Impact factors for patent behavior among 4TU academics:

Insights and survey instrument construction

Master Thesis

MASTER OF SCIENCE IN BUSINESS ADMINISTRATION
MASTER OF SCIENCE IN INNOVATION MANAGEMENT & ENTREPRENEURSHIP

Marc Pijffers

August 2018

“Impact factors for patent behavior among 4TU academics: Insights and survey instrument construction”

Master thesis project (25 ECTS)

MSc in Business Administration (BA)
Specialization in Entrepreneurship, Innovation and Strategy
University of Twente (UT)
School of Business, Management and Social Sciences
Department NIKOS/ESIM (Chair Prof. Dr. Ir. P.C. De Weerd - Nederhof)
First supervisor: Dr. R. (Rik) van Reekum
Second supervisor: Dr. K. (Kasia) Zalewska-Kurek

Master thesis project (30 ECTS)

MSc in Innovation Management & Entrepreneurship (IME)
University of Technology Berlin (TUB)
Centre for Entrepreneurship
Department of Innovation Economics (Chair Prof. Dr. rer. pol. K. Blind)

Key words

Entrepreneurial university; valorization; academic patenting; intellectual property management; propensity to patent; academic patent behavior; academic researcher

Correspondence: mpijffers@hotmail.com (abuse is not appreciated).

0. Acknowledgement

This thesis is the product of years of studying business administration, innovation and entrepreneurship and there are some people that I owe a debt of gratitude.

First of all, I want to express my gratitude to my supervisors. Rik, I would like to thank you for your understanding, your comments and suggestions to improve this paper, the freedom that you provided me with and your belief in my competence. Besides that, I really enjoyed the interesting and pleasant conversations on other matters. Kasia, you entered my master thesis project in the last stage, but nevertheless I would like to thank you for your collaboration.

I also thank sincerely the other teachers in the two MSc programs for providing me the scientific knowledge and practical skills which will help me to stand out of the crowd and have the competence to be meaningful in a rapidly changing world. Besides that, I highly appreciate Charlotte Röring (UT study Advisor MScBA) and Karina Cagarman (TUB MScIME Coordinator) for advice and effort during my master thesis project.

Next, I want to thank my friends that supported me and provided the necessary relaxation.

Lastly, but mostly I want to thank my mother for her understanding, support, encouragement and adequate advice.

Marc Pijffers

Enschede, the Netherlands

August 2018

List of Abbreviations

EPC – European Patent Convention

EPO – European Patent Office

IP – Intellectual property

IPR(s) – Intellectual property right(s)

OECD – Organization for Economic Co-operation and Development

R&D – Research and development (OECD Frascati Manual: R&D can be categorized in basic research, applied research and experimental development)

SDT – Self-determination theory

TTO(s) – Technology transfer office(s)

WIPO – World Intellectual Property Organization

1. Abstract

Introduction – Valorization by means of patenting, technology transfer and spin-off forms a third mission for Dutch universities of technology to make a socio-economic contribution to society. Following current policies much reliance is placed on academics' competence and engagement to identify and disclose potential patentable inventions from research while they are expected to, to the best of their ability, support patent procedures (and patent exploitation). In this sense, academic patent behavior is defined as all individual actions directed at the realization of a (potential) patent from research within an academic context. The propensity to engage in academic patent behavior is relevant to study, because realizing patents from research by academics is under volitional control despite rules, regulations and job expectations.

Research question – "What perceived organizational and individual factors influence the propensity of 4TU academics to engage in academic patent behavior?"

Research objectives – The main objectives that are being served with this explorative, qualitative research is to be able to (1) understand how academics' propensity to engage in academic patent behavior is formed and (2) find first careful insights on what perceived organizational and individual factors influence the propensity of 4TU academics to engage in academic patent behavior.

Research methodology – Research was executed by means of a comprehensive literature study and semi-structured interviews (N = 13) with academic researchers working at 4TU universities varying on relevant characteristics such that a variety of perceptions could be included to ensure validity.

Insights – To exploit inventive academic research via (worthwhile) patents as entrepreneurial university, academics must engage in academic patent behavior. Academic patent behavior is a valid new concept and the propensity to engage in it is dependent on the fact if academics feel capable (i.e. control beliefs), feel empowered (i.e. normative beliefs) and perceive the realization of patents as worthwhile (i.e. outcome beliefs) and if they perceived an effective, coordinated and aligned academic context (university-wide, TTO and department) oriented towards the realization of patents. Academics use individual and contextual cues to form salient beliefs which determine ultimately the propensity to engage in academic patent behavior.

Academic relevance – This research acts upon gaps in knowledge as it is one of the limited studies that have tackled the phenomenon of academic patenting from the academic-level of analysis. It opens up the psychological black box on how academics' propensity to engage in academic patent behavior is formed and which perceived organizational and individual factors possibly enlarge and reduce this propensity. This resulted in the construction of a survey instrument for further research on engagement in academic patent behavior.

Practical relevance – This research has practical implications for universities' administrations, TTOs, departmental managers and academic researchers to create the right conditions within an academic context on different levels to convert results of its pioneering, relatively large and long-term focused R&D into worthwhile IPRs as effectively and efficiently as possible.

Contents

2. Introduction

This chapter considers the background, the research objectives, research relevance and research questions. It serves as foundation for this research.

2.1 Background

In the first part the role of knowledge, innovation and appropriation measures is considered, while introducing patents and related relevant aspects in the next part. The trend to entrepreneurial universities and the importance of IP management for academic patenting is discussed in the last sections.

2.1.1 The Role of Knowledge, Innovation and Appropriation Measures

The studies of Solow (1956) and Arrow (1962) claim that knowledge and innovation play an important role as engines of economic development and growth as they either create and implement new and unique value-generating resources or endow existing resources with enhanced potential for new value generation (Drucker, 2003; Schumpeter, 1942). The pro-innovation bias (Abrahamson, 1991; Kimberly, 1981; Rogers, 1983) or innovation maximization fallacy (Anderson et al., 2014) explicates the (false) presumption that innovation is good, worthwhile and desirable and that all forms of innovation and its diffusion will have a positive process and outcome. In general, enduring innovation seems to be associated with lower cost, higher growth, bigger market-share, higher profitability and success (Tidd et al., 2001). This is demonstrated by literature that shows the importance of creating and sustaining innovation for organizational performance in the private (e.g. Van de Ven, 1986; Christensen, 1997) and public sector (e.g. Bartos, 2003; Damanpour et al., 2009). A systematic literature review of Edison, Bin Ali and Torkar (2013) showed a most complete definition which sees innovation as “production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production; and establishment of new management systems. It is both a process and an outcome” (Crossan & Apaydin, 2010, p. 1156).

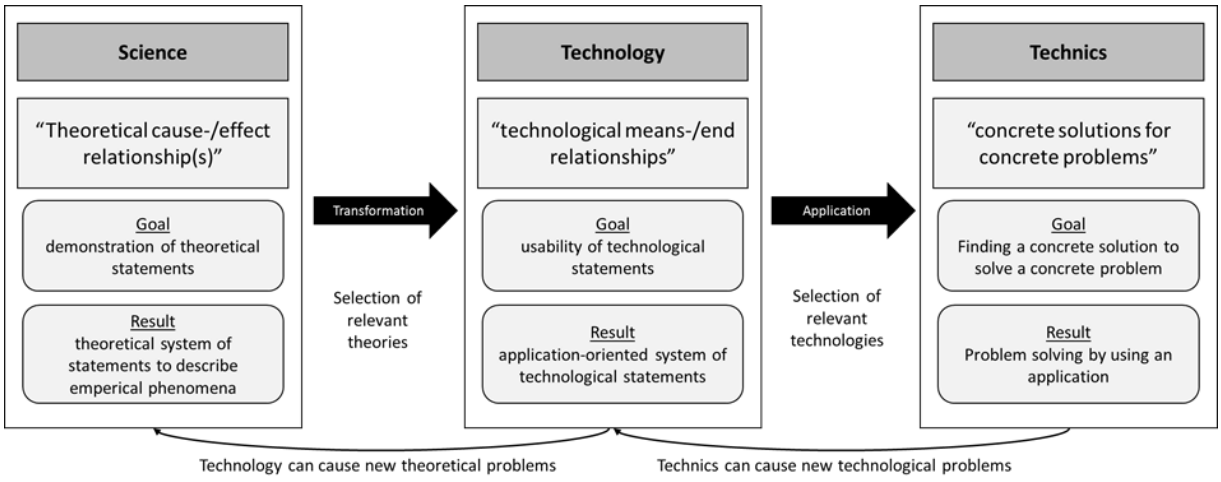

Figure 1. Science, technology and technics and its interrelatedness (based on McGinn, 1992)

Knowledge can be seen as the essence of the innovation process and the outcome of this process (Nonaka and Takeuchi, 1995). No innovation without new knowledge, but not the other way around. Creating and using knowledge to generate tangible and intangible value is exemplary for the knowledge economy (Drucker, 1969). The transition to a knowledge economy has been characterized by the upheavals in technological innovations, new business models and the competitive need for continual innovation with new and valuable products, services and processes that are developed from the research and development community. Nowadays knowledge as part of intellectual capital is as critical as other economic factors for superior performance, long-term growth and survival of organizations (Powell & Snellman, 2004). In knowledge-intensive organizations employees put effort

with their mind to produce ideas, knowledge and inventions, considered as R&D activities. Following McGinn (1992) the R&D process consist of interrelated phases of science, technology and technics[1]. Figure 1 shows that science could be transformed in new technology and technology can be applied to develop new technics, although technics and technology could cause new technological and theoretical problems respectively.

Generally, the function of R&D in organizations is to generate and acquire new knowledge about scientific and technological subjects with the goal of uncovering and enabling the development of new and valuable inventions as possible precursors of innovations. An invention is underlined with technical knowledge which defines a relation between technical features and a technical effect. Technical knowledge, as public good, has a non-excludable nature, is impossible to dispossess and cannot be irreversibly transferred (Arrow, 1962; Nelson, 1959; Samuelson, 1954). Others with sufficient absorptive capacity (Cohen and Levinthal, 1990) could be able to exploit the stock of generated knowledge while not bearing the full initial cost of generation, known as freeriding (Pasour, 1984). This knowledge spillover to others could lead to consciously or unconsciously copying (i.e. imitation). Imitation is not costless, but is still less costly than innovation (Mansfield et al., 1981; Toshihiro, 2013). Appropriation is demonstrated by legal and non-legal protection measures to capture the benefits of acquired knowledge and inventions. An intellectual property right (IPR) turns the immaterial nature of knowledge into a material property as the commercial use of knowledge that underlines an invention can be protected. This IPR creates a market for technology and helps appropriation and diffusion of results of R&D effort. In theory, IPRs are established "to provide ex ante incentives to innovate by providing a reward system that makes it easier for innovators to make ex post profits if their innovation is successful by allowing them to exclude imitators for a finite period" (Hall et al., 2014, p.3). These incentives are in place to encourage knowledge production, inventive activity and innovation which all assure that the quality of human life is continuously improved. Organizations may not be allowed, able or willing to legally protect all of intellectual products they possess. So intellectual property is considered as the acquired intellectual products that are protected by law (Poltorak & Lerner, 2011). Possible forms of IPRs are:

- a patent to protect an invention (obtained by application and examination);
- an utility model to protect a small invention (obtained by registration);
- a registered (community) design to protect the external appearance (obtained by registration);
- a trademark or geographical indication to protect distinctive identification (obtained by use and/or registration);
- a copyright to protect original creative and art works (exists automatically);
- a trade secret to protect valuable confidential information (by non-disclosure agreements).

Organizations could also apply alternative non-legal protection measures to increase the challenge for competitors to copy or reverse engineer inventions and resulting innovations (e.g. Arundel, 2001; Cohen et al., 2000; Hall et al., 2014, Hurmelinna-Laukkanen & Puumalainen, 2007; Levin et al., 1987; Ruuskanen & Seppänen, 2013) and so gain and sustain competitive advantage. Such alternative protection measures are non-disclosure of pivotal tacit knowledge, lead time advantage, learning-effect advantage, strong customer relationships, complex design and secrecy of relevant information. For example, many patents don't reveal all information on the invention which resulted in many patents with big secrets (Anton & Yao, 2004). Evidence available from various organizational-level surveys (Arundel, 2001; Baldwin et al., 1998; Blind et al., 2006; Brouwer & Kleinknecht, 1999; Cohen et al., 2000; Cohen et al., 2002a; Gonzales-Alvarez & Nieto-Antolin, 2007; Hall et al., 2014; Hanel, 2005; Harabi, 1995; Hipp & Herstatt, 2006; Konig & Licht, 1995; Laurens & Salter, 2005; Levin et al., 1987; Mairesse & Mohnen, 2003; Paallysaho & Kuusisto, 2006; Saltter, 2005) suggest that on average firms rely more on

[1] McGinn (1992): s*cience* is directed at the generation of theory-related knowledge of phenomena as function to get an better understanding of nature by demonstrating cause and effect relationships. *Technology* is the application of relevant scientific knowledge for solving general technical problems by demonstrating technological means-/end relationships. *Technics* are concrete material solutions for concrete technique-oriented problems by selecting relevant technologies.

non-legal measures to protect their inventions, although patents are still a pivotal protection measure especially in case of products, large organizations and specific sectors (e.g. chemicals or high-tech). Innovators use even more than one appropriation measure for an invention and non-legal and legal appropriation measures are used in a complementary way (Davis & Kjaer, 2003; Paallysaho & Kuusisto, 2006). Organizations could also decide to reveal an invention by disclosing an enabling description of it in the public domain (accessible for patent examiners) which provides prior art (i.e. defensive publishing). An important function of publishing is preventing another party from obtaining a patent, securing the freedom to operate and demonstration of scientific competence for recruitment and partnering purposes, although publishing can reveal valuable know-how to competitors (Van Reekum, 2006). In the next subsection an introduction is given on patents as appropriation measure of technological inventive activity.

