profiles, what factors make the differences? If the external incentives are the same, for instance, the university policy, surroundings, support mechanism, etc., when will the incentives success in motivating the inventors, but fail on authors? What intrinsic motivations drive academics to invent and file patent, or hinder this process? In a nutshell, what makes an academic inventor?

These questions map a positivism in the epistemological position (Bryman and Bell, 2011). Accordingly, this research is designed as a cross sectional study, by collecting both qualitative and quantitative data to analyze the driving forces that influencing Swedish academics behavior of engagement in patenting activities.

Deductive approach is adopted for this research in following the logic: general research questions -> theory -> research questions -> data collection-> findings -> revision of theory. With established theories and empirical papers from adjacent fields within the similar phenomenon, we put forward a theoretical framework for data analysis, and designed to gather solid quantitative data from survey.

Data collection strategy

To address the research questions, we collect data mainly focus on the factor investigation and motivation analysis. The strategy covers three channels: secondary data from literatures and industry publication; empirical data from survey.

We have reviewed literatures in the second section and generalized probable factors. In the framework defined in previous context, determinants are categorized in two levels to explain academics preference and behavior of patenting. First comes the internal, or instinct level, referring individual characteristics, such as interests, personal value orientation. External level not only limited to incentives from public policy, university support mechanism, but also includes group culture, networking, personal rewards, etc. The emphasis would rest on their integrated influence on individuals, especially in psychological aspects.

Secondary data from industry and public reports, such as VINNOVA, OECD, and WIPO, are to be used across this research. In this paper, these data together serve the function of survey variables and questions design. In future plan, they support analysis combining with primary data from the survey.

Survey is the main method to collect empirical data, by conducting a self-completion questionnaire - A Survey of Influencing Factors on Swedish Academics for Patenting, of which construction is the main work of this thesis. Within the future steps, survey conduction process would be carried out in three phases: first, to interview several scientists to check and complement qualitative data, and modify questionnaire; second step is a survey pilot in Nano-science field in Swedish academia by telephone; final to carry out in a full sample.

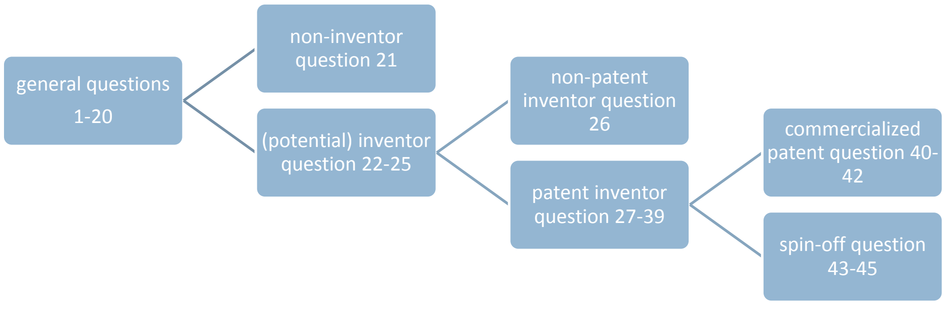

FIGURE 8 QUESTIONNAIRE STRUCTURE

Reliability, replicability and validity

Reliability and validity are important criteria to assess the quality of quantitative research. The research is mainly based on quantitative empirical data from survey, overall characterized by high reliability. The control questions present in the questionnaire will ensure that the measures devised in the survey are consistent and stable. However, reliability also means having consistency across the results and that may be difficult. For the hard facts like time spend on research and patenting, gender, results are reliable, but those from value orientation may not stable due to personal belief vary across time. In addition, the results may be affected by respondents' mood bias when fill in the questionnaire. From response sets, the systematic bias in answers has two prominent types: acquiescence, namely 'yes-saying' and 'naysaying', and social desirability bias (Bryman and Bell 2011). Acquiescence refers to the tendency for respondents' consistently to agree or disagree with a set of questions. Social desirability bias refers to the distortion of data that caused by respondents' attempts to construct an answer conforming to socially desired belief or behavior. Furthermore, individuals interpret questions differently. Respondent may not be sharing the same meaning systems with interviewer and survey drafter, and hence imply different things.

To mitigate and avoid these bias, we test specific variable by asking different questions in different ways. Answers for questions are designed at a minimum of binary variables. Dummy and count variables are adopted instead. In case of any other consideration omitted in the questionnaire, a semi-structured interview on a few respondents prior survey pilot is taken as a complementary to the disadvantage of quantitative method. To ensure a higher response rate for pilot data collection, we are going to reach the respondents by telephone.

Variables

In this part we retrieve the factors from previous literature review, and reorganize them as variables in the following variable blocks.

Dependent variables

We consider four dependent variables, within which ‘Patent’ is the core dependent variable and the other three ‘Publications’, ‘Commercialization’, ‘Spin-offs’ are the behaviors most connecting to academic patents. Respondents were asked on their publication productivity and average citations, patent filling count, and how many of them been commercialized or spin-offed.

TABLE 1 DEPENDENT VARIABLES

Dependent Variables	Symbol	Type	Measure description
publications	PBL_CNT	Count	Number of respondent's publication
research excellence	CTN_CNT	Count	Average citation of respondents publication
patents	PT_CNT	Count	Respondent participating in a patent application or granted for a patent at patent office
commercialization	PT_CMCL	Count	Number of commercialized patent
spin-offs	PT_SPF	Count	Start-ups inspired or founded by his/her invention

Control variable

From the analysis of literatures we found that individual and professional demographic information influencing scientists’ invention behavior in different extents. Gender tends to be a controversial factor, with evidence demonstrate not obvious distinction between the two groups, but Goel and Göktepe-Hultén (2013b) argue that female researchers were less likely to patent. In terms of scientific fields, certain disciplines are better at yielding patentable inventions. Those who from life and natural science disciplines are more likely to patent. However the researchers’ age and academic title seemed to have a similar effect on the propensity to patent and to industry engagement. Therefore, we control the attribution of academics’ gender, family background, research age, patent age, research field, academic title, industry occupation, university affiliation, number of colleagues within research group, and time spending in research, as well as if he/she got funds or not.