2.1.2 An Introduction to Patents

Patents are the most well-known and discussed form of IPRs. From a social perspective a patent is a contract between inventor/owner and the society whereby the inventor gets recognition for its creativity and the owner gets a temporary exclusive right to exploit when it discloses the enabling explanation of an invention in a specific, standardized technical format understandable by qualified third parties. Public disclosure creates knowledge spillovers and lowers research duplication. Generally, a patent is an exclusive registered right to prevent others from commercially making, using, selling or distributing the patented technological invention based on formulated patent claims without permission of the patent owner within a territory and a limited amount of time (max. 20 years) (WIPO, 2017). In fact, it is a security that can be bought, sold, rented, but also be given away, lost or invalidated. In the context of law an invention in all fields of technology is patentable if it meets the relevant conditions to be granted a patent and to be held valid (EPC 2016, article 52:1). A patent claim states for what subject matter protection is sought in terms of technical feature(s) and its effect(s). The subject matter can be a product, the apparatus for producing the product, the process/method for producing the product or the use of the product. Some results of R&D shall not be considered as invention[2] and there are three exceptions to patentability[3]. Three relevant conditions determine the patentability of an invention and are assessed in a formal patent procedure:

- Being *novel* by being new in relation to globally known prior art before the time of filing (i.e. priority date) of the patent application (EPC 2016, art.54). The European Patent Office (EPO) applies the first-to-file principle which means that a patent is granted to the first person to file a patent application, regardless of the actual date of the invention.
- Including an *inventive step* by differing essentially and being non-obvious to a person skilled in the art (EPC 2016, art.56).
- Capable of an *industrial application* by being reproducible and having at least one practical purpose in an industry (EPC 2016, art.57).

Patenting can be done retrospective by doing it when an invention is completed and market-ready or prospective by doing it before an invention has been demonstrated physically (Poltorak & Lerner, 2011) although both have its advantages[4]. In academic environments retrospective patenting of the output of technology-oriented research seems to be most likely to happen. Organizations seeking protection in several countries need to file a patent at multiple national patent offices or have to engage in regional (EPO) or international (WIPO) procedures. Obtaining a patent only is not enough to

[2] "(a) discoveries, scientific theories and mathematical methods, (b) aesthetic creations, (c) schemes, rules and methods for performing mental acts, playing games or doing business, and programs for computers, (d) presentations of information" (EPC 2016, art.52:2, p. 108).

[3] "(a) inventions and its commercial exploitation that are contrary to the public order and morality, (b) inventions regarding plant or animal varieties or essentially biological processes for the production of plants or animals or (c) inventive methods for treatment of the human or animal body by surgery or therapy and diagnostic methods practiced on the human or animal body" (EPC 2016, art.53, p. 110).

[4] Advantages of *prospective patenting* could be reducing the risk of being blocked by others, increased chance of getting the patent granted, increased chance of broadening the scope, increased chance of setting a standard or possibly deterring others. Advantages of *retrospective patenting* are longer protection time, no provision of early signs to competition and lower risk of not securing a patent or obtaining a weak patent caused by insufficient evidence.

guarantee protection. Owner(s) of the patent must meet requirements to maintain it, actively screen the environment on infringements and be able and willing to prevent, negotiate or litigate to end infringement and get compensation for possible provable damage related to the (provable) infringement. To conclude, patenting is worthwhile when benefits obtained from pre-emption, defense and exploitation are higher than the drawbacks resulting from patent costs, reputation damage caused by patent battles and negative effects of public knowledge disclosure (Van Reekum, 2006). A patent represents an investment that is done in prospect of exclusive exploitation by patent protection, commercialization, sale or licensing. The effectiveness of patents may be indicated by the degree of appropriation: the degree to which actors are able to capture the benefits of the invention. Perceived effectiveness of patents may be limited (e.g. Granstrand, 1990; Cohen et al., 2002a) by:

- a filing process that is too slow for the pace of innovation in an industry;
- a weak or loose appropriability regime: low efficacy of the available legal mechanisms for protection (Teece, 1986), for example bad working, partial or unjust judicial system;
- enforcement of a patent in court may be complex and long-lasting;
- difficulty to demonstrate novelty;
- difficulty to trace and prove infringements (e.g. patents protecting process inventions);
- exceptions to patentability;
- inability to adequately enforce a patent (small-medium enterprise vs. corporate)
- legally inventing around by competitors;
- low capacity to monitor infringement (e.g. small-medium enterprises or public research organizations);
- low competence to exploit the patent;
- malicious practices of patent trolls;
- patent cost (e.g. application, maintenance and defense) that are too high to finance and/or don't outweigh the benefits;
- possibility that patents may be challenged and invalidated in court.
- revealing too much valuable know-how caused by requirements for disclosure.

Despite many drawbacks of patents and their perceived low effectiveness in some situations organizations however patent more and more frequently, known as the patenting paradox (Gasnier, 2008). Mostly, patents are known for their function of providing protection for the commercialization of inventions, but they are also known for "appropriating returns to research activity, inspiring circum- and inventiveness, identifying potential partners for co-operation and business, ensuring visibility and building reputation, securing financial arrangements and incentivizing inventive and innovative activity" (Van Reekum, 2006, p.2). Further, patents can offer retaliatory power against competition, provide a possibility to access technology of others by (cross-)licensing, promote technology transfer (from academia to industry), promote advancement of technology by making patents open source (e.g. Tesla, Inc), offer a bargaining position in standard-setting battles and offer valuable information to identify and understand technology and market changes (i.e. foresight) as well as current and future competition (i.e. competitive intelligence).

Patents could be the lifeblood of an organization as they protect technologies that help to gain and sustain competitive advantage. The core of a competitive strategy is continually relating the organization to its constantly changing market, industry and environment (Porter, 1980) to gain competitive advantage (Porter, 1985). Dynamic capabilities reflect the ability of an organization to early and adequately change its resource base to gain competitive advantage in an innovative way to address a rapidly changing environment (Teece et al., 1997; Eisenhardt & Martin, 2000). Poltorak & Lerner (2011) argue that patents could be the basis for building a new business or industry, enabling and stimulating the offering of innovation and establishing a standard or competitive advantage in an industry. Patents could also provide a competitive disadvantage when they inhibit change. Investments in and success of particular patented technology could have a potential lock-in-effect (David, 1985) and create path-dependency (Arthur, 1989). Lock-in is caused by investments in fixed assets, organizational

inertia and the refusal to cannibalize on profitable mainstream business (Lieberman & Montgomery, 1988). Ahuja and Lampert (2001) argue that lock-in is caused by favoring the familiar, the mature and the search for solutions near existing solutions, but that it can be solved by experimenting with respectively novel, emerging and pioneering technologies. Organizations could better engage in sufficient exploitation to ensure current viability and simultaneously proactively spend resources on exploration to ensure future viability, also known as balancing exploration and exploitation (a.o. March, 1991; O'Reilly & Tushman, 2013). A university is a public institution in which the main focus have been on exploration for a long time and exploitation awareness about inventions has been relatively low. In the next subsection a trend towards entrepreneurial universities is considered.

2.1.3 The Trend towards Entrepreneurial Universities

The pivotal role of knowledge and innovation in fostering economic growth, technological development and international competitiveness have been recognized and illuminated the fundamental role of sufficient and adequate interactions between the R&D community and the business world. Multiple actors and their interactions play a role in the generation, spreading and application of knowledge (Dosi, 2000; Freeman, 1987; Lundvall, 1992; Nelson, 1993). The "national innovation system" concept (Lundvall, 1992; Nelson, 1993) and the "Triple Helix" model (Etzkowtiz & Leydesdorff, 1997; Leydesdorff & Etzkowitz, 1996) help to design policies and institutional arrangements to provoke, support and coordinate beneficial interactions between business, academia and governments. Universities generate new knowledge about scientific and technological subjects with the goal of uncovering and enabling the development of new and valuable inventions as possible precursors of (industrial) innovations, growth and business. Branscomb, Kodama and Florida (1999) discovered that high-growth industries (biotechnology, medicine, microelectronics, new materials and software) are the closest to the science base that offer highly skilled people and latest research. More recent research of Lissoni (2012) shows that academic patenting in Europe is significant and most evident in science-based technologies such as pharmaceuticals & biotechnology, followed by chemicals & materials, measurement & scientific instruments and electrical engineering & electronics.

For a long time, universities acted as open science organizations targeting generation and wider dissemination of knowledge (Dasgupta & David, 1994). The term "entrepreneurial universities" (Branscomb et al., 1999; Etzkowitz, 1998) was introduced as different demands on universities resulted in a shift in practices and desired outcomes (Coriat & Orsi, 2002). Nowadays academics are asked to think and act like entrepreneurs and be part of commercial science (Lockett and Wright, 2005) known as "third task" going beyond the delivery of pure basic science (Bush, 1945) and provision of education. Engagement in (successful) exploitation of academic knowledge and inventions is known as academic entrepreneurship (Rothaermal et al., 2007). Academic entrepreneurship is formally exerted by university connected start-ups, university patenting, business-science collaborations and licensing (Fini et al., 2010; Phan & Siegel, 2006; Siegel et al., 2007) and informal ways like consulting and partnering (Perkmann et al., 2011; Perkmann & Walsh, 2008). Multiple drivers have contributed to the growth of this entrepreneurial phenomenon in universities:

- a change in regulation created the possibility to obtain ownership of and commercialize IP created with government funding (e.g. Mowery et al., 2001);
- creation and implementation of transfer-oriented mechanisms (Baldini et al., 2005) as TTOs, science parks and business incubators;
- universities complied to entrepreneurial objectives (Etzkowitz & Leydesdorff, 2000) and universities were assessed by entrepreneurial-oriented indicators (i.e. patents) systematically (Van Looy et al., 2003);
- the search for alternative funding as allocation of resources to public research initiatives declined (Baldini et al., 2005);
- governments and societies demanding higher economic and social returns on public research investments (Baldini et al., 2005);
- business R&D started to embrace the principles of open innovation (Chesbrough, 2006) signaling the decline of organizational self-sufficiency. Drivers were the widely distributed nature

of knowledge and highly-educated employees, demand for flexibility to react to increased technological and competitive turbulence and the need to share associated rising R&D and innovation costs and risks.

Open innovation believes in complementarity and argues that organizations could make the best use of internal and external resources and internal and external paths to the market to increase their innovation capacity (Chesbrough, 2006). It could be value-enhancing as it could positively influence the effectiveness (i.e. newness and fit to the market) and efficiency (i.e. cost and time to the market) of innovation (Diener & Piller, 2009), but could also have a cost-increasing effect (e.g. Faems et al., 2010) due to coordination effort, free-riding, conflicts and sacrifice. Involvement of business with universities consist of arranging contract research and education, establishing partnerships and fostering knowledge and technology transfer.

Scientists have different beliefs about the appropriate relationship between science and academic entrepreneurship (Lam, 2010; Owen-Smith & Powell, 2001; Renault, 2006). On one side there are academics that believe in the pivotal link between science and academic entrepreneurship for scientific advancement and a socio-economic contribution to society. Those argue that academic entrepreneurship could enable and stimulate further academic research by establishing links with the business community to ensure new research investments, assignments and partnerships. On the other side there are academics that favor less or non-integrated science and entrepreneurship within academia. These academics may have principal and practical objections towards academic entrepreneurship. Principal objections refer to patenting conflicting with open science norm and entrepreneurialism decreasing scientific progress. Some argue that academic patenting conflicts with the open science norm (Baldini, 2006; Etzkowitz et al., 2000) that expects that scientific knowledge is owned by the community and social benefit of this knowledge is maximized (as stated in Huang et al., 2011). Other voices argue that patenting and open science go hand in hand, because priority is ensured under patent law when a patent application is filed and there isn't an obstacle to publication as it won't hurt the novelty criterion anymore. In addition, the patent review process provides technological validation, patent information is publicly available and granted academic patents are not always licensed exclusively by universities (Mowery et al., 2001; Ostrom & Hess, 2005). Multiple studies demonstrate that publishing and patenting of academics co-exist and may actually complement and reinforce each other (Ambos et al., 2008; Azagra-Caro et al., 2007; Azoulay et al., 2007; Buenstrof, 2009; Huang et al., 2011; Van Looy et al., 2006) up to a certain level of patenting activity (Crespi et al., 2009) and depending on the scientific field (Stephan et al., 2004). Some studies indicate that most academic research generates knowledge with a dual-use nature (Agrawal & Henderson, 2002; Jensen & Murray, 2005; Stephan et al., 2004) providing opportunities for patent-paper pairs as patentable research seems to be often publishable and a patent application document is an adequate basis for a high-quality scientific publication about executed research.

Academic entrepreneurialism could negatively influence time, energy and resources devoted to basic research and teaching and even reducing the quality of these activities (Baldini, 2006). Universities are forced to act like companies and this could influence academic freedom, the degree and way of knowledge dissemination and research agenda's (Baldini, 2008; Davis et al., 2011; Jacobsen et al., 2001). Applied research may be less publishable in top journals (Geuna & Nesta, 2004) and decrease scientific progress. Academic patenting may delay (Dasgupta & David, 1994) or even limit knowledge dissemination (Calderini & Franzoni, 2004; Lee, 2000; Thursby & Thursby, 2002) as it initially redistricts communication with colleagues (Blumenthal et al., 1996) and enlarges secrecy and withholding of data (Blumenthal et al., 1986; Campbell et al., 2000).

Practical objections refer to limited resources to be ambidextrous, conflicts of commitment and interest and lacking the necessary skills for academic entrepreneurship. Universities and scientists have to be ambidextrous, simultaneously striving for research and teaching excellence and fostering research commercialization (Ambos et al., 2008; Chang et al., 2009). Available time, energy and funds are scarce for academics with full-time duties as teaching and doing research. Managing the balance between

teaching and doing research is often perceived as an “uneasy division of labor” (Clarck, 1986) or a “constant tension” (Light, 1974) by academics. Academic entrepreneurialism could create conflicts of commitment and interest when involved with the “third task” providing academics with a “role overload” (Jain & Yusof, 2007). Academics may lack the necessary domain-specific skillset to make commercial exploitation of research a success (Leloux et al., 2017). Academics seem to lack knowledge about markets and market instruments like patents and are therefore less likely to assess the commercial relevance or value of IP leading to less engagement in patenting (Baldini et al., 2005; 2007) and technology transfer (Vohora et al., 2004).