TABLE 2 CONTROL VARIABLES

Group	Control Variables	Symbol	Type	Measure description
	research age	AGE_RS	Count	Relate to experience and competence
	patent age	AGE_PT	Count	Relate to patenting persistence
	research field	RSFD	Dummy	Control science area character
	academic position	PST	Dummy	Relate to competence
	industry occupation	IND_OCP	Dummy	Relate to engagement with industry
	R&D and teaching time	TM_RDT	Count	Control to time conflict and focus
	funds	GRT	Binary	Control effect of fund opportunity
demographic data	age	DOB	Count	Year of birth
	gender	GNDR	Binary	Control the effect of gender
	family background	MARG	Dummy	Single, couple, couple with children. Relate to effect of spare time
	university / institute	UNIV	Dummy	Control the effect of group
	type /name of department	DEPT	Dummy	Control discipline distribution
	academic staff in your research group	STFCNT	Count	Control the effect of group

Independent variables

In the second section we reviewed previous academic studies on the factors influencing scientists' behavior of technology transfer activities. Nevertheless, are these findings from other regions, and non-patenting activities also apply to Swedish academics' patenting preference?

We test these motivations by re-organizing to eight variable groups: financial incentives, legislation and public policy, university supports, industry supports, Group &networking, R&D incentives, personal rewards and intrinsic motivation. For each group, there are detailed variables which are incorporated into difference questions in the survey, aiming to reduce the misinterpretation and society desire bias. Questionnaire (Appendix A) is structured in several tracks (see figure 8), depending on that if the respondent is inventor, patent holder, and if he/she engaged in patent commercialization and spin-off.

TABLE 3 INDEPENDENT VARIABLES

Group	Independent Variables	Symbol	Description
financial incentives	Public funds	IMP_FDPBLC	financial incentives from universities, public, government, e.g. ERC, VINNOVA
	Industry funds	IMP_FDIND	funds from industry, including VC
	Incomes as return	IMP_ICMPT	incomes from patent licensing, royalties, shares, etc.
legislation/ public policy	tax credits	IMP_TXCRD	
	time span	IMP_TMSP	
	legal and regulation environment	IMP_LGRGL	
university supports	science park	IMP_SCPK	
	academic incubator	IMP_INCB	
	university TTO	IMP_TTO	To examine the effectiveness of Technology Transfer Office
	know-how	IMP_KWH	courses and training regarding patenting, Relate to experience
	hard-conditions	IMP_UNRS	facility, equipment and conditions from university
industry supports	hard-conditions	IMP_INDH	facility, equipment from company
	soft-resource	IMP_INDS	Personnel, data and other from industry
Group &networking	academic peers	IMP_ACDP	cooperation and help from academic peers

	networking time	IMP_NTWT	
	networking with industry	IMP_NTWIN	With co-researcher, co-inventor from company
R & D incentives	funding for research	IMP_RDFD	
	access to resources and research expertise	IMP_RDRS	
	stimuli for future research	IMP_RDSTI	
	to enhance research excellence	IMP_RDEX	
	to enrich teaching quality	IMP_TCQA	
personal rewards	career status	IMP_CRST	promotion, CV add-value, possibility for better career
	financial benefits	IMP_PRFN	salary raising, immediate incomes from patenting
	seeking IPRs	IMP_IPR	
	university prestige	IMP_UNIPR	
	personal reputation	IMP_PRREP	
intrinsic motivation	propensity and interests	IMP_INTR	Inclination to research, or to commerce, or medium
	open science	IMP_IMOS	Contribution to society, knowledge sharing
	sense of achievement	IMP_IMACH	Satisfaction
	intellectual challenge	IMP_IMINC	
	curiosity and knowledge learning	IMP_IMKLN	
	security	IMP_IMSEC	Job stability

Financial determinants- Costs

In comparison with publishing, patenting usually implies a higher cost, meanwhile it brings higher financial gains afterwards, for its commercial exploitation. According to WIPO, PCT applicants generally pay three types of fees when they file their international applications: an international filing fee of 1,330 Swiss francs (in 2004 initial filling fee is CHF 1400, which was lowered to CHF 1300 in 2008), a search fee which can vary from approximately 150 to 2,300 Swiss francs depending on the ISA chosen, and a small transmittal fee which varies depending on the receiving Office. The costs in national / regional phase are not included here, as well as additional translations and agents fees, if applicable. In a study about how PCT applicants' filling decisions are to changes in the international filling fees. WIPO (2014) reveals a highly inelastic, but statistically significant, fee responsiveness.

Licensing fee. Based on the exclusive rights conferred by a patent, licensing is a permission granted by the patent owner to another to use the patented invention on agreed terms and conditions, while the patent owner continues to retain ownership of the patent. Licensing not only creates an income source for the patentee, but also has a cost in the process of ownership transfer.

Time

In the PCT system, an application lasts more than 30 months, within which involves amount of administrative procedures. Applicants need to spend time and efforts on these activities. If the filling process is applied by the academics him-/herself, it might have an effect on teaching and researching, in the way of time and effort conflict. If it is carried by an agency or attorney, it turns to another consideration of commission cost.

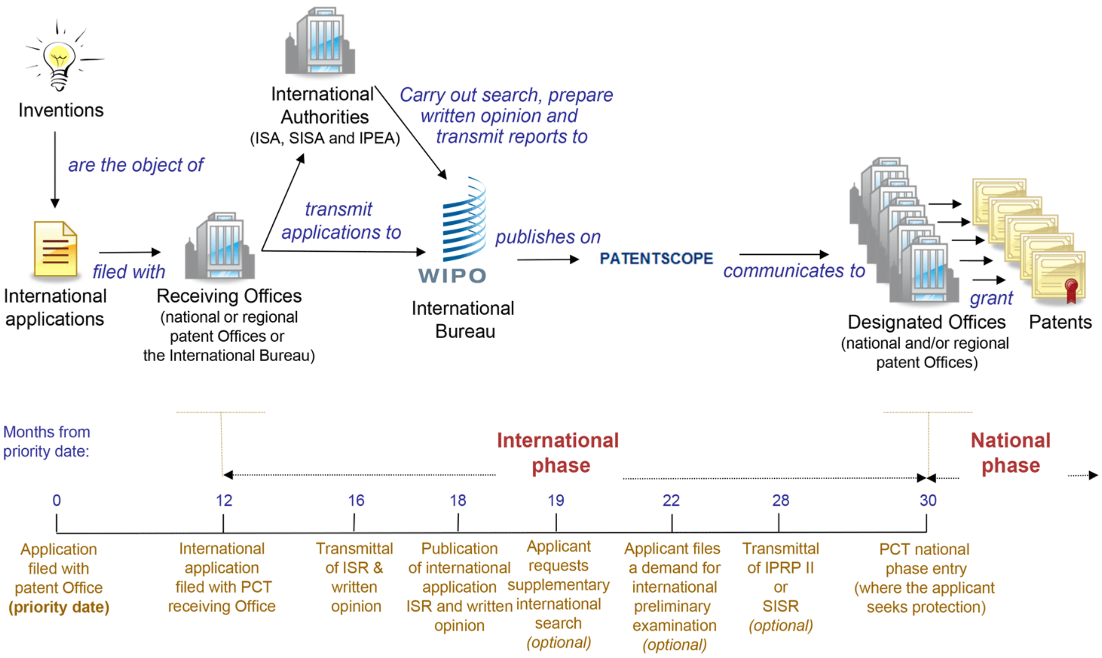

FIGURE 9 OVERVIEW OF THE PCT SYSTEM *SOURCE: WIPO*
HTTP://WWW.WIPO.INT/PCT/EN/FAQS/FAQS.HTML

Risk of imitation and IPR

Risk of imitation, and IPR purpose are defined as one variable but in different question forms. It is corresponding to academics' belief of Open Science, to examine respondents' attitude toward knowledge diffusion.