The entrepreneurial evolution within academia is demonstrated by “an increase in patent and licensing activities, the institutionalization of spin-out activities and managerial and attitudinal changes among academics with respect to collaborative projects with industry” (Van Looy et al., 2006, p.2). Entrepreneurial universities have the additive role to establish links with the business community to enable and inspire further and new academic research by contract research and strategic partnerships, foster industrial innovation and business by knowledge and technology transfer and stimulate faster exploitation and diffusion of inventions by technology transfer and academic spin-off activity. The importance of academic entrepreneurship is pivotal in the economy as academic research accounts for a large share in all R&D and industry relies mostly on short-term R&D whereas universities execute pioneering long-term R&D (Thursby et al., 2001). Evidence shows that public R&D has a positive effect on innovation and industrial productivity in different sectors across countries (a.o. Branscomb et al., 1999; Jaffe, 1989; Mansfield, 1991; Cohen et al., 2002b). This means that the use of knowledge from research at knowledge institutions is important for society to deal with societal challenges and act upon economic opportunities. In the next subsection the importance of IP management for academic patenting is considered.

2.1.4 IP Management and Academic Patenting

Valorization is now one of universities’ core tasks as it is officially included in the laws in the Netherlands. Nowadays most university boards attach great value to the exploitation of academic knowledge and inventions as “third task”. As universities are responsible for improving socio-economic contribution to society they are increasingly expected to professionalize their IP practices (Kern & Van Reekum, 2012). Management of IP is highly relevant to public institutions as they have the affirmative duty to diligently manage their affairs and resources as best as they can to achieve public objectives. IP management[5] deals with converting results of R&D into worthwhile IPRs as effectively and efficiently as possible whereas IPR management is aimed at converting existing IPRs into beneficial returns as effectively and efficiently as possible (Van Reekum, 2006). IP management is concerned with the social and environmental conditions for appreciation and appropriation of acquired inventive output (Van Reekum, 1999). Poltorak & Lerner (2011) argue that mismanagement and non-management of (potential) IP could result in waste or loss of value, for example failure to sufficiently and adequately identify, appropriate and exploit commercially attractive inventions. IP management within academia is important to create adequate conditions which enable, support, guide and stimulate the generation and exploitation of worthwhile patents. To bridge the gap between invention and exploitation universities have established patent funds, patent regulations and TTOs. Currently, much reliance is placed on academics’ competence and engagement to identify and disclose potential patentable inventions while they are expected to, to the best of their ability, support patenting and patent exploitation. Timely and proper internal disclosure is particularly important regarding inventions that could be protected by patents. Possible reasons for non-disclosure of inventions are being too busy, not perceiving an incentive, refusing to recognize the (commercial) significance and low IP awareness (Poltorak & Lerner, 2011).

But what determines academic patenting? Already some time ago researchers focused on some individual determinants of academic patenting (e.g. Azoulay et al., 2007 Baldini et al., 2005, 2007; Goektepe, 2008; Huang et al. 2011; Moutinho et al., 2007; Owen-Smith & Powell, 2001). Besides that,

[5] In general, *IP management* is referred to the practices related to the creation and exploitation of IPRs (Van Reekum, 2006).

research started to consider some general organizational factors such as the influence of academic incentive and reward systems, the institutional context and role of support structures (e.g. Baldini et al., 2005, 2007; Goektepe, 2008; Huang et al. 2011; Moutinho et al., 2007; Owen-Smith & Powell, 2001) on the decision to patent or not. In this research, academic patent behavior is defined as all individual actions directed at the realization of a (potential) patent from research within an academic context. The conceptualization of innovative work behavior of Scott and Bruce (1994) is adopted here and adapted to academic patenting, implying that the academic patent behavior process consists of (patent) idea generation, patent idea promotion and patent idea realization. Individual patent awareness is described as the knowledge about patent law and patent procedures, use of patent information and being aware of the functions of patents (Pitkethly, 2012) as necessary antecedent of patent behavior. Without engagement there is actually nothing to enable as organization. Therefore, the individual propensity to engage in academic patent behavior namely the individual intention to undertake actions directed at the realization of a (potential) patent from research within an academic context is an important factor to study. The degree of intention shows how hard academics are willing to try or how much effort they want to put to perform academic patent behavior. The propensity to engage in academic patent behavior is relevant to consider as academic patent behavior is under volitional control as academics possess high discretion despite rules, regulations and job expectations.

This explorative qualitative research tried to discover insights on the explanations and predictors of engagement in academic patent behavior. Informed by the theory of planned behavior (Ajzen, 1991) it explores which self and contextual cues academics use to form outcome, normative and control beliefs regarding academic patent behavior. This brings the need to examine the academics' differentiated perceptions, beliefs and experiences regarding patent behavior to interpret the motivations, necessities and barriers that underline their intention to engage in academic patent behavior. To implement effective policies and practices that target academics' exploitation of inventive research through (worthwhile) patents, universities' decision makers and managers consider some crucial questions. Among them: why do academics engage in patent behavior? And why not? And how do they form their intention to do so? This makes the research question: *"What perceived organizational and individual factors influence the propensity of 4TU academics to engage in academic patent behavior?"*

2.2 Research Objectives

The objectives that are being served with this explorative qualitative research is to be able to:

- opening up the psychological black box on how academics' propensity to engage in academic patent behavior is formed;
- find first careful insights on what perceived organizational and individual factors influence the propensity of 4TU academics to engage in academic patent behavior;
- construct a survey instrument for further quantitative research on the individual propensity to engage in academic patent behavior.

2.3 Research Relevance

In this section, the academic and practical relevance of this research is considered. Academic relevance considers the distinctive character of the research relative towards existing literature. Practical relevance considers the value for improving business and societal outcomes.

2.3.1 Academic Relevance

This research is positioned within the domain of IP management science. Much research on academic patenting is aimed at aggregate studies of changes in the number and quality of patents over time, patent impact, patent exploitation and patents' distribution by class (Berkovitz et al., 2001; Huang et al., 2011). Limited studies have tackled the phenomenon of academic patenting from the inventor-level of analysis (Azoulay et al., 2007). Prior researchers studying academic patenting identified some individual and organizational aspects that intents to explain patent production within academic environments across different countries by illuminating significant correlations (e.g. Baldini, et al, 2005, 2007; Goektepe, 2008; Huang et al., 2011; Moutinho et al., 2007; Owen-Smith & Powell, 2001). Instead of looking at academic patent production this study targets the factors that influence the underlying

propensity of academics to engage in academic patent behavior. Discovered impact factors for academic patent behavior could complement limited research that explains variation of patenting outcomes of universities, departments and faculties (Audretsch & Kayalar-Erdem, 2005; Carayol, 2007; Huang et al., 2011; Stephan et al., 2004). Cross-national studies are important such that inter-country variation in individual and contextual impact factors for academic patenting could be adequately explained and understood (Moutinho et al., 2007). Most studies are executed within a USA context in which the TTO has a more active role in identifying, handling and exploiting patentable research (e.g. Huang et al., 2011). The Dutch context is considered with a more reserved and supportive TTO as universities' policies and regulations lay more responsibility upon the academic inventor as they are expected to identify and disclosure patentable inventions and heavily support patenting and patent exploitation.

Some studies argue that there is still little evidence on individual and organizational factors that motivate patent behavior in (public) research organizations across different contexts (e.g. Moutinho et al., 2007). In addition, this research intends to complement motivations with factors that prevent or hinder academics to engage in patent behavior (Baldini et al., 2005). Further research is needed to develop an adequate complete framework to link individual and contextual impact factors (Moutinho et al., 2007). To conclude, conclusive patterns about and a complete picture of the factors influencing academic patent behavior are not demonstrated yet. What forms and determines the propensity of academics to engage in academic patent behavior is still considered a psychological black box. Informed by the theory of planned behavior (Ajzen, 1991) this study explores which self and contextual cues academics use to form outcome, normative and control beliefs that are assumed to influence academics' propensity to engage in academic patent behavior.

2.3.1 Practical Relevance

Research at universities regularly results in new technological developments and inventions. The use of knowledge from research at knowledge institutions like universities is important for society to deal with the societal challenges and act upon economic opportunities as:

- universities have pioneering R&D in most fields (Branscomb et al., 1999 ; Lissoni, 2012);
- universities account for a relatively large share in total R&D (Thursby et al., 2001);
- universities execute long-term R&D whereas business focuses more on short-term R&D (Thursby et al., 2001).

Research at universities regularly results in new technological developments and inventions. Nowadays most university boards attach great value to the exploitation of academic knowledge and inventions as "third task". Patents can play an important role in effective deployment of research results when inventions could be commercially exploited due to new relevant industrial applications. Legal protection of developed technologies by means of granted patents ensure that universities make it more attractive for ventures, companies and investors to exploit academic inventions as patents provide proprietary positions. Academic inventors are considered as gate keepers as they control the knowledge flow that is pivotal for the transformation of academic R&D into patents and products with commercial value (Agrawal & Henderson, 2002; Thursby et al., 2001; Thursby & Thursby, 2002). Academics must have the ability, motivation and provided opportunity to be engaged in invention disclosure, patenting and patent exploitation. Insight into the psychology and considerations of academics regarding engagement in academic patent behavior could help to develop new policy instruments or provide a basis for making policy recommendations. Therefore, this research could help to provide first careful insights to universities' policy makers and managers on how to evaluate relevant conditions that influence academics' outcome, normative and control beliefs regarding academic patent behavior. After all, the function of IP management within academia is to create the right conditions such that the generation of (worthwhile) patents through academics is sufficiently and adequately enabled, supported and stimulated and misappropriation or non-appropriation of commercially attractive academic inventions is reduced (to a zero point). Translating academic knowledge and research results into patents and economically and socially valuable innovations and business creates benefits for academic inventors, departments, TTOs, universities and last but not least the (regional) society. In this sense, universities

are increasingly expected to professionalize their IP practices to be “an entrepreneurial university” and improve socio-economic contribution to society (Kern & Van Reekum, 2012).

2.4 Research Questions

In this section, the main research question and sub-questions are presented. The main research question is formulated as neutral, specific and information-focused (Saunders et al., 2009) as possible: *“What perceived organizational and individual factors influence the propensity of 4TU academics to engage in academic patent behavior?”*

To be able to answer this question and construct a survey instrument, a number of sub-questions are formulated:

1. What is engagement in academic patent behavior?
2. How is academics’ propensity to engage in academic patent behavior formed?
3. What perceived organizational factors influence academics’ propensity to engage in academic patent behavior?
4. What perceived individual factors influence academics’ propensity to engage in academic patent behavior?

3. Conceptual Framework

In this chapter the conceptual framework is introduced and explained as organizing device that directs the collection and analysis of data. First of all, the dependent variable is defined and conceptualized. Also, a framework is built on how the propensity to engage in academic patent behavior is formed. Next, the possible organizational and individual impact factors for academic patent behavior are proposed.

3.1 Engagement in Academic Patent Behavior

In this research, academic patent behavior is defined as *all individual actions directed at the realization of a (potential) patent from research within an academic context*. Patent behavior can be present even without getting a patent granted. This conceptualization excludes protection and exploitation activities regarding academic patents. Academic patent behavior is built on a process-oriented notion to operationalize it and identify specific steps within this process to consider competences and necessities for engagement in academic patent behavior. Close to patent behavior is creative behavior which is behavior directed at the generation of novel and useful ideas (Amabile, 1988). Creative behavior solely considers idea generation while innovative work behavior consist of a process of idea generation, idea promotion and idea realization (Scott & Bruce, 1994). The conceptualization of Scott and Bruce (1994) is adopted here and adapted for academic patenting, implying that the academic patent behavior process consists of (patent) idea generation, patent idea promotion and patent idea realization with in every step distinctive possible action (see table 1). Past studies often use the end-point of the patent behavior process, patenting and patent production, as construct of interest, and not the whole process itself.

The (patent) idea generation step considers the actions to build a concrete idea for a patent that makes sense and is ready to be promoted in the organization. The inventor(s) draw(s) up if the identified invention is likely to lead to a successful patent application and if there are ideas for commercial exploitation. If both aspects are considered plausible the inventor (and department) could decide to promote the patent idea in the organization when the inventor has an intention to engage in patent behavior. In the next step the focus lies on internal disclosure of the concept, coalition building and issue selling to decision makers. The mandated TTO decides if patenting is worthwhile within a context of the limited effectiveness of patents, limited resources, motives and organizational strategies. The last stage starts after an organizational go-decision regarding patent application and is focused on gaining access to necessary resources and other complementary support to file a patent application and get a patent granted via an interactive procedure at a patent office or offices. An independent patent attorney experienced in the field is mostly hired and draws up a patent application together with the inventor. A formal patent procedure can consist of filing a patent document, a received search report, publication in

databases, substantive examination, decision to grant the patent, validation in other states, opposition by third parties and appeal by third parties (EPO, 2011).

Process steps	Possible actions
(Patent) idea generation	• Creation or identification of an invention within research. • Retrieval and analysis of scientific publications and official patent documents in database(s) (Breitzman & Mogee, 2002; Osborn et al., 1997; Tseng et al., 2007). • Determination of patentability of the invention (EPC, 2016). • Determination of commercial relevance of the invention. • Building a concrete idea for a patent (by means of filling-out an invention disclosure form).
Patent idea promotion or "invention disclosure"	• Internal disclosure of the patent idea concept to decision maker. • Coalition building with important stakeholders to gain influence. • Issue selling (Dutton et al., 2001; Howard-Grenville, 2007) to organizational decision makers to get commitment.
Patent idea realization or "patenting"	• Mobilizing necessary financial and human resources (Moutinho et al., 2007). • Consultation of patent expert and attorney. • Writing an understandable patent application with concrete patent claims in a standardized format. • Filing a patent application and external interaction with patent office(s) (Moutinho et al., 2007).

Table 1. Patent behavior process steps and actions (adapted from Scott & Bruce, 1994).

The central variable in this research is academic patent behavior. A long time, there is the belief that behavioral achievement is dependent on behavioral intention and behavioral control. Ability-Motivation-Opportunity (AMO) theory (Appelbaum et al., 2000; Boxall & Purcell, 2003) in the Human Resource Management (HRM) domain assumes that individual behavioral performance can be explained and predicted by three aspects in a multiplicative fashion:

- the *ability (A)* of the individual to act;
- the *motivation (M)* of the individual to act;
- the *opportunity (O)* provided by the (organizational) context to act.

Ability is a necessary pre-requisite, while motivation and provided opportunity are also pivotal, but only after sufficient ability is established (e.g. Bos-Nehles et al., 2013). As knowledge and skills appears to enable action, motivation seems to encourage action and opportunity provision allows action to get to desired outcomes. In other words, the performance of these actions depends upon the individual being knowledgeable and skillful, but this doesn't necessarily mean that being skillful will increase the likelihood of engagement in certain action. In order to obtain and use patents as an instrument to its fullest, one requires understanding of the patent system. In this sense, academic patent behavior is conceptualized in figure 2 as function of individual patent awareness and the individual propensity to engage in academic patent behavior resulting in output(s) and outcomes.

Patent awareness is described as the knowledge about patent law and procedures, use of patent information and being aware of the functions of patents (Pitkethly, 2012) as necessary antecedent of patent behavior. Academics seem to lack knowledge about markets and market instruments like patents and are therefore less likely to assess the commercial relevance or value of IP leading to less engagement in patenting (Baldini et al., 2005; 2007) and technology transfer (Vohora et al., 2004). Moutinho, Fontes and Godinho (2007) found that both patenting and non-patenting researchers perceived difficulties regarding the knowledge about patenting and university's patent procedures. Patent awareness at two Dutch academic research institutes was found to be low (Nijmanting, 2012), although it could be aroused and increased by institutionalizing patent incentive schemes, provision of

patent education and support and adequate access to or supply of patent information (Kern & Van Reekum, 2012).

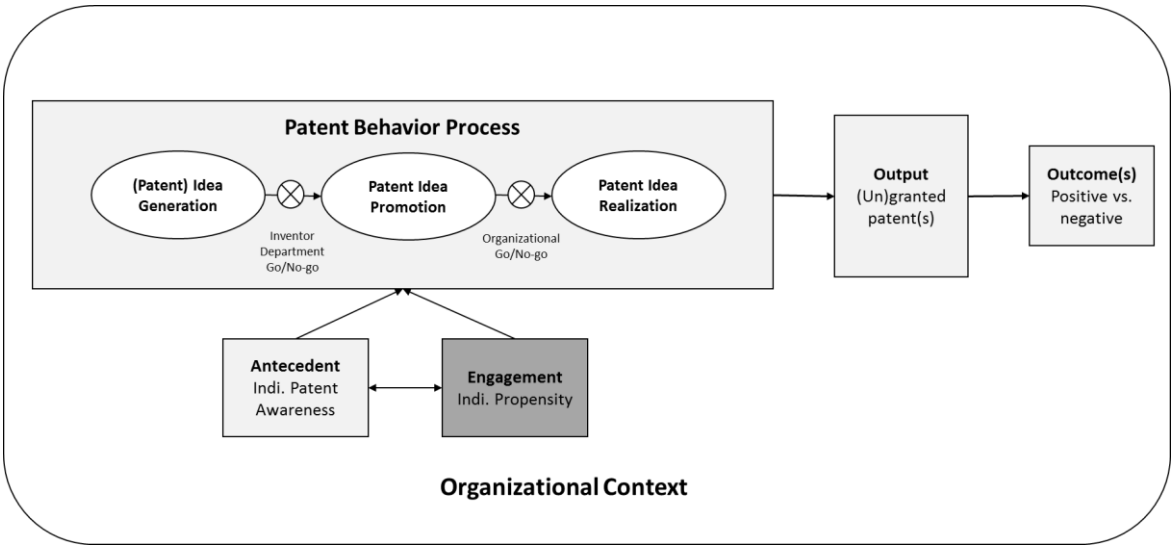

Figure 2. The patent behavior process resulting in output and outcome(s)

In general, the propensity to patent is found to measure the degree or tendency to which inventions are patented or protected by patents (Brouwer & Kleinknecht, 1999; Mansfield, 1986; Scherer, 1983) in points or periods in time. Previous studies target important factors that influence the propensity to patent on an organization -, sector -, regional - and country level (a.o. Arundel & Kabla, 1998; Benoliel, 2015; Blind et al., 2003; Blaszek & Escribano, 2014; Brouwer & Kleinknecht, 1999; Chabchoub & Niosi, 2005; Duguet & Kabla, 1998; Hall & Ziedonis, 2001; Fontana et al., 2013; Granstand & Holgersson, 2012; Han & Hesmati, 2015; Lopéz & Orlicki, 2007; Maekinen, 2007; Perez-Cano & Villén-Altamirano, 2013; Scherer, 1983; Wolf, 2013; Zaby, 2010). As this study is on an academic-level of analysis it considers the individual propensity to engage in academic patent behavior, namely the individual intention to undertake actions directed at the realization of a (potential) patent from research within an academic context. The degree of intention shows how hard academics are willing to try or how much effort they want to put to perform academic patent behavior. This implies that the stronger the intention, the more likely is the engagement in academic patent behavior. The propensity to engage in academic patent behavior is a function of the factors within or beyond a person that hinder, arouse and sustain their engagement in academic patent behavior. The behavioral intention is relevant to consider when behavior is under volitional control: when someone can decide to engage in behavior or not. This seem the case for academic patent behavior as academics possess high discretion in their decision to engage in patenting and commercial activity despite rules and regulations (Goektepe-Hulten & Mahagaonkar, 2010; Hayter & Feeney, 2016) and academic patent behavior is mostly outside or in addition to the required job expectations.

Engagement in patent behavior depends also on the organizational context that provides someone with the opportunity to perform patent behavior. The individual opportunity for academic patent behavior could be shaped by the establishment of rules and norms, procedures and policies and the provision of resources and support. Engagement in patent behavior could result in a granted patent, but this doesn't have to be the case as the patent application needs to explain how and why the invention meets the three requirements described earlier. During or after the patent process an academic is confronted with positive and negative consequences as outcomes of academic patenting (Owen-Smith & Powell, 2001). Ownership of a granted patent in case of employment is provided to the employer as the employer claims it which lowers obtainable benefits from a granted patent for the inventor. Dutch patent law prescribes that the employer is the rightful claimant of an employee invention when some

conditions are fulfilled[6]: the invention needs to be patentable[7], an employment contract in the private or public sector has to exist[8] and the invention was created in his or her employment and was a result of tasks that he or she was assigned. Most organizations include an intellectual property stipulation in an employment contract clarifying ownership of intellectual property, but the inventive employee must be recognized as inventor and has a possible right on a fair financial compensation due to the lack of ownership of the patent[9]. In the next section, we dive into the question how academics form their propensity to engage in academic patent behavior.

3.2 Formation of Academics' Propensity to Engage in Academic Patent Behavior

People make decisions about behavior at work. Much behavior is routine, based on habit, history, tradition and unconscious scripts. Managers want to enable and stimulate certain desired behavior(s) and eliminate certain undesired behavior(s). Aforementioned refers to the concept of motivation: "the forces within or beyond a person that arouse and sustain their commitment to a course of action" (Boddy & Paton, 2011, p. 450). Content theories of motivation try to identify and explain factors that provoke and sustain certain behavior, while process theories of motivation intent to explore how people decide which several possible actions will (best) satisfy their needs and desires.

The goal of psychology as science is to gain more insight in the thoughts, doings and decisions of humans in general and specific situations. Here it is about the underlying cognitive process that determines the individual propensity to engage in academic patent behavior. In psychology, human decision making is considered as a cognitive process that results in the commitment to a belief or a course of action among alternative possibilities. Maximizers intent to make a decision that optimizes the outcome while "satisficers" try to find an option that meets an acceptability - and sufficiency threshold (Simon, 1956). A decision process can be associated with (an interplay between) a fast, automatic intuitive system by making use of heuristics or a slow, effortful rational system (Kahneman, 2011). It is assumed that academics make conscious and rational choices about how to act in their work. What forms and determines the propensity of academics to engage in academic patent behavior is still considered a psychological black box. The inner life of humans cannot be objectively recorded through scientific observation, although it can be subjectively perceived and indicated by introspection and understanding. The theory of planned behavior (Ajzen, 1991), as extension of the theory of reasoned action (Fishbein, 1967; Fishbein & Ajzen, 1975), is suitable for studying behavioral intention, especially for behavior that is under volitional control like academic patent behavior. Therefore it is adopted as process theory of motivation and adapted for this study to describe how academics form their propensity to engage in academic patent behavior. It is considered as a valid and well-supported theory to explain and predict human behavior in specific contexts (Ajzen, 1991) and has more than 1200 research bibliographies in academic databases around health-related behavior, pro social behavior, consumer behavior, environmental-related behavior and technology acceptance. Following this theory, the individual propensity to engage in academic patent behavior can be determined by the attitude towards academic patent behavior, the subjective norm regarding academic patent behavior and the perceived behavioral control to perform academic patent behavior. Antecedents of these determinants are respectively salient outcome, normative and control beliefs relevant to academic patent behavior that are formed by considering present and relevant background factors (by means of cues).

The theory of planned behavior is adopted here in a conceptual model towards the individual propensity to engage in academic patent behavior (see figure 3). The determinants attitude, subjective norm and perceived behavioral control are the cognitive demonstration of the outcome, normative and control beliefs that are formed by cognitive consideration of background factors and thereby these

[6] Artikel 12 lid 1 Rijksoctrooiwet 1995 (ROW 1995)
[7] Art. 2-7 ROW 1995
[8] Art. 7:610 Burgerlijk Wetboek (BW)
[9] Art. 12 lid 6 ROW 1995

beliefs are seen as antecedents of the individual propensity. The relative importance of these determinants is expected to vary across behaviors, situations and cultures (Ajzen, 1991).

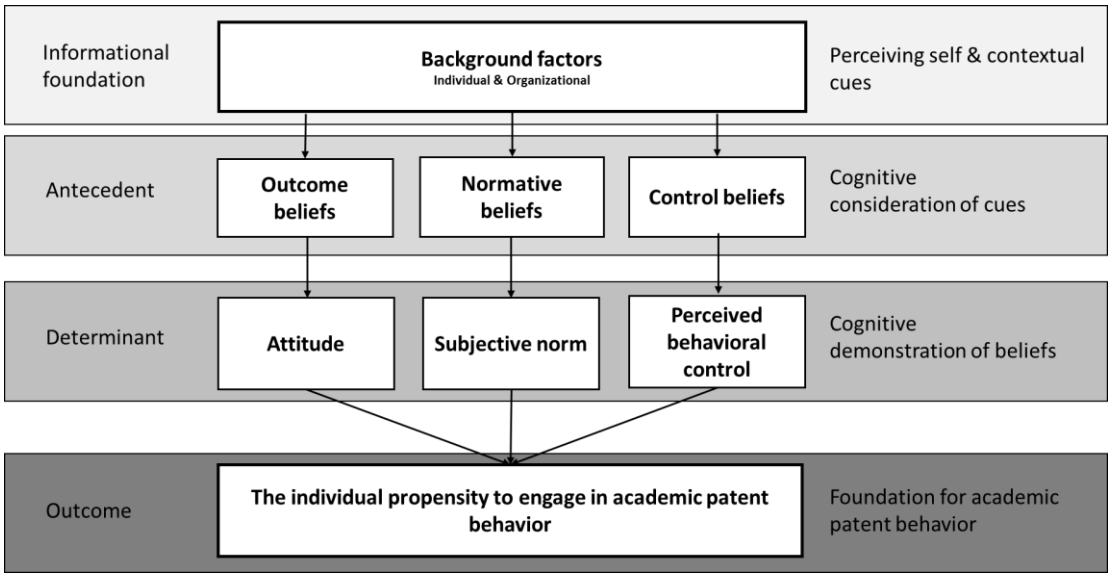

Figure 3. The conceptual process model regarding the formation of the individual propensity to engage in academic patent behavior (adapted from Ajzen, 1991, p.182)

The *attitude* refers to the degree to which a person has a favorable or unfavorable evaluation of the desirability of academic patent behavior itself and the desirability of outcomes of academic patent behavior. The attitude can be estimated by analyzing attitude's informational foundation by eliciting the outcome beliefs that are formed by the belief strength (i.e. the subjective likelihood that behavior will produce the specific outcome) and the evaluation of behavioral outcomes. Humans act on the basis of outcomes or expected outcomes of their behavior according to the expectancy theory of Vroom (1964). An academic is assumed to be rational in weighting the perceived positive and negative consequences of academic patenting (Owen-Smith & Powell 2001). The logic here is that patent behavior is (personally) instrumental or desirable when patent behavior leads to a valued outcome, in other words when (individual) benefits are evincive higher than (individual) costs. As humans have different needs and desires they also value outcomes differently. The value an individual attributes to the outcomes is dependent on individuals' dynamic value system: -1 (avoiding), 0 (indifferent) and +1 (welcoming) (Vroom, 1964). Self-determination theory (Ryan & Deci, 2000a; Ryan & Deci, 2000b) considers motivation as an outcome of interaction at a given time and place between (1) intrinsic motivational factors and (2) extrinsic motivational factors.