Patents usually contain a broad range of advanced or interdisciplinary technologies of which data source are rarely available to public. When apply for a patent, the content of the documents cover a rich amount of such information. As the patent documents are required to be disclosed to the public, these valuable information are thus accessible to future legal users as well as potential imitators. The disclosure, therefore, maybe lead to similar inventions or illegal imitations which can compete with original patents in the market, but with lower costs. IP protection is crucial for acquiring technology through licensing. Inventors apply for patent for defensive often have the concern of what if the invention is infringed by others' products?

Ownership of IP rights is prerequisite to transfer technology from academic individuals to industry for commercial use, which can be effectively done through appropriate IP protection Without IP rights, transfers of technology would be hindered. However, patent is not a panacea to prevent others from imitating the invention. Even if the inventor has patent granted, he still need to spend time and money on claiming the infringement.

Knowhow and persistence

The knowhow and experience for patenting is asked in the way of their first patent filing experience and university supportive courses and trainings. Scientist who have previously patent their inventions are more likely to continue, and to be more inclination to industry activity, and have a greater chance of being an entrepreneur (Goel and Göktepe-Hultén 2013b).

Intrinsic motivations

According to Maslow's need hierarchy theory, individuals' behavior usually are determined by their strongest need. In the survey, we use these physiological elements to identify academics' intrinsic motivations: social-, group belongingness, reputation/

acceptance, friendship; esteem- need for both self-esteem of achievement and external esteem (status, recognition and attention); self-actualization - achieving one's potential, and self-fulfillment.

We ask the respondents' personal value of technology by weighing their attitude for open science and IPR. Whether they believe that knowledge diffusion should be a public benefit or should be commercial exploitation.

Propensity and inclination to commerce or research is examined in questions of their purpose for invention, patenting, research commercialization and stat-up business. If they are proactive to commercialization, to entrepreneurship, to patent filing, to invention itself, or limited to scientific research. Industry-inclined inventors file patent for proactive use.

Sampling

The population of this survey is all the academics working in Swedish universities. Although patent is a key measurement to evaluate innovation output, a disadvantage cannot be neglected is that patent is not applicable for all fields. It is less meaningful to use it in basic research than applied research. As a result, we use the survey as a pilot study in the first step. Pilot sample is generated from previous research *Academic Inventors and Knowledge Technology Transfer in nanoscience in Sweden* - 57 paired academic authors and academic inventors in Nano-science and technology field. We choose the small sample of 114 academics on the ground that Nano-technology and science is

- ✓ Need-driven applied research field
- ✓ Advanced, emerging growth area
- ✓ High R&D invested
- ✓ Close to market, higher social / commercial value
- ✓ Corresponding to OECD data- for secondary data analysis

Statistics description of pilot sample

Individual and professional demographic information of the sample, age/YOB, gender, university affiliation, academic title and education, as well as data of publication and patent are directly withdraw from database KEINS (Lissoni, Sanditov, Tarasconi, 2006), a list of academic employees in Swedish universities. Although the general descriptive statistics are available, we still need to ask some of them in the questionnaire, for these data might be out of date. Especially for the information of publications and patents, a new processing is necessary to obtain the latest version of sample data. We update the 114 authors' publication data from *Web of Science* with their names as string. In order to avoid duplications, we refined search results by researcher ID, and manually looking up into author affiliations and addresses, as well as publication details.

From the available information in the selected sample, we can find some noteworthy features. Most of the academics come from Chalmers Technology University and University of Umea. Scientists from the disciplines of Physical Sciences and Chemical Sciences make up for equivalent majority, respectively 38% and 43%. Those with title of Professor almost domain half of the total sample.