Social relationships and broader social structures govern social practice. The *subjective norm* refers to the social pressure or freedom a person perceives to engage or not engage in academic patent behavior. The subjective norm as perceived socially accepted mode of conduct can be injunctive and descriptive. The subjective norm can be explored by analyzing subjective norm's informational foundation by eliciting the normative beliefs that are formed by the belief strength (i.e. the subjective likelihood that important referent individuals or groups advocate or oppose engagement in academic patent behavior) and the motivation to comply with the referent in question. It provides the degree to which someone expects the setting to be open to patent behavior and receptive to a patent outcome. The person-in-context perspective or situationism (Mischel, 1968; Mischel, 1973) entails that behavior cannot be understood and explained adequately without considering various factors of the individual's social context (Epstein & O'Brien, 1985).

The *perceived behavioral control* refers to the perceived ease or difficulty of performing academic patent behavior. It reflects the evaluation of the necessities to perform academic patent behavior as well as the expected barriers and obstacles that could hinder performance of academic patent behavior. The perceived behavioral control can be estimated by analyzing its informational

foundation by eliciting the control beliefs that are formed by the belief strength (i.e. the subjective likelihood of the presence and absence of control factors) and the perceived power of the particular control factors to facilitate or hinder performance of academic patent behavior. In this sense, it is argued that the more necessities (e.g. knowledge, skills, position or resources) to perform academic patent behavior a person possesses or has access to, and the fewer barriers and obstacles are expected to perform academic patent behavior, the greater the perceived control over academic patent behavior.

The *outcome, normative and control beliefs* relevant to academic patent behavior are formed by cognitive consideration of background factors on an organizational and individual level. A belief is a state of mind in which a person considers something to be true with or without factual certainty and must be elicited from the individuals themselves. A personal belief is formed by perceiving: the cognitive process by which individuals become aware or conscious about someone or something directly by any of their senses, especially sight or hearing. People makes sense of themselves and their context by selecting and interpreting information, although every person perceive a situation differently (Weick, 1995). Someone extracts cues from their environment to decide what information is relevant and what explanations are acceptable and plausible (Salancick & Pfeffer, 1978; Brown et al., 2007). Be aware that cognitive and personal biases may influence perceptions and beliefs. It seems realistic that individuals suffer from "bounded rationality" caused by limits on available information, available time and cognitive information-processing ability (Simon, 1956). In short, the theory implies that:

(1) perceived organizational and individual background factors provide an informational foundation for salient outcome, normative and control beliefs relevant to academic patent behavior;
(2) these salient behavioral, normative and control beliefs are antecedents for the personal attitude, the social norm and the perceived behavioral control regarding academic patent behavior respectively;
(3) the more favorable the personal attitude, the more empowering social norms and the greater the perceived behavioral control the higher the propensity to engage in academic patent behavior.

The individual propensity as outcome shows how hard academics are willing to try or how much effort they want to put to perform academic patent behavior. This implies that the stronger the intention, the more likely is the engagement in academic patent behavior. In the next section, we dive into possible factors that influence the individual propensity to engage in academic patent behavior.

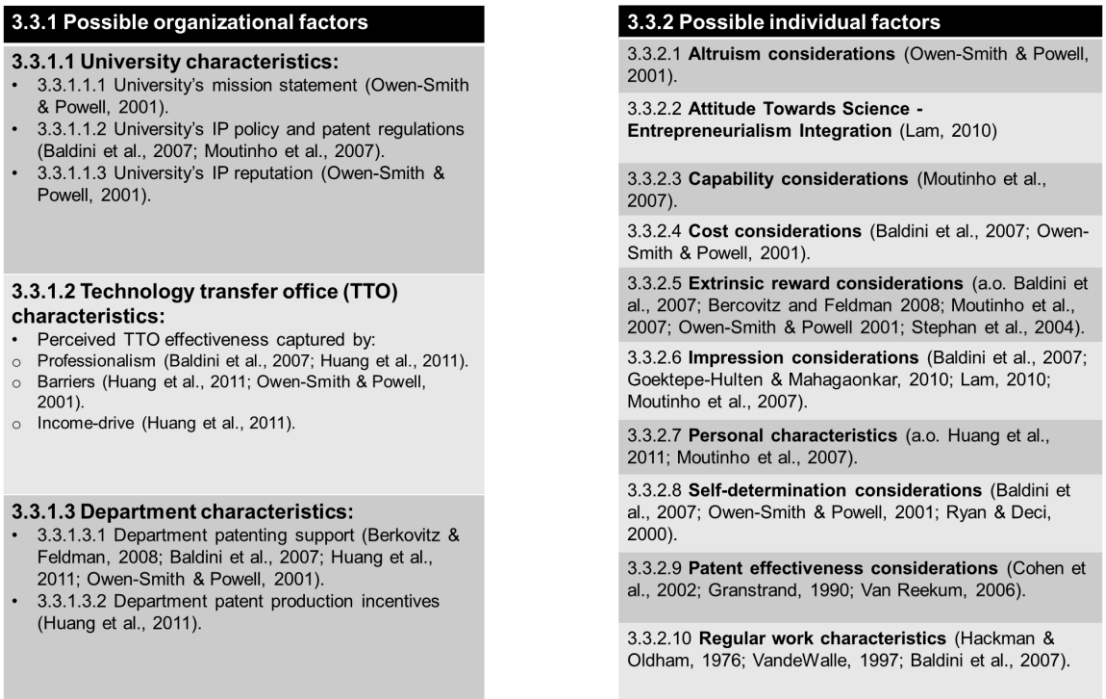

Figure 4. Possible background factors that might be considered by academics to formulated outcome, normative and control beliefs relevant to academic patent behavior.

3.3 Factors Influencing Academics' Propensity to Engage in Academic Patent Behavior

In this section perceived organizational and individual background factors are proposed that provide an informational foundation for salient outcome, normative and control beliefs as ultimate antecedents of the individual propensity to engage in academic patent behavior.

3.3.1 Possible Organizational Impact Factors

The main resources for the creation and maintenance of entrepreneurial universities is human capital and a shaped organizational environment directed at (successful) entrepreneurship (Guerrero and Urbano, 2012). Individuals don't act in isolation at work, but they are embedded in multiple social settings. The person-in-context perspective or situationism (Mischel, 1968; Mischel, 1973) entails that an individual or his or her behavior cannot be understood and explained adequately without considering various factors of the individual's context (Epstein & O'Brien, 1985). The social context provides forces that constrain or produce behavior (Ross & Nisbett, 1991) as work environments have an impact on intrinsic and extrinsic motivations or discouragement (Deci et al., 2017).

Organizational culture is often defined as the collective values, norms, beliefs and assumptions that members share within a formal organizational unit at a point or period in time (e.g. Schneider, 1990; Schein, 1990, 2010). It gives guidance on what happens in organizations. Organizational culture and organizational climate are overlapping concepts and can reciprocally influence each other (Denison, 1996). The phenomenon of shared organizational perceptions among employees within formal organizational units at one point or period in time is considered as organizational climate (e.g. James & Jones, 1974; Schein 1990; Schneider, 2000). A strong culture, strong climate (Schneider et al., 2002) or strong situation (Mischel, 1973) characterizes cohesion by which employees (1) understand what behavior is appropriate and desired and (2) form a collective sense of what is supported, expected and rewarded (Bowen & Ostroff, 2004). Organizational practices, policies, procedures are the properties of an organizational climate and a result of the quantification of the organizational culture perceived directly or indirectly by employees (Konopaske et al., 2007). Individual psychological climate is the individual cognitive interpretation (Jones & James, 1979; James et al., 1990) or experiential based perception (Schneider, 1990, 2000) of an organizational atmosphere. In this sense, the organizational climate, shaped by organizational practices, policies and procedures, create an internal context that academic inventors use and interpret to formulate outcome, normative and control beliefs about engagement in academic patent behavior.

Organizational success at patenting depends on individual perceptions of the benefits of patenting, the ease of the university patent process and the time and resource cost of interacting with TTO within a perceived context of a university's history, environment for technology transfer, capacity and reputation (Owen-Smith & Powell, 2001). At a university a climate for patenting can be shaped which enlarges the perception of potential support and benefits and reduces apparent risks and costs of academic patenting (Owen-Smith & Powell, 2001). The perceived climate for patenting can be influenced by a number of possible organizational factors on different levels. It is assumed that academic patent behavior cannot be clearly understood and explained without considering organizational factors as academics use and interpret cues about the context.

3.3.1.1 University-wide-level Characteristics

On a university-wide-level the mission statement, IP policy and patent regulations and IP reputation could be possible impact factors.

University's Mission Statement

Strategic management is considered as formulation, implementation and evaluation of actions that enable and guide an organization to achieve set objectives (Drucker, 1974). Generally, a mission statement is a written formal communiqué that attempts to capture an enduring purpose, scope of operations, uniqueness, behavioral standards and values of an organization (e.g. Bart & Tabone, 1998; Pearce & David, 1987). It is recognized as an important first phase in a circular strategic management

process (Pandey et al., 2017; Pearce & David, 1987; Staples & Black, 1984). In the Netherlands most universities are public institutions and fall therefore in the nonprofit sector. Nonprofit managers downplay the strategic value of the mission statement and find them perfunctory, while scholars have acknowledged its importance (Anheier, 2005; Phills, 2005). The mission statement is demonstrated as driver of organizational performance (Bartkus et al., 2006; Kirk and Nolan 2010, Pandey et al., 2017) and shaper of the organizational culture (Stallworth Williams, 2008; Swales & Rogers, 1995). There are many rationales behind a mission statement. A mission statement can, for example:

- provide a sense of common purpose and narrow the scope of operations (Bart, 1997; Campbell & Yeung, 1991; Ireland & Hitt, 1992; King & Cleland, 1979; Klemm et al., 1991)
- enable objective establishment and strategy & policy making (Bart, 1998; Cochran et al., 2008; Drucker, 1974);
- generate interest in the organizational purpose (Bartkus et al., 2000) with which employees can identify or not (King & Cleland, 1979);
- inspire and motivate employees to attain objectives (Bart, 1997; Cochran et al., 2008; Ireland & Hitt, 1992; King & Cleland, 1979; Klemm et al., 1991);
- support the development of shared values to build a (strong) culture within the organization (Bart, 1997; Campbell & Yeung, 1991; Ireland & Hitt, 1991; Pearce & David, 1987).

To conclude, the mission statement can be a strategic, communication and cultural tool (Bartkus et al., 2000; Campbell et al., 2001; Pearce, 1982) when it is used properly (Mullane, 2002). It seems that crafting a good mission statement is costly but mostly beneficial for an organization. A mission statement could be unrealistic, not well formulated, not well aligned with the context, not well supported by stakeholders or not up-to-date. In this sense, a mission statement could be a waste of time, energy and resources resulting in lower stakeholders' motivation and poor organizational decision-making harming organizational performance.

Entrepreneurial objectives were added as third aspect of the mission of universities (Etzkowitz & Leydesdorff, 2000). Although open science mentality at university seems to be a cultural problem regarding academic patenting (Baldini et al. 2007), a university mission statement could clearly acknowledge, justify and provoke academic patenting (and technology transfer). A university mission statement may indirectly influence patent behavior of academics:

- as it generates university-wide interest and a sense of common purpose in patenting (and technology transfer);
- as it inspires and motivates academics to patent and be involved in technology transfer to add value related to entrepreneurial objectives;
- as it supports the development of a strong culture that legitimates and institutionalizes patenting (and technology transfer).

A mission statement forms employees' psychological perception about approval and desirability of academic patent behavior on a university-wide-level. By means of a mission statement employees perceive a socially accepted mode of conduct. In this sense, a university mission statement, is expected as help for the formulation of individual normative beliefs regarding engagement in academic patent behavior.

University's IP Policy and Patent Regulations

An opportunity to create and exploit IP is shaped by the establishment of rules, procedures and policies and the provision of resources and support at university. A university's IP policy is a formally-adopted document describing a deliberate system of principles that gives guidance on how to make decisions concerning the creation and exploitation of IP to best serve the public interest (WIPO, 2017). In Portuguese PSROs 40 percent of non-patenting scientists were unaware of the internal IP policy and 70 percent of non-patenting scientists had a need for clarification or development of the IP policy (Moutinho et al, 2007). These findings are exemplary for low awareness of IP internal policies and patent regulations among academics. University-level patent regulations guides the creation and exploitation of patents as they "…describe the steps that inventors have to take to patent their inventions, the

mechanisms for deciding to file a patent application, the duties and benefits for employer and employees, the royalty scheme, and which party bears the cost of filing the patent application and controls the licensing process" (Baldini et al., 2007, p.347). At Italian universities the amount of filed patents tripled when internal patent regulations were adopted (Baldini et al., 2006). Existence of written, clear and well-disseminated university-level patent regulations is an important mean to lower inventors' perceptions about obstacles as long as it signals universities' commitment to support and reward patenting (Baldini, et al., 2005; 2007). Sufficient monetary rewards for researchers, funds to cover patent costs, lower bureaucracy, the institutionalization of a TTO and formal contracts with industry may positively influence academic patenting (Baldini et al., 2007). In general, a university's IP policy entails[10]:

- objectives and available funds regarding the creation and exploitation of IP;
- the clarification of ownership of and the right to use IP resulting from university or collaborative R&D;
- the organization and procedure on how to accurately identify, evaluate, protect and manage patentable results of R&D;
- the means and opportunities to exploit IP by technology transfer and spin-off;
- a transparent framework for personnel, the university and third parties that provides guidelines on sharing economic benefits arising from exploitation of IP (i.e. distribution of income arrangement).