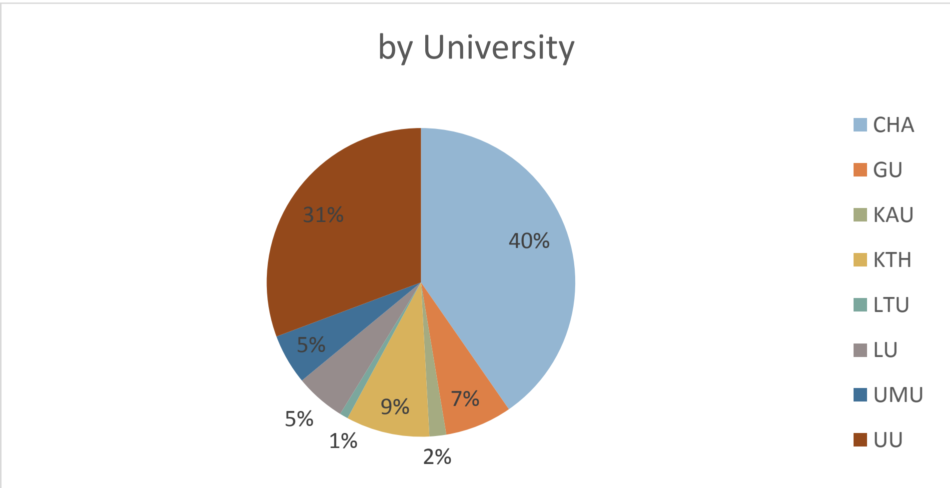

FIGURE 10 ACADEMICS UNIVERSITY DISTRIBUTION

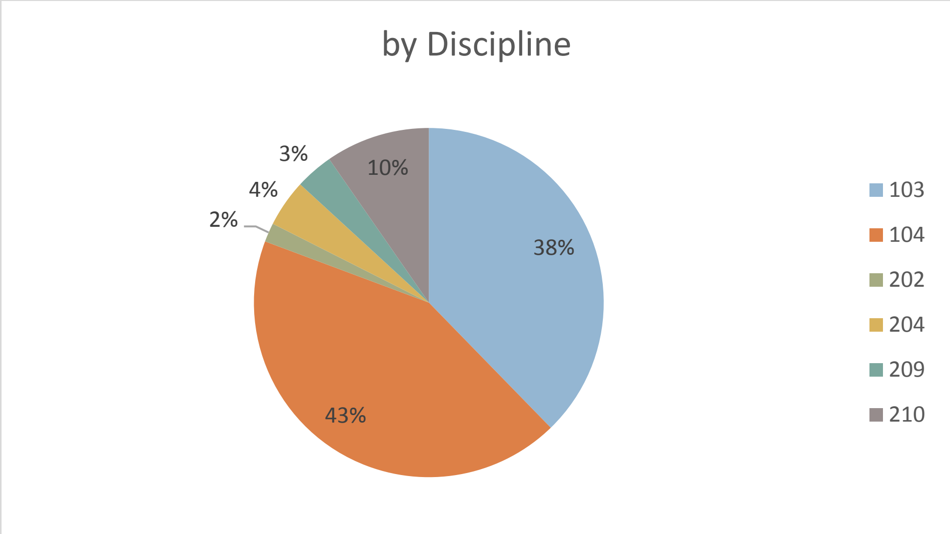

FIGURE 11 ACADEMICS DISCIPLINE DISTRIBUTION

Note: Discipline code in this research is accordance with the classification system by the Swedish National Agency for Higher Education. 103-Physical Sciences; 104-Chemical Sciences; 202- Electrical Engineering, Electronic Engineering, Information Engineering; 204- Chemical Engineering; 209- Industrial Biotechnology; 210- Nano-technology.

When compare the research excellence and productivity on the current data, we can find that academic inventors outperformed their matched counterpart- academic author, in terms of both Publication count and Publication citation (figure 12).

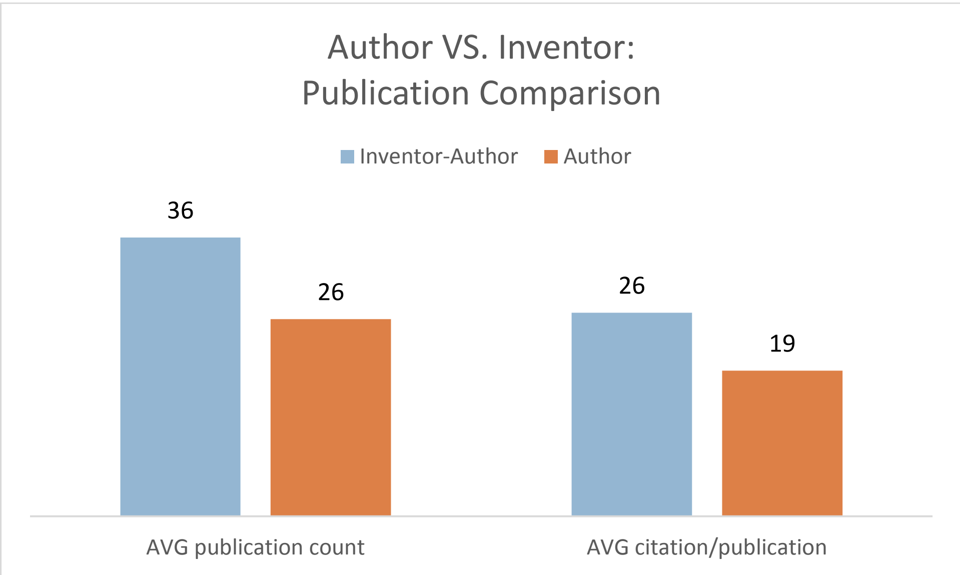

FIGURE 12 PUBLICATION COMPARISON

For the single Academic Inventor group, a weak correlation between Patent count and Publication count is presented (figure 14), as well as between Patent count and Average Publication Citation (figure 13). But there are also exceptions in extreme cases. Some inventors have a distinguished number of patent but a low productivity in publication. We can propose an assumption of U-shape effect in this correlation, similar to UK evidence, and examine if it is supported by new data from survey.