Royalty sharing may be an incentive for faculty invention disclosures (Argyres & Liebeskind, 1998), but personal earnings for academics are not perceived as the main motivator for involvement in patenting (Baldini et al.,2005; 2007; Baldini, 2011; Goektepe-Hulten & Mahagaonkar, 2010; Lam, 2010; Moutinho et al., 2007; Owen-Smith & Powell, 2001; Stephan et al., 2004). Available research from multiple contexts (Arqué-Castells et al., 2015; Baldini et al., 2007; Baldini, 2010; Belezon & Schankerman, 2009; Caldera & Debande, 2010; Goektepe & Mahagaonkar, 2010; Huang et al., 2011; Lach & Schankerman, 2008; Link & Siegel, 2005; Markman et al., 2004; Sauermann et al., 2010) shows mixed results on the effectiveness of royalty sharing on incentivizing academics' patenting and licensing endeavor. It seems that academics consider royalty sharing when revenues to be distributed are expected to be sufficiently large. Expected individual royalty income for academics is dependent on royalty sharing arrangements, TTO effectiveness in research commercialization and the patentability and licensability of research (Arqué-Castells et al., 2015; Lach & Schankerman, 2008). In short, effectiveness of royalty sharing arrangements may vary across institutional contexts (Sauermann et al., 2010). A study indicates that a university's royalty sharing policy removes initial barriers by signaling potential monetary benefits of patent production, although it doesn't incentivize continued patent production (Huang et al., 2011). Dissatisfaction with university's patent procedures may lead to circumvention of the TTO (Siegel et al., 2007). Process and cultural difficulties regarding patenting may recalibrate the benefits of academic patenting (Owen-Smith & Powell, 2001). The degree to which a university's IP policy and patent regulations make patenting easy/difficult and attractive/costly for inventors can influence the propensity of academics to engage in academic patent behavior. It forms employees' psychological perceptions about the desirability of academic patent behavior, the procedure and support to realize a patent and rewards of patenting on a university-wide-level. In this sense, it is expected to help the formulation of individual outcome, normative and control beliefs regarding engagement in academic patent behavior.

University's IP Reputation

Patenting, technology transfer and spin-off activities can play an important part in shaping a university's reputation. A reputation is the image or perception that people in general have about something or someone. When a reputation is established it can have a negative or positive nature and consequently creates worth-of-mouth by which the information about the entity is passed from person to person by communication. Organizational reputation affects the way in which various stakeholders behave towards an organization (Chun, 2005). From an organizational behavior perspective reputation is viewed as sense-making experiences of employees or the perception they held about the organization (Fombrun

[10] WIPO (2017) IP Policies for Universities and Research Institutions retrieved from http://www.wipo.int/policy/en/university_ip_policies/ on 02-08-2017

& Van Riel, 1997). Studies demonstrate that perceived organizational reputation is an important predictor of employee attitude and engagement in multiple contexts (e.g. Men, 2012; Otchere-Ankrah et al., 2016; Shirin & Klein, 2017). An IP reputation informs or gives an indication to employees about university's past experience, tradition and performance in creating and exploiting IP. Owen-Smith & Powell (2001) argued that academics take the decision to patent or not in a context of a university's history and reputation. For example, a history of success regarding creation and exploitation of patents contributes to sustained performance by increasing patent awareness, changing the perception about patenting and reinforcing tangible and intangible benefits of academic patenting (Owen-Smith & Powell, 2001) possibly resulting in employee "buy-in" and peer behavior. The nature of a university's IP reputation can influence the propensity of academics to engage in academic patent behavior. It forms employees' psychological perceptions about the outcomes of academic patent behavior and to which degree academic patent behavior will be approved and expected within the university. In this sense, a university's IP reputation is expected to help the formulation of individual outcome and normative beliefs regarding engagement in academic patent behavior.

3.3.1.2 Technology Transfer Office (TTO) Level Characteristics

Technology transfer is the process of all activities that transmit (1) relevant explicit and tacit information about physical processes, facilities, techniques, explanations etc. associated with (legally protected) technology and (2) ownership of and/or the right to operate this IP charged with transaction costs from the university of its origination to a wider distribution of places and in-groups within the socio-economic environment (Bozeman, 2000; Diaconu & Dutu, 2014). Technology transfer ensures knowledge valorization such that scientific and technological findings at universities are accessible to others to further develop, apply and exploit the technology in new products, processes and services from which the public will eventually benefit (Bozeman, 2000; Capart & Sandelin, 2004; Diaconu & Dutu, 2014). The importance of technology transfer is pivotal as academic research account for a large share in all R&D and industry relies mostly on short-term R&D whereas universities execute long-term R&D (Thursby et al., 2001).

Universities have to be ambidextrous organizations, at the same time executing research and teaching and fostering commercialization of research outcomes (Ambos et al., 2008; Chang et al., 2009). Organizational ambidexterity can be achieved by the establishment of a TTO. A TTO is mandated to take patent decisions and charged with the implementation of university's IP policy and patent regulations as it is a formal organizational unit, agent or center responsible for and facilitating the identification, evaluation, protection and exploitation of knowledge generated (e.g. Thursby et al., 2001). The university's "patenting capacity" seems to be impacted by TTO's existence, capacity, competence and experience (Ambos et al., 2008; Berkovitz & Feldman, 2008; Baldini et al., 2005; 2007; Coupe, 2003; Goektepe, 2008; Huang et al., 2011; Owen-Smith & Powell, 2001).

A TTO has a pivotal role in academic patenting by raising patent awareness, providing information about invention disclosure and patenting, serving academic inventors with assistance and support to reduce patent burdens, evaluating which patents to file and facilitating technology transfer from academic inventors to industry and societal use (Huang et al., 2011; Thursby et al., 2001). With regard to academic patenting a TTO functions (e.g. Bradley et al., 2013) as:

- *service center* by offering complementary assets as information, assistance, advice and education on all areas related to IP to the university, faculty, students and staff;
- *intermediate organization* that assist and realizes interactions between academic inventors, patent attorneys, patent offices and industry;
- *patent generator* by (1) identifying and evaluating R&D output regarding patentability, freedom-to-operate and appropriation attractiveness and so (2) ensuring (worthwhile) patenting;
- *patent portfolio administrator* by continually analyzing, deciding on and collectively managing the mix of current and pending patents to best achieve goals while honoring constraints;
- *patent defender* by identifying infringement and consider possible actions to stop infringement and get compensation for provable damage;

- *income generator* by identifying and evaluating exploitation opportunities with the goal of (1) licensing or selling patents to industry, (2) establishing contracts or ventures with industry and (3) actively facilitating the formation of university connected spin-offs;
- *encourager of entrepreneurial spirit at university* to create patents and exploit them in the socio-economic environment;
- *marketing communicator* on university's patent and innovation activities to create a trustworthy image for recruitment and partnering purposes.

A TTO requires necessary funds, staff and competences to fulfill important functions (Moutinho et al., 2007). Effective TTOs intend to solve commercialization problems as perceived scarce possibilities for research exploitation, difficulties in assessing commercial relevance and scarce interest of (local) industry in academic research (Baldini et al., 2007).

Generally speaking a university is a professional bureaucracy that gives employed academics a relatively high degree of autonomy. Despite rules and regulations academics possess high discretion in their choice to engage in patenting and commercial activity (Goektepe-Hulten & Mahagaonkar, 2010; Hayter & Feeney, 2016). The requirement for academics to disclose and assign inventions to TTOs is not easily monitored and enforced in practice (Baldini et al., 2005; Markman et al. 2008; Siegel et al. 2003) and opportunism is hard to diminish (Panagopoulos & Carayannis, 2013). Recent evidence confirms that only a minority of researchers are aware of the existence of a TTO at their university (Huyghe et al., 2016) and bypass TTO for multiple reasons (Goel & Göktepe-Hultén, 2017) to engage in publishing before filing a patent (Argyres & Liebeskind, 1998), opportunism (Panagopoulos & Carayannis, 2013), informal technology transfer (Link et al., 2007) and external patenting (Hayter & Feeney, 2016; Markman et al., 2008; Thursby et al., 2009; Perkmann et al., 2015). When academics have TTO awareness, a TTO must have a sufficient level of competence to manage the technology transfer process of invention disclosure, patenting and exploitation. TTO effectiveness could be objectively measured by responsiveness to clients, the IP portfolio characteristics, (net) income generated and contributions to industrial innovation, spin-off creation and (socio-)economic development (Bozeman, 2000; Thurbsy et al., 2001). A rational academic is considered as someone that weights the perceived individual costs and benefits of enabling and interacting with a TTO to pursue the realization of a patent. In this sense, TTO's professionalism, barriers and income-drive are constructs to capture employees' perception of TTO effectiveness (based on Huang et al., 2011).

TTO Professionalism

Incentives to engage in academic patent behavior are increased or decreased by the perceived benefits of interacting with the TTO or dealing with patenting alone. TTO professionalism is loaded with:

- perceived visibility within the university community (Owen-Smith & Powell, 2001);
- perceived quality of service provision (advice, assistance, education, information and transfer);
- perceived activity to identify university's potential patentable R&D output, although most TTOs lack the capacity and competences to do this (Owen-Smith & Powell, 2001);
- perceived competence to evaluate invention disclosures (i.e. patentability, freedom-to-operate and appropriation attractiveness) and ensure (worthwhile) patenting.

TTO Barriers

Incentives to engage in academic patent behavior are increased or decreased by the perceived cost of interacting with the TTO or dealing with patenting alone. TTOs need to be selective about financing patents and patent exploitation to reduce cost and increase office efficiency because of limited resources (Huang et al., 2011). TTO barriers is loaded with:

- perceived TTO bureaucracy and discomfort (Moutinho et al., 2007; Siegel et al., 2003; Thursby & Kemp, 2002). The heterogeneity in academic inventors demand an adaptive and flexible TTO instead of the provision of standardized solutions to different cases (Goektepe, 2008);
- perceived forms of distance or misalignment, for example the lack of common mindset or trust between the TTO and the faculty (Sideri & Panagopoulos, 2016);

- perceived procedural and outcome unfairness (De Cremer et al., 2010), for example only interested in certain mature, profitable and patent-friendly disciplines.

TTO Income-drive

A patent represents an investment that is done in prospect of exclusive exploitation by patent protection, commercialization, sale or licensing. Individual royalty income of academics could be dependent on TTO's income-drive. TTO income-drive is loaded with:

- perceived competence to identify infringement and exclude the commercial use by others and get compensation in case of provable infringement damage;
- perceived performance to license and sell patents;
- perceived performance to facilitate the formation of university connected spin-offs.

In theory, the degree of TTO professionalism, TTO barriers and TTO income-drive will have an influence on employees' perception about TTO effectiveness and result in a TTO reputation. Negative experiences with the TTO are likely to hinder future efforts as the benefits of IP protection don't outweigh the cost (Owen-Smith & Powell, 2001; Siegel et al., 2003), although researchers might have a window of tolerance when office is young and improvements are expected. TTOs have to "…understand that they must create and support an environment that encourages the disclosure of inventions and where the benefits obtained from patenting are understood and the inventors are engaged participants in the patent and technology transfer process" (Capart & Sandelin, 2004, p.10). Regression results from Sweden and Germany show that academics that received support from TTO are much more likely to file a patent application (Sellenthin, 2009). Perceived TTO effectiveness forms employees' perceptions about expected royalty income and support for academic patent behavior and the degree to which it is worthwhile to interact with the TTO to realize a patent. In this sense, perceived TTO effectiveness is expected to help the formulation of individual outcome, normative and control beliefs regarding engagement in academic patent behavior.

3.3.1.3 Department-level Characteristics

The third university mission can be cultivated, legitimated and embedded within the university when incentives and support mechanisms on a departmental-level foster a favorable entrepreneurial environment (Huang et al., 2011). On a department-level patenting support and patent production incentives are proposed to be impact factors.

Departmental Patent Support

Patenting can be a long-lasting, time-consuming and complex activity. Especially for academic inventors that entry patenting assistance and support is very welcome whereas serial patenting academics may have more experience and are better able to manage conflicts of time, commitment and interest. Colleagues, considered as social capital, can be complementary resources with helpful knowledge and skills, contacts, encouragement and time resources that could provoke and support invention disclosure and patenting and increasing its efficiency and effectiveness. Even at a department-level peer support (Baldini et al., 2007; Owen-Smith & Powell, 2001) from knowledgeable and experienced colleagues could foster patenting activities (Huang et al., 2011) by overcoming problems such as lack of time, the difficulty to assess commercial value (Baldini et al., 2005), lack of knowledge about patenting and the university-level patent procedure and difficulties to access financial resources (Moutinho et al., 2007).

Individuals are socially embedded in the direct work environment. Every organization may have its own unique culture, but in larger organizations co-existing or conflicting subcultures in departments may be shaped (Deal & Kennedy, 2000; Heskett & Kotter, 1992; Schein, 1992). Local group norms, department culture and peer-effects seem to have a significant influence on the aspiration (Erikson, et al., 2015) and decision to patent (Bercovitz & Feldman, 2008; Louis et al., 1989; Renault, 2006; Stuart & Ding, 2006; Stephan et al., 2004) as well in inside (via TTO) or outside (bypass TTO) patenting (Hayter & Feeney, 2016). Peer pressure considered here as the direct influence on academics by colleagues such that academics get encouraged or threatened to follow the attitudes, values or behaviors of the

influential group within the department. Informal coercive incentives could exist when an academic inventor can expect that engagement in academic patent behavior will result in a force (e.g. rejection and conflicts) being used or not being used against him or her by colleagues. Social imprinting and role models within the department, scientific discipline or research group are likely to influence patenting (Baldini et al., 2007; Goektepe, 2008; Louis et al., 1989; Renault, 2006; Stuart & Ding, 2006; Stephan et al., 2004) as evidence shows that academics which work in patent-conducive contexts are more likely to patent (Azoulay et al., 2007; Bercovitz & Feldman 2008). This could result from peer behavior with possible personal intentions to adopt attitudes, values or behaviors to belong to a group and competitive behavior which positively influences individual influence, status and power within a group. Huang, Feeney and Welch (2011) found some support that a work environment that values entrepreneurial behavior will be more likely to produce a patent.

Huang, Feeney and Welch (2011) considered department patenting assistance existence of a knowledgeable colleague responsible for helping the department with invention disclosure and patenting activities. Results from the USA show that department patenting assistance doesn't notably influence the likelihood of having a patent or the amount of patents produced because the TTO seems to be the primary service organization that supports patenting. In fact, only measuring assistance as a dummy variable doesn't give a complete picture of the degree of patenting support. This study tries to conceptualize it broader by considering the perceived tendency to which a department shows:

- *patent cooperation* when colleagues encourage and support (positive effect);
- *patent neutrality* when colleagues are indifferent (zero effect);
- *patent counteraction* when colleagues discourage, hinder and sabotage (negative effect).

The perceived position of the department towards academic patenting may have an influence on the propensity to engage in academic patent behavior as it forms employees' psychological perceptions about the degree to which academic patent behavior will be approved/disapproved and supported/hindered within the direct work environment. These perceptions are expected to help the formulation of individual outcome, normative and control beliefs regarding engagement in academic patent behavior.

Departmental Patent Production Incentives

As discussed in University's IP Policy and Patent Regulations (section 3.3.1.1.2) a university royalty sharing arrangement provides awareness and expectation about financial compensation due to the lack of ownership of the patent. The department can incentivize academic patenting by offering (potential) benefits to inventive staff (Huang et al., 2011; Owen-Smith & Powell, 2001) so that they want to perform actions and increase the quality of those actions directed at the realization of a (potential) patent. Departmental patenting incentives are reflected in the extent to which patenting is recognized and rewarded as an important part of scholarship (Huang et al., 2011).

Incentives are effective when they positively influence the motivation to undertake actions that lead to favorable outcomes. Expectancy (Vroom, 1964) and goal-setting theory (Locke, 1968) together emphasize the importance of correctly designing and clarifying objectives, identifying and communicating the requirements for performance and ensuring a clear link between performance and valued rewards. Every employee needs to be fairly rewarded who achieves stated performance criteria. The incentive regime may constitute of monetary and non-monetary rewards. They seem effective but may bring unintended effects. Over time employees may consider an incentive as an entitlement and not as motivator or even demanding more and higher incentives which is of course costly. Monetary incentives may be less effective related to enduring commitment to an objective than nonmonetary incentives, especially over time. Incentives also limits focus to activities that are incentivized, while other important un-incentivized activities might be easily forgotten. In real word settings, characterized by imperfect knowledge and moral hazard, incentives are more complex and could lead to unexpected negative effects.

Individual patent production seems to be significantly correlated with department-level incentives (Huang et al., 2011). Possible formal departmental incentives positively influencing patent production include:

- a positive impact on job design (e.g. more autonomy or responsibilities);
- a positive impact on job security;
- a positive impact on the periodic job performance appraisal (when patent production is part of the evaluation);
- provision of financial reward (e.g. one-time gratification or structural salary increase);
- provision of more resources, training and facilities for further research;
- provision of promotion;
- provision of recognition and appreciation for achievement and reputational reward;
- provision of opportunity for patent exploitation.

The perceived departmental incentive regime may have an influence on the propensity to engage in academic patent behavior as it forms employees' psychological perceptions on how and the degree to which academic patent behavior will be rewarded within the direct work environment. These perceptions are expected to help the formulation individual outcome and normative beliefs regarding engagement in academic patent behavior.

3.3.2 Possible Individual Impact Factors

"…scientists may be extrinsically and/or intrinsically motivated to different degrees in their pursuit of research commercialization" (Lam, 2010, p.11) and their choice of ways of research commercialization (Shinn & Lammy, 2006). It is demonstrated that the degree to which an individual's behavior is intrinsically motivated and self-determined seems to have a dominant role in provoking and sustaining individual behavior (e.g. Deci, 1975; Lindenberg, 2001). Self-determination theory (SDT) (Ryan & Deci, 2000a; Ryan & Deci, 2000b) considers motivation as an outcome of interaction at a given time and place between (1) three individual innate psychological needs and (2) external regulatory processes. SDT is exemplary for a content theory of motivation and the core of the theory is shaped by the theorem that an optimal individual performance, growth and well-being is allowed when the three universal psychological needs are fulfilled. These innate psychological needs are the basis for self-motivation and self-determination (as stated in Ryan & Deci, 2000a, p.68):

- *autonomy*: "the universal desire to be causal agents of one's own life and act in harmony with one's integrated self" (note this doesn't refer to being independent from others) (e.g. deCharms, 1968);
- *competence validation*: "the seek to control the outcome and experience mastery" (e.g. White, 1959)
- *social relatedness*: "the desire to interact, be connected to, and experience caring for and be cared for by others" (e.g. Baumeister & Leary, 1995).

The application of these needs can be universal although it salience and expression may be dependent on context and time (Chrikov et al., 2004). Besides that, individual differences in self-determination may exist because of differences in social/organizational context that hinder and support needs, personal causality orientations (i.e. impersonal, controlled or autonomy) and personal life goals (i.e. long-term intrinsic and extrinsic aspirations that guide people's decisions) (e.g. Deci et al., 2017).

Motivation for certain behavior can be categorized in unwillingness, compliance and active personal commitment. SDT distinguishes intrinsic motivation, extrinsic motivation and amotivation (Ryan & Deci, 2000a). Intrinsic motivation refers to the inherent internal interest, pleasure and satisfaction of doing something and the natural tendency to explore and take on challenges associated with proving personal competence and striving for personal learning and development. Of course, much of what people do is not, strictly speaking, intrinsically motivated. Extrinsic motivation refers to the external regulation and rewards or other separable outcomes that are considered by recipients. Extrinsically motivated behavior is the least autonomous and is performed to satisfy an external demand or serving external regulation. The nature of motivation is dynamic as behavior that is firstly extrinsically motivated

can turn in intrinsically motivated as someone internalize values and self-regulation that underlines this behavior (Ryan & Deci, 2000a) or behavior that is firstly intrinsically motivated can turn in extrinsically motivated by psychological substitution effects (Frey, 1997). Amotivation refers to the lack of intention to do something as there is a lack of interest, lack of control, personal incompetence or the activity and outcomes are not valued.

This brings a need to examine the academics' differentiated perceptions and beliefs regarding benefits, cost, enablers and obstacles of academic patent behavior to interpret the motivations that underline their intention to engage in academic patent behavior. It is assumed that academic patent behavior cannot be clearly understood and explained without considering individual factors as academics use and interpret cues about themselves.

3.3.2.1 Altruism Considerations

Altruism is defined as "the principle or practice of unselfish concern for the welfare of others" (Thefreedictionary.com, 2017) which guides everyday prosocial behavior. Prosocial motivation is a specific form of intrinsic motivation (Grant, 2008) and has an association with feelings of social relatedness. In organizational psychology altruism is found in concepts as organizational citizenship behavior and extra-role behavior. Organizational citizenship behavior (Bateman & Organ, 1983; Organ, 1988) is individual extra-role behavior (Van Dyne et al., 1995) that has a discretionary nature (performed as result of personal choice), goes beyond role expectations, is not included in the formal reward system and positively influences the performance of organizational units. Those concepts could be linked to academic patent behavior as there is high discretion, academic patentees are not directly rewarded by the university when a patent is granted and realizing a patent could have a positive effect on organizational or societal performance.

Expected performance effects are positive when academics believe that engagement in academic patent behavior will bring performance enhancement or efficiency gains for (an) organizational unit(s) or society. Academics can engage in patenting by having altruistic considerations as they accept the legitimacy of the ultimate objective and feel obliged or committed and connected to others (Owen-Smith & Powell, 2001). Patenting in life sciences is motivated by a desire to contribute to society while this is less in physical sciences (Sauermann et al., 2010). An academic could believe that patent behavior will be rewarded by a sense of self-esteem or personal gratification (intrinsic motivation) and approval or admiration from others (extrinsic motivation). Altruism considerations could have an influence on the propensity to engage in academic patent behavior as it is expected to help the formulation of individual outcome beliefs regarding engagement in academic patent behavior.

3.3.2.2 Attitude towards Science - Entrepreneurialism Integration

For a long time, universities acted as open science organizations in a traditional "Mertonian" world of academic research (Merton, 1957; 1973) creating conditions in which scientists ensure the generation and wider dissemination of knowledge to establish priority by rapid publication and thereby gain visibility, credit and reputation that could be monetized into high incomes (Dasgupta & David, 1994). Scientists were motivated by the "gold" (income), "ribbon" (reputational/career rewards) and "puzzle" (intrinsic satisfaction) (Stephan & Levin, 1992). After the institutionalization of the "entrepreneurial university" universities and scientists had and have to engage in (successful) exploitation of academic knowledge and inventions. Generation and exploitation of patents is exemplary for academic entrepreneurship.

Scientists have different beliefs about the appropriate relationship between science and academic entrepreneurship (Lam, 2010; Owen-Smith & Powell, 2001; Renault, 2006). On one side there are academics that believe in the pivotal link between science and academic entrepreneurship for scientific advancement and a socio-economic contribution to society (win-win situation). On the other side there are academics that favor less or non-integrated science and academic entrepreneurship. There are principal and practical objections towards academic entrepreneurship (as discussed in section 2.1.3). Principal objections refer to patenting conflicting with the open science norm and entrepreneurialism decreasing scientific progress. Individual positive open science attitude may

increase the likelihood of engagement publishing (Dasgupta & David, 1994; Huang et al., 2011). Studies demonstrate that academics don't perceive patents as inappropriate and as obstacles to publication and conferences (e.g. Baldini, 2011; Moutinho et al., 2007) but as by-product (Stephan et al., 2004) hinting at the complementary nature of patenting and publishing (e.g. Huang et al., 2011; Van Looy et al., 2006). Practical objections refer to the limited resources to be ambidextrous (Chang et al., 2009), the conflicts of commitment and interest resulting in a role overload (Jain & Yusof, 2007) and the lack of necessary domain-specific skillset to make commercial exploitation of research a success (Leloux et al., 2017).

Lam (2010) formulated four types regarding scientists' orientation towards the degree to which science and entrepreneurship go together based on the level of congruence of personal values and those associated with entrepreneurialism:

- type "*pure traditional*": believes science and entrepreneurship should be separated and pursues success strictly in the scientific domain;
- type "*pragmatic traditional*": believes science and entrepreneurship should be separated, but also recognizes the need for exploitation of academic knowledge;
- type "*hybrid*": believes in the fundamental importance of the science-entrepreneurship link for scientific advancement, although recognizing the need for a boundary;
- type "*entrepreneurial*": believes in the fundamental importance of science-entrepreneurship integration for knowledge valorization.

It seems that academics don't have a homogenous nature when it comes to motives and orientations towards patenting. Academics attitude towards the science - academic entrepreneurialism integration could have an influence on the propensity to engage in academic patent behavior as it is expected to help the formulation of individual outcome and control beliefs regarding engagement in academic patent behavior.

3.3.2.3 Capability Considerations

The patent behavior process demands domain-general and domain-specific skills to carry out action. Capability[11] is considered here as the cleverness and ability to perform certain actions to achieve certain outcomes. Capability considerations refer to the personal beliefs (not objective reality) if he or she has the necessary knowledge and skills (i.e. self-efficacy) and/or access to (complementary) resources to perform the necessary actions in the patent behavior process that targets the realization of a patent from research. Academics have to manage the tension between academic and commercial demands (Ambos et al., 2008) which logically speaking demands time management and cognitive/behavioral flexibility. Someone could get support or even outsource some actions internally or externally. Someone that perceives a lack of control or personal incompetence could result in amotivation such that there is no intention (Ryan & Deci, 2000a) to engage in academic patent behavior. Capability considerations could have an influence on the propensity to engage in academic patent behavior as it is expected to help the formulation of individual outcome and control beliefs regarding engagement in academic patent behavior. The degree to which someone has positive/negative capability beliefs tend to influence the individual propensity to engage in academic patent behavior positively/negatively.

3.3.2.4 Cost Considerations

Engagement in academic patent behavior could entitle someone to cost. A rational academic is considering perceived cost and negative consequences of academic patenting (Owen-Smith & Powell 2001). Possible costs or negative consequences are:

- effort and time;
- information cost (about procedures);
- interaction cost (with TTO, department, patent office, industry, etc.);
- opportunity cost and feelings of personal sacrifice (a benefit that a person could have had, but gave up, to engage in academic patent behavior);

[11] *Ability* refers to an actual skill unrelated to an outcome whereas *capacity* refers to the potential to develop a skill. Capability can be enhanced by education, information supply, experience and observation learning.

- learning cost (dependent on previous personal experiences);
- patent cost (when not reimbursed by TTO or department);
- feelings of stress, conflicts and a negative impact on personal performance (inability to get regular tasks done or lower task performance).

Organizational support mechanisms could lower the cost of engagement in academic patent behavior. Cost considerations could have an influence on the propensity to engage in academic patent behavior as it is expected to helps the formulation of individual outcome and control beliefs regarding engagement in academic patent behavior. Logically speaking cost that are perceived as too high and/or don't outweigh the benefits lower the propensity to engage in academic patent behavior.

3.3.2.5 Extrinsic Reward Considerations

By the institutionalization of the "entrepreneurial university" reward structures of two previously separated systems of traditional Mertonian open science (production of knowledge) and commerce (exploitation of knowledge) meet each other. Extrinsic rewards are shaped by the organizational and wider context. Possible rewards are:

- provision of visibility and reputation to get access to industry's research infrastructure, data and knowledge to leverage faculty's research: complementary resources, funds, more research opportunities and stimuli for (patentable) research (Baldini et al., 2007; Bercovitz and Feldman 2008; Owen-Smith & Powell 2001; Stephan et al., 2004);
- provision of the opportunity to build and expand professional network;
- provision of opportunities for knowledge and technology transfer and academic spin-off (Owen-Smith & Powell, 2001);
- provision of opportunities for promotion and career advancement (Baldini et al., 2007; Moutinho et al., 2007);
- provision of direct financial reward (e.g. one-time gratification or structural salary increase) (Huang et al., 2011);
- provision of indirect financial reward as university's royalty sharing arrangement ensures that financial benefits are postponed till the moment when income is generated by licensing or selling the patent (e.g. Lach & Schankerman, 2008);
- provision of more resources, training and facilities for further research (Baldini et al., 2007; Moutinho et al., 2007);
- provision of recognition for invention and granted patent and reputational reward (Baldini et al., 2005; 2007; Giuri et al., 2006; Goektepe, 2008; Goektepe-Hulten & Mahagaonkar, 2010; Lam, 2010; Moutinho et al., 2007; Owen-Smith & Powell, 2001; Stephan et al., 2004);
- provision of a negative right to exclude commercial use of the invention by third parties within a limited time and territory (Owen-Smith & Powell, 2001);
- shown appreciation from others.