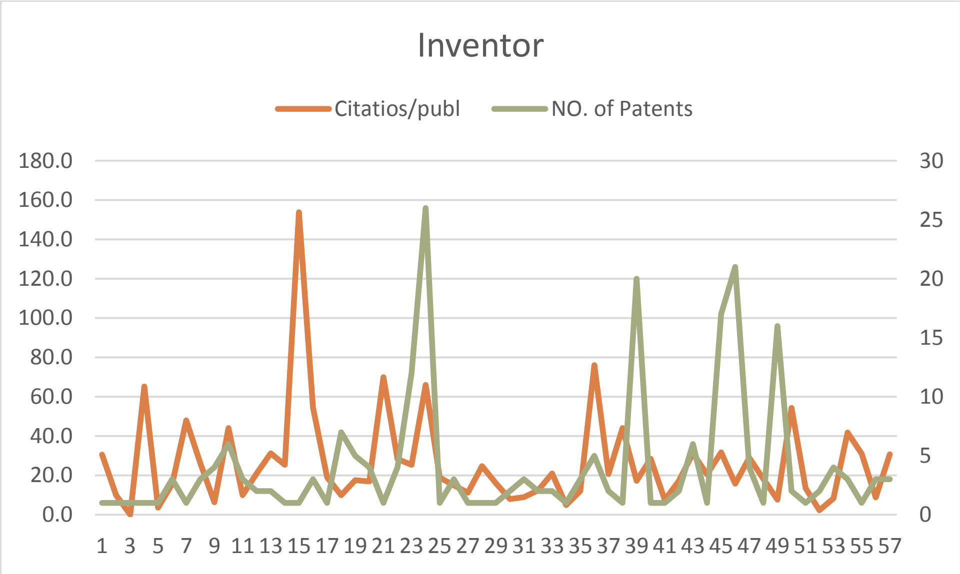

FIGURE 13 RELATION OF CITATION PER PUBLICATION AND PATENT NUMBER OF INVENTORS

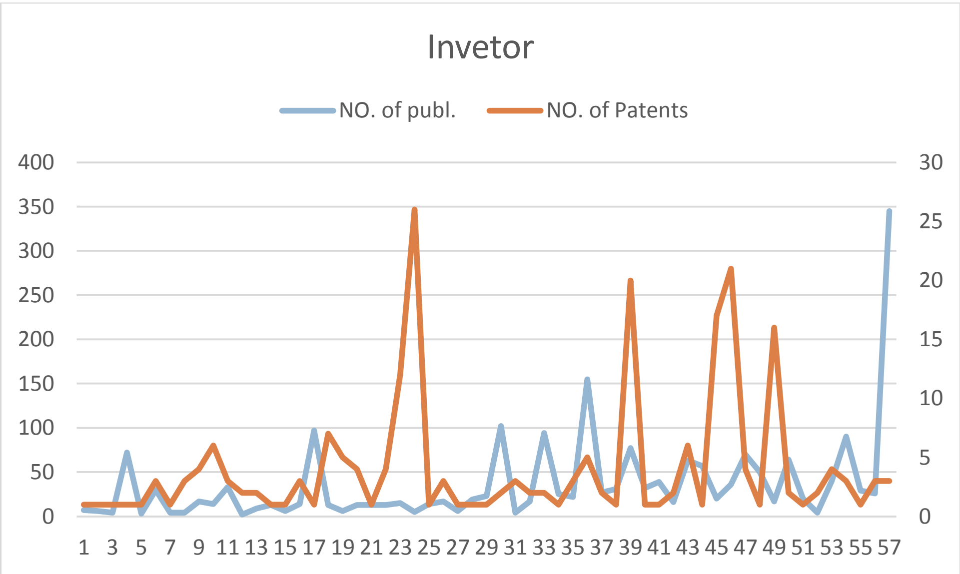

FIGURE 14 RELATION OF PUBLICATION AND PATENT NUMBER OF INVENTORS

4. Conclusions

In this thesis, we examined the public and industry reports regarding academic patent, and systematically searched literatures in related topics.

We illustrate a comprehensive understanding of academic patent topic in Swedish context; identified and generalize the motives for academic patenting and related activities in 8 groups: to eight variable groups: financial incentives, legislation and public policy, university supports, industry supports, Group &networking, R&D incentives, personal rewards and intrinsic motivation; proposed a framework to analyze how these motivations effect academics' preference and behavior.

Finally, with the framework and summarized motivations, we constructed a survey to serve the purpose of investigating Swedish university faculties' motivation for academic patenting. Nano-science technology field is selected as the sample for the survey pilot in this research.

In further steps, an interview is planned to obtain qualitative empirical data. Motivations and survey will be modified depending on the result of the interview and survey pilot, then sent to a broader scope of Swedish academia for a comprehensive analysis basing on empirical data.

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Appendix A: Academic Patenting Questionnaire

General information derived from existing database

Age/Year of Birth

Gender

University

Type /Name of department

General questions

1. What is your professional position?
    a. Professor
    b. Associate professor
    c. Researcher
    d. Post doctor
    e. Lecturer
    f. PhD fellow
    g. PhD student
    h. Other

2. What is your family background?
    a. Single
    b. Couple
    c. Couple with children under 16 years old

3. Which discipline do you engage in?
    a. Chemical Science
    b. Chemical Engineering
    c. Physical Science
    d. Nano-technology
    e. Other

4. How long have you been engaged in this field?
    a. *choose number of* year

5. How much important do you think patenting is to the field?
    a. (weight 1-5, 5 as most important)

6. Are you employed by a company (tick one or more)?

a. No
b. As a consultant
c. As a trainer
d. As a contracted researcher
e. Other

7. How long have you been working at this positon (the longest if more than one)?
    a. *Number of year*

8. Do you collaborate with a company?
    a. No
    b. As an informal consultant
    c. As a guest trainer
    d. Co-research
    e. Other

9. How much working time do you spend on the following activities? (in 5 scales: non, very few, few, some, most)
    a. Teaching
    b. Research & publishing
    c. Invention & patenting
    d. U-I interaction (consulting, contract research, training, etc.)
    e. Research commercialization, e.g. licensing patent to company
    f. Start up business
    g. Other

10. What is the size of your research group?
    a. *The number of staff*

11. How many of your colleagues in the group have patent(s)?
    a. *The number of inventor*

12. How many of your network acquaintances (friends, colleagues, co-inventors, co-authors etc.) are involved in patenting activities?
    a. *The number*

13. How many of your network acquaintances (friends, colleagues, co-inventors, co-authors etc.) run start-up(s)?
    a. *The number*

14. How many of your network acquaintances (friends, colleagues, co-inventors, co-authors etc.) have cooperation with industry?
    a. *The number*

15. How many articles have you published in refereed journals (as single or co-author)?
    a. 0-5
    b. 6-10
    c. 11-15
    d. >15

16. How many research grants have you applied for from the following agencies:
    a. Int. government research councils/agencies EU/WHO/etc.
    b. Government Councils/Agencies (VR/VINNOVA/SSF/KK)
    c. University
    d. Business sector, including Venture Capital
    e. Private funding

17. How important is the following supportive factors do you think for inventing (weight 1-5, 5 as most important)?
    a. Funds from universities, public, government, e.g. ERC, VINNOVA
    b. Funds from industry, including grant and venture capital
    c. Incomes from patent licensing and royalties
    d. Tax credits
    e. Time span, from priority date to grant date
    f. Legal and regulation environment, IPR
    g. Science park
    h. Academic incubator
    i. University Technology Transfer Office (TTO)
    j. Courses and training regarding patenting
    k. Resource, facility, equipment and conditions from university
    l. Facilities and equipment from company
    m. Resource and data from industry
    n. Cooperation with staff from company
    o. Cooperation and help from academic peers

18. How important is publication/ patent for your status in career (weight 1-5, 5 as most important)?
    a. Peer reviewed publication
    b. Non-patented inventions
    c. Patents

19. How important is patent for you in the following aspects (weight 1-5, 5 as most important)?
    a. It inspires more research projects
    b. It promotes more publications
    c. It increase more peer review of my publications

d. It helps maintain network for research, e.g. co-inventor for co-author

20. How many inventions have you developed (as single or co-inventor)? [if ‘a’, to non-inventors Q; others to inventor Q]
    a. 0, never or not success
    b. 0, but planning to.
    c. 1-5
    d. 6-10
    e. >10
    f. There is/are *number* in developing process.

Non-inventor questions

If the answer to question 20 is “a.”-

21. Why not invent? Please rank the following reasons according to their importance (weight 1-5, 5 as most important):
    a. No interest in developing invention
    b. Digression from my core objectives
    c. Research result should be published to public, “Open science” mentality
    d. Financial cost is high, not enough fund
    e. Time-consuming, conflict with my duty
    f. Incompetence, lack of ability to invent
    g. Lack of network with industry partner to co-invent
    h. Lack of cooperation with academic partner
    i. Lack of support from university for invention: facilities, resource, etc.
    j. Lack of support from industry: information, resource, facilities, etc.

------------*NON-INVENTOR END*--------------

(Potential) Inventor questions

If the answer to question 20 is not “a.”-

22. Why you invent? Please rank the following reasons according to their importance (weight 1-5, 5 as most important):
    a. More fund for research
    b. Learning and sharing knowledge
    c. Access to resources and research expertise
    d. To get stimuli for future research
    e. To enrich research quality

f. To enrich teaching quality
g. Job security
h. Opportunity for salary raising and career promotion
i. It is a career goal
j. Personal reputation and status
k. To build and maintain the network with experts
l. It is an intellectual challenge
m. Interested in invention, enjoy the process
n. Curios about the technology prospect
o. Sense of achievement
p. Contribution to society

23. How many patents have you **applied** (as single or co-inventor)? [if ‘a’, to non-patent-inventor Q, others direct to Patent-Inventor Q]
    a. 0. Never
    b. 0, but planning to.
    c. 1-5
    d. 6-10
    e. >10

24. Why you patent your invention? (weight 1-5, 5 as most important)
    a. More fund for research
    b. Learning and sharing knowledge
    c. Access to resources and research expertise
    d. To get stimuli for future research
    e. To enrich research quality
    f. To enrich teaching quality
    g. Seeking IPRs
    h. Job security
    i. Opportunity for salary raising and career promotion
    j. To boost value in CV
    k. It is a career goal
    l. Incomes from patenting including royalties, shares, licensing
    m. Personal reputation and status
    n. To maintain stronger relationship with industry
    o. Curious about the technology prospect
    p. Sense of achievement
    q. To diffuse knowledge to public, contribution to society
    r. To commercialize in the future, bring to market

25. How many patents have you been **granted** (as single or co-assignee)? [if ‘a’, to non-patent-inventor Q, others direct to Patent-Inventor Q]
    a. 0. Never
    b. 1-5
    c. 6-10

d. >10
e. There is/are *number* in progress.

Non-patent-inventor questions

If the answer to question 23 or 25 is "a"-

26. Why not patent your invention? Please rank the following factors according to their importance (weight 1-5, 5 as most important):
    a. Not interested in patents.
    b. Innovation is small, it does not worth when balance cost-benefit
    c. Difficulties in evaluating the commercial potential
    d. Risk of imitation, too much data is open and available for others
    e. Financial cost, not enough fund
    f. It lasts too long period
    g. Excessive bureaucracy, legislation and rigidity of administrations, potential burdensome regulations
    h. Scarce knowledge and experience of patent regulations and process
    i. Inefficiency of TTO, less experienced staff
    j. "Open science" mentality

-------------*NON-PATENT INVENTOR END*----------------

Patent-Inventor questions

If the answer to question 23 or 25 is not "a"-

27. What percentage of your time spent on inventing and patenting?
    a. <5%
    b. 5%-20%
    c. 20%-35%
    d. 36%-50%
    e. >50%

28. When did you first time develop an invention?
    a. Year

29. When did you first time apply patent?
    a. Year

30. Did you get training about patenting knowledge when you first time patenting? [if not ‘c’, skip next Q]
    a. Yes
    b. No, I learned by myself.
    c. No, I got help from others.

31. Who helped you with first patent application? (choose one or more)
    a. My friends
    b. TTO
    c. University colleagues
    d. Partner from industry
    e. Agency
    f. Attorney
    g. Other

32. Who motivated you to file the first patent? (choose one or more)
    a. The research group
    b. The university
    c. The cooperated company
    d. Co-inventor from industry
    e. Co-inventor from university
    f. Other friends in network

33. How long is the average time span to obtain your patents (from filing date to grant date)?
    a. <20 month
    b. 20-30 months
    c. 31-40 months
    d. >40 months

34. How is your relationship with your co-inventor?
    a. Only co-work for specific invention
    b. Partnership with specific research projects
    c. Long-term partner with publishing
    d. Long-term partner in doing researches

35. Who owns the patents you (co-)invented? (fill in the number)
    a. University
    b. Firm--- *if 0, skip next Q*
    c. Individuals
    d. Other

36. Why you co-applied for patent with a company? (extent 1-5, 1 as not at all, 5 as cover all)

a. The idea is inspired by that company
b. I have a co-inventor from company
c. To get resource from industry
d. To realize the commercial value of invention
e. Other reason

37. Please rank the coverage of funds inventing and patenting costs? (extent 1-5, 1 as not at all, 5 means cover all)
    a. Int. government research councils/agencies EU/WHO/etc.
    b. Government Councils/Agencies (VR/VINNOVA/SSF/KK)
    c. University
    d. Business, including VC
    e. Private

38. To what extent are you satisfied with the supports regarding patenting? (weight 1-5, 5 as most satisfied):
    a. funds from universities, public, government, e.g. ERC, VINNOVA
    b. funds from industry, including VC
    c. incomes from patent licensing and royalties
    d. tax credits
    e. time span, from priority date to grant date
    f. legal and regulation environment, IPR
    g. science park
    h. academic incubator
    i. university Technology Transfer Office (TTO)
    j. courses and training regarding patenting
    k. resource, facility, equipment and conditions from university
    l. facility, equipment, data and conditions from company
    m. personnel resource from industry
    n. cooperation and help from academic peers

39. How much returns did patents bring? (weight 1-5, 5 as most satisfied):
    a. Financial returns, personal incomes
    b. Academic returns, promote reputation of university and research group
    c. Returns in the U-I relationship, collaboration with industry

Commercialization

40. How many of your patents been commercialized (e.g. licensed to a firm)? [if "a", skip next Q]
    a. 0
    b. Number
    c. *Number* In progress

41. Which factor is important for commercializing your invention? (weight 1-5, 5 as most important)
    d. TTO
    e. Co-inventor from company
    f. Relationship with industry
    g. Market
    h. Other

42. Why not commercialize your invention? (weight 1-5, 5 as most important)
    i. Not interested in
    j. Have no experience
    k. Lack of support from university, like TTO
    l. Lack of support from industry
    m. Lack of legal knowledge
    n. Too much administrative
    o. Other

Spin-off

43. Has your invention helped found a new company? [if "a", skip next Q]
    a. No
    b. Yes, I am a board member
    c. Yes, I act as a CEO (chief executive officer)
    d. Yes, I act as a CTO (chief technology officer)
    e. Yes, I work in other positon

44. Which factor is important for spin-off, start-up? (weight 1-5, 5 as most important)
    f. Incubator
    g. Inventors' Entrepreneurship
    h. Finance support
    i. Business partner
    j. Administrative knowledge
    k. Market knowledge
    l. Other

45. Why not spin-off? (weight 1-5, 5 as most important)
    m. Not interested in
    n. Lack of supportive scheme, e.g. incubator
    o. Lack of entrepreneur knowledge- how to start a company
    p. Lack of business partner
    q. Lack of finance support

r. Lack of market knowledge
s. Other

------------- *END*----------------

Appendix B: Sample Statistics List

Inventor ID	NO. of publ.	Tot. Cit.	Tot. Cit. W/T. Self-Cit.	Cit./publ.	NO. of Patents	Year of 1st Patent	Year of Birth	UNI_CODE	UNIVERSITY	DISCIPLINE	DSP_CODE
Iv1	7	220	214	30.6	1	1994	1968	KAU	Karlstad University	Chemical Engineering	204
Iv2	6	70	60	10.0	1	2007	1980	CHA	Chalmers University	Chemical Sciences	104
Iv3	4	29		0.0	1	1999	1947	UU	Uppsala University	Chemical Sciences	104
Iv4	72	4886	4696	65.2	1	1994	1966	CHA	Chalmers University	Chemical Sciences	104
Iv5	3	11	11	3.7	1	2001	1960	CHA	Chalmers University	Chemical Sciences	104
Iv6	30	515	471	15.7	3	2002	1962	CHA	Chalmers University	Physical Sciences	103
Iv7	4	193	192	48.0	1	2000	1960	GU	Goteborg University	Physical Sciences	103
Iv8	4	106	105	26.3	3	1999	-	UMU	Umeå University	Chemical Sciences	104
Iv9	17	120	108	6.4	4	2004	1957	CHA	Chalmers University	Nano-technology	210
Iv10	14	622	618	44.1	6	1992	-	KTH	Kungliga Tekniska Hög	Industrial Biotechnology	209
Iv11	33	387	327	9.9	3	1993	1970	UU	Uppsala University	Physical Sciences	103
Iv12	2	42	42	21.0	2	2007	1978	CHA	Chalmers University	Chemical Sciences	104
Iv13	9	282	281	31.2	2	2001	1967	UU	Uppsala University	Elect-Engineering, Information Engineering	202
Iv14	13	334	330	25.4	1	2007	1958	UU	Uppsala University	Physical Sciences	103
Iv15	6	926	923	153.8	1	2005	1969	GU	Goteborg University	Chemical Sciences	104
Iv16	14	773	762	54.4	3	2000	1964	CHA	Chalmers University	Chemical Sciences	104
Iv17	97	2027	1839	19.0	1	1998	1947	GU	Goteborg University	Physical Sciences	103
Iv18	13	135	130	10.0	7	1996	-	KTH	Kungliga Tekniska Hög	Physical Sciences	103
Iv19	6	106	105	17.5	5	1993	-	KTH	Kungliga Tekniska Hög	Industrial Biotechnology	209
Iv20	13	235	219	16.8	4	1990	-	UMU	Umeå University	Chemical Sciences	104
Iv21	13	921	910	70.0	1	2005	1970	UU	Uppsala University	Chemical Sciences	104
Iv22	13	384	369	28.4	4	1980	-	KTH	Kungliga Tekniska Hög	Chemical Engineering	204

Iv23	15	404	380	25.3	12	1996	1951	UU	Uppsala University	Chemical Sciences	104
Iv24	5	331	330	66.0	26	1995	1948	CHA	Chalmers University	Nano-technology	210
Iv25	14	302	264	18.9	1	2004	1981	CHA	Chalmers University	Physical Sciences	103
Iv26	17	268	255	15.0	3	1992	1949	UU	Uppsala University	Chemical Sciences	104
Iv27	6	71	67	11.2	1	2007	1962	UU	Uppsala University	Physical Sciences	103
Iv28	19	504	470	24.7	1	2007	1975	CHA	Chalmers University	Physical Sciences	103
Iv29	23	397	370	16.1	1	2001	1955	CHA	Chalmers University	Physical Sciences	103
Iv30	102	1010	807	7.9	2	1996	1957	CHA	Chalmers University	Nano-technology	210
Iv31	4	40	36	9.0	3	1997	1962	CHA	Chalmers University	Physical Sciences	103
Iv32	17	231	209	12.3	2	1997	1943	LTU	Luleå Tekniska	Chemical Engineering	204
Iv33	94	2033	1972	21.0	2	2003	1965	UU	Uppsala University	Physical Sciences	103
Iv34	25	126	122	4.9	1	2007	1949	CHA	Chalmers University	Chemical Sciences	104
Iv35	22	307	265	12.0	3	2004	1967	CHA	Chalmers University	Chemical Sciences	104
Iv36	155	12325	11787	76.0	5	1995	1964	UU	Uppsala University	Chemical Sciences	104
Iv37	27	597	559	20.7	2	2003	1970	CHA	Chalmers University	Physical Sciences	103
Iv38	31	1396	1368	44.1	1	1997	1958	CHA	Chalmers University	Chemical Sciences	104
Iv39	77	1533	1324	17.2	20	2001	1960	UU	Uppsala University	Chemical Sciences	104
Iv40	32	968	912	28.5	1	2001	1964	CHA	Chalmers University	Nano-technology	210
Iv41	39	364	295	7.6	1	2007	-	UMU	Umeå University	Physical Sciences	103
Iv42	16	306	275	17.2	2	2003	1978	UU	Uppsala University	Physical Sciences	103
Iv43	63	2032	1968	31.2	6	1995	1956	CHA	Chalmers University	Chemical Sciences	104
Iv44	57	1213	1170	20.5	1	2000	1953	UU	Uppsala University	Physical Sciences	103
Iv45	20	656	635	31.8	17	2001	1967	CHA	Chalmers University	Nano-technology	210
Iv46	36	597	569	15.8	21	1977	1946	CHA	Chalmers University	Chemical Sciences	104
Iv47	70	2159	2032	29.0	4	2002	-	KTH	Kungliga Tekniska Hög	Chemical Sciences	104
Iv48	50	989	909	18.2	1	2006	1974	LU	Lund University	Physical Sciences	103
Iv49	17	151	131	7.7	16	1989	1944	GU	Goteborg University	Physical Sciences	103

Iv50	64	3657	3474	54.3	2	2000	1966	UU	Uppsala University	Chemical Sciences	104
Iv51	20	275	270	13.5	1	2004	1974	CHA	Chalmers University	Chemical Sciences	104
Iv52	4	10	9	2.3	2	1996	1951	CHA	Chalmers University	Chemical Sciences	104
Iv53	40	421	333	8.3	4	1994	1961	UU	Uppsala University	Chemical Sciences	104
Iv54	90	4086	3764	41.8	3	1997	1957	LU	Lund University	Physical Sciences	103
Iv55	29	927	902	31.1	1	2007	1956	UU	Uppsala University	Physical Sciences	103
Iv56	26	243	228	8.8	3	1995	1957	CHA	Chalmers University	Nano-technology	210
Iv57	345	12004	10607	30.7	3	2007	1948	LU	Lund University	Physical Sciences	103

Author ID	NO. of publ.	Tot. Cit.	Tot. Cit. w/t. Self-Cit.	Cit./publ.	Year of Birth	UNI_CODE	UNIVERSITY	DISCIPLINE	DSP_CODE
Au1	7	31	29	4.1	1960	UU	Uppsala University	Chemical Sciences	104
Au2	5	29	22	4.4	1981	CHA	Chalmers University	Chemical Sciences	104
Au3	15	297	291	19.4	1949	UU	Uppsala University	Chemical Sciences	104
Au4	34	739	713	21.0	1966	CHA	Chalmers University	Chemical Sciences	104
Au5	10	150	144	14.4	1971	CHA	Chalmers University	Chemical Sciences	104
Au6	69	5862	5634	81.7	1969	UU	Uppsala University	Physical Sciences	103
Au7	22	311	297	13.5	1961	GU	Goteborg University	Physical Sciences	103
Au8	11	67	64	5.8	-	UMU	Umeå University	Chemical Sciences	104
Au9	60	1451	1372	22.9	1959	CHA	Chalmers University	Nano-technology	210
Au10	142	2925	2675	18.8	-	KTH	Kungliga Tekniska Hög	Industrial Biotechnology	209
Au11	39	702	663	17.0	1969	UU	Uppsala University	Physical Sciences	103
Au12	4	39	39	9.8	1978	CHA	Chalmers University	Chemical Sciences	104
Au13	8	385	383	47.9	1972	UU	Uppsala University	Elect-Engineering, Information Engineering	202
Au14	19	447	411	21.6	1963	UU	Uppsala University	Physical Sciences	103
Au15	8	208	208	26.0	1966	KAU	Karlstad University	Chemical Engineering	204
Au16	6	8	7	1.2	1966	CHA	Chalmers University	Chemical Sciences	104

Au17	93	1448	1242	13.4	1947	GU	Goteborg University	Physical Sciences	103
Au18	53	753	645	12.2	-	KTH	Kungliga Tekniska Hög	Physical Sciences	103
Au19	3	21	21	7.0	-	KTH	Kungliga Tekniska Hög	Industrial Biotechnology	209
Au20	8	56	54	6.8	1966	UU	Uppsala University	Chemical Sciences	104
Au21	6	139	135	22.5	1971	UU	Uppsala University	Chemical Sciences	104
Au22	2	1	1	0.5	-	KTH	Kungliga Tekniska Hög	Chemical Engineering	204
Au23	9	285	284	31.6	1970	UU	Uppsala University	Physical Sciences	103
Au24	29	233	157	5.4	1943	CHA	Chalmers University	Nano-technology	210
Au25	11	254	237	21.5	1952	UU	Uppsala University	Physical Sciences	103
Au26	22	1480	1432	65.1	1948	UU	Uppsala University	Chemical Sciences	104
Au27	19	169	149	7.8	1964	UU	Uppsala University	Physical Sciences	103
Au28	41	1431	1364	33.3	-	UMU	Umeå University	Chemical Sciences	104
Au29	17	398	372	21.9	1946	CHA	Chalmers University	Physical Sciences	103
Au30	18	223	215	11.9	1960	CHA	Chalmers University	Nano-technology	210
Au31	91	1686	1638	18.0	1960	CHA	Chalmers University	Physical Sciences	103
Au32	6	38	36	6.0	1980	CHA	Chalmers University	Physical Sciences	103
Au33	15	661	645	43.0	1949	GU	Goteborg University	Chemical Sciences	104
Au34	3	88	88	29.3	1953	CHA	Chalmers University	Chemical Sciences	104
Au35	10	451	435	43.5	1971	CHA	Chalmers University	Chemical Sciences	104
Au36	31	839	811	26.2	1984	CHA	Chalmers University	Chemical Sciences	104
Au37	11	77	73	6.6	1976	CHA	Chalmers University	Physical Sciences	103
Au38	23	558	544	23.7	1957	CHA	Chalmers University	Chemical Sciences	104
Au39	34	828	780	22.9	1961	UU	Uppsala University	Chemical Sciences	104
Au40	8	135	129	16.1	1963	CHA	Chalmers University	Nano-technology	210
Au41	5	67	61	12.2	-	UMU	Umeå University	Physical Sciences	103
Au42	3	13	12	4.0	1977	UU	Uppsala University	Physical Sciences	103
Au43	34	463	433	12.7	1959	CHA	Chalmers University	Chemical Sciences	104

Au44	63	1005	936	14.9	1960	UU	Uppsala University	Physical Sciences	103
Au45	21	134	104	5.0	1967	CHA	Chalmers University	Nano-technology	210
Au46	16	372	363	22.7	1945	CHA	Chalmers University	Chemical Sciences	104
Au47	21	257	245	11.7	-	KTH	Kungliga Tekniska Hög	Chemical Sciences	104
Au48	14	149	145	10.4	1970	LU	Lund University	Physical Sciences	103
Au49	30	974	942	31.4	1966	GU	Goteborg University	Physical Sciences	103
Au50	14	93	89	6.4	1966	UU	Uppsala University	Chemical Sciences	104
Au51	3	69	69	23.0	1975	CHA	Chalmers University	Chemical Sciences	104
Au52	35	395	379	10.8	1952	CHA	Chalmers University	Chemical Sciences	104
Au53	43	1389	1332	31.0	1961	UU	Uppsala University	Chemical Sciences	104
Au54	66	1391	1261	19.1	1965	LU	Lund University	Physical Sciences	103
Au55	24	209	204	8.5	1956	UU	Uppsala University	Physical Sciences	103
Au56	40	974	905	22.6	1968	UU	Uppsala University	Physical Sciences	103
Au57	6	42	41	6.8	1961	LU	Lund University	Physical Sciences	103