Academics are sensitive to diverse incentives with varying importance depending on personal characteristics and context (Baldini, 2011). The importance of support-to-research, knowledge exchange, career advancement and recognition/reputation considerations seem to be high and whereas personal earnings seem to have a low impact regarding academic patenting (e.g. Baldini et al., 2007; Baldini, 2011; Goektepe-Hulten & Mahagaonkar, 2010; Lam, 2010; Moutinho et al., 2007; Owen-Smith & Powell, 2001; Stephan et al., 2004). Behaviors lead to a combination of outcomes which tells us that intrinsic and extrinsic motivations does not necessarily rule out each other and can be co-existent. The crowding theory of human motivation (Frey 1997) assumes a systematic interaction and dependency between intrinsic and extrinsic motivations under the same conditions. For example, autonomous individuals like artists and academics may be strongly intrinsically motivated in their work while simultaneously motivated by external rewards (e.g. recognition, career and money) (Amabile et al., 1994). Others found that extrinsic motivation may rule out intrinsic motivation in multiple contexts owing to psychological substitution effects (e.g. Frey, 1997; Lepper et al., 1973). Some argue that money as

extrinsic reward is a hygiene factor (Hertzberg, 1966) contributing to individual (dis)satisfaction while not having the ability to motivate on its own.

Academic patenting could entitle someone to rewards. A rational academic is considering perceived benefits and positive consequences of academic patenting (Owen-Smith & Powell 2001). Academics have to be aware of possible rewards to be considered. The value that an individual attributes to rewards is dependent on an individual's value system that may change over time (Vroom, 1964). Extrinsic reward considerations could have an influence on the propensity to engage in academic patent behavior as it is expected to help the formulation of individual outcome and normative beliefs regarding engagement in academic patent behavior.

3.3.2.6 Impression Considerations

People's reality is to some extent socially constructed. The act of engaging in certain behavior has a symbolic function as it is a signal and gives an impression by conveying information about an actor to the social context. Based on the impression the social context is able to (re)formulate its perception about the acting actor. Impression considerations about other's (potential) perceptions are important determinants of behavior as it has an impact on others' reactions to the actor and therefore the possibility to get access to resources, opportunities and support in case of innovative work behavior (Yuan & Woodman, 2010). Here, impression management is considered as a conscious or subconscious process in which an academic attempts to influence the perceptions that others held about him or her and his or hers associated aspects. Literature distinguishes between defensive and assertive impression management (Tetlock & Manstaed, 1985). Whereas defensive impression management concerns the protection and maintenance of an established personal reputation provoked by negative affective states (i.e. expected image losses) assertive impression management concerns improving a personal reputation provoked by self-enhancing reasons (i.e. expected image gains).

Academics are motivated to achieve reputation and recognition among peers (Merton, 1957; 1973; Stephan & Levin, 1992) by successfully fulfilling their academic tasks. Peer recognition is gained by establishing scientific priority of discovery by being first to publish (so-called "winning the game"). Scientific achievement, often measured by publications, citations, awards and positions at top-ranked institutes, is the basis for academic credibility which is associated with a solid scientific reputation and related personal satisfactions. Contemporary academics may consider patents as alternative currency to gain peer recognition and increase their scientific and professional image as it ascribes academic status to commercial success (Owen-Smith & Powell, 2001). Patenting may be an information transfer mechanism (Long, 2002) as individuals may engage in patenting to signal personal knowledge and skills and demonstrate the quality, novelty, uniqueness and applicability of their research to a relevant audience (Baldini et al., 2007; Goektepe-Hulten & Mahagaonkar, 2010). Multiple studies found that recognition and image considerations play a significant role in the decision to patent (Baldini et al., 2005; 2007; Giuri et al., 2006; Goektepe, 2008; Goektepe-Hulten & Mahagaonkar, 2010; Lam, 2010; Moutino et al., 2007; Owen-Smith & Powell, 2001; Stephan et al., 2004). Academic patenting may be done for expected image gains and associated rewards like personal earnings (e.g. Baldini et al., 2007), career advancement (Moutinho et al., 2007; Goektepe, 2008), access to extra stimuli and support for research (Baldini et al., 2007) and enhancement of influence and power within a context (Louis et al., 1989). Besides image gains there are also image losses with associated negative effects. This could be the case for example when patenting doesn't lead to a registered worthwhile patent, too much patenting negatively affects the fulfillment or quality of other personal academic tasks or patenting finds place within a context with a dominant open science culture resulting in a less pleasant personal situation for the academic patentee. A strong personal reputation and institutional status favor patenting (Moutinho et al., 2007). Due to low risks of losing their image and credibility, academics with strong reputations have more freedom, access to resources and higher incentives to patent (Goektepe, 2008). This could be questioned as someone with a strong reputation may likely experience decreasing marginal utility of image gains. The university and the departments have a role in enhancing peer recognition and reputation of patentees by putting them in the spotlights internally and externally. Impression considerations emphasize the symbolic function of engagement in academic patent behavior and the

current position (rank/status) and the use of expected image gains and losses is expected to help the formulation of individual control and outcome beliefs regarding engagement in academic patent behavior.

3.3.2.7 Individual Characteristics

Literature analysis showed that individual characteristics may influence the ability, motivation, and provided opportunity to patent to different degrees. The following characteristics were found:

- *academic qualification*: someone that holds a PhD is more likely to patent (Moutinho et al., 2007);
- *academic rank/status*: professorship provides more freedom, resources, flexibility and motivation to patent (Baldini et al., 2007; Ejermo & Lavesson, 2012; Huang et al., 2011; Moutinho, et al., 2007)
- *age*: seniority is positively correlated with patenting, because of job security, cumulative knowledge and prior experience (Baldini et al., 2007; Huang et al., 2011; Moutinho et al., 2007; Thrusby et al., 2007);
- *career life cycle/academic experience*: in early career stages academics pursue publishing to attain credit and promotion while in later stages of their career academics may prefer to exchange knowledge for economic returns via patenting (Goektepe, 2008; Huang et al., 2011; Levin & Stephan 1991), although now younger researchers are expected to be more entrepreneurial;
- *career switch*: patent performance of academics serves as employee branding in order to develop job opportunities in industry and thereby increases the propensity to patent (Goektepe, 2008);
- *type of funding*: both public and private funding of research have a positive impact on patent production (Azagra-Caro et al., 2006). Academics that work under conditions of generous research funds could be more motivated by traditional academic values (Goektepe-Hulten & Mahagaonkar, 2010);
- *corporate experience* which increases patent awareness and provides exposure to rewards and thereby increases propensity to patent (Huang et al., 2011);
- *field of research* vary in their degree of technology development opportunities and patentability of research outcomes (Baldini et al., 2007; Carayol & Matt, 2004; Huang et al., 2011; Stephan et al., 2004);
- *gender*: women are less likely to patent caused by slower career advancement (Azoulay, et al., 2007; Baldini et al., 2007; Ejermo & Lavesson, 2012; Huang et al., 2011);
- *interaction with industry*: industry provides new stimuli and resources for patentable research, enhances patent awareness and have a strong patent focus to protect inventions and thereby increases propensity to patent (Huang et al., 2011; Moutinho et al., 2007)
- *job stability*: someone with a permanent job is more likely to patent (Goektepe, 2008; Moutinho et al., 2007);
- *past patent education* creates patent awareness and thereby increases propensity to patent (Huang et al., 2011);
- *patent experience* increases patent awareness, pass through mastery experience and exposure to rewards and thereby increases propensity to patent (Agrawal & Henderson, 2002; Huang et al., 2011);
- *risk attitude:* risk aversion has a significant negative effect on invention disclosures of academics but not on patenting (Goel & Goektepe-Hulten, 2017).

These individual characteristics could have an influence on the propensity to engage in academic patent behavior as they are expected to have an influence on the individual outcome and control beliefs regarding academic patent behavior.

3.3.2.8 Self-determination Considerations

Policy makers often assume that academic inventors are sensitive for financial incentives related to successful exploitation of generated knowledge and inventions. For example, Lam (2010) demonstrated that academics are motivated by mixture of extrinsic and intrinsic rewards in their pursuit of academic entrepreneurialism. Intrinsic motivations regarding engagement in academic patent behavior are exerted by: feelings of (1) curiosity and interest, (2) fun, intellectual stimulation or professional challenge,

(3) personal achievement and being value-adding, (4) personal competence and (5) personal development and growth. Intrinsic motivation cannot be enforced, although it can be enabled by the creation of the right organizational conditions:

- provision of a sense of meaningfulness/task significance regarding academic patent behavior;
- provision of a sense of personal choice/autonomy/freedom regarding academic patent behavior;
- provision of a sense of personal competence validation regarding academic patent behavior;
- provision of a sense of personal growth/progress regarding academic patent behavior.

It is demonstrated that the degree to which an individual's behavior is intrinsically motivated and self-determined seems to have a dominant role in provoking and sustaining individual behavior (e.g. Deci, 1975; Lindenberg, 2001). Although the crowding theory of human motivation (Frey 1997) assumes a systematic interaction and dependency between intrinsic and extrinsic motivations under identifiable conditions. Academics have an innate curiosity in and fasciation for research and a taste for inventing which gives joy and other satisfactions. Satisfactions of doing research, solving the research question and publishing could be sufficient to forego patenting (Merton, 1957; Stephan & Levin, 1992). Engaging in academic patent behavior (e.g. reading/writing patents) is perceived as challenge and essential training for academics (Owen-Smith & Powell, 2001) and may help forward research thinking (stimulating inventiveness and research agendas) (Van Reekum, 2006). More recent research show patenting as a matter of doing something professionally satisfying and meaningful (Gulbrandsen, 2005; Baldini et al., 2007; Goektepe, 2008). Academic patenting seems to be more satisfying when academics believe that they make a difference and are adding real value. Self-determination considerations could have an influence on the propensity to engage in academic patent behavior as it is expected as help to formulate individual outcome beliefs regarding engagement in academic patent behavior.

3.3.2.9 Patent Effectiveness Considerations

A patent represents an investment that is done in prospect of exclusive exploitation by patent protection, commercialization, sale or licensing. Consequently, individual royalty income of academics and engagement in spin-off activity is dependent on patent effectiveness: the extent to which a patent protects the technology that creates value and help to gain and sustain competitive advantage in the market. Patent effectiveness considerations refer to the personal perception to which extent a patent fulfills its functions of guaranteeing protection and enabling technology transfer and company formation. This relates to shaping a convincing and compelling business case with regard to the exploitation of a patent (application). Patenting is worthwhile when benefits ere evincive higher than its cost. An academic inventor can evaluate to which extent appropriation is attractive and which appropriation measures are most suitable and valued. Patents may have multiple functions (Van Reekum, 2006), although perceived effectiveness of patents may be limited (e.g. Granstrand, 1990; Cohen et al., 2002a). Academics could decide to pursue secrecy by keeping discoveries for themselves or prefer to strategically publish before filing a patent to ensure that everybody has the freedom to operate the invention because of open-science aspirations (Dasgupta & David, 1994). Patent effectiveness considerations could have an influence on the propensity to engage in academic patent behavior as it is expected to help the formulation of individual outcome beliefs regarding engagement in academic patent behavior.

3.3.2.10 Regular Work Characteristics

Regular work characteristics include autonomy, job performance considerations and time resources.

Autonomy

Academics have to manage the tension between academic and commercial demands by pursuing a range of academic and commercial activities simultaneously (Ambos, et al., 2008). Designing for both exploration and exploitation could be done on different (inter)organizational-levels (O'Reilly & Tushman, 2013). A contextual mode empowers individuals to decide on dividing their time or changing roles based on cognitive/behavioral flexibility. Autonomy is considered here as the freedom and flexibility someone has in their work to decide about their allocation of personal resources to certain activities (Hackman & Oldham, 1976). The degree of autonomy provides the opportunity to someone to engage in academic

patent behavior. Autonomy is granted by the establishment of agreements, rules, procedures and policies. For example, professorship provides more freedom and flexibility to patent (Moutinho, et al., 2007). Perceived autonomy could have an influence on the propensity to engage in academic patent behavior as it is expected as help to formulate individual control beliefs regarding engagement in academic patent behavior.

Job performance considerations

Job performance is the assessment to what degree someone meets the predetermined expectations and requirements associated with a job. In theory, a job requirement for patents explicitly specifies the relevance of academic patent behavior for job performance. One reason to engage in academic patent behavior in the workplace is to bring personal job performance gains. These performance gains could have a positive impact on the periodic job performance appraisal when engagement in academic patent behavior is part of the evaluation and so recognized as an important part of scholarship. Improved job performance increases competitiveness, prestige and success of an academic and thereby enlarges the chances for career advancement. Personal job performance can be put into context by comparing it to colleagues' performance as yardstick. A competitive work environment can spur improvement with the intention to outdo each other or can pit coworkers against one another resulting in a hostile nature. Criteria for career advancement were strongly based on the amount and impact of scientific publications (Baldini et al. 2007) and are now also based on the evaluation of the production of patents (Sandberg et al., 2014; Stevens et al., 2011). Job performance considerations could have an influence on the propensity to engage in academic patent behavior as it is expected to help the formulation of individual outcome beliefs regarding engagement in academic patent behavior.

Time resources

Engagement in academic patent behavior can be a long-lasting and time-consuming activity. The availability of resources, in particular time, enables individual actions to realize a patent. Lack of time (Baldini et al., 2007) and being too busy (Poltorak & Lerner, 2011) are often called as an obstacle resulting in a lack of intention to engage in academic patent behavior. Fortunately, internal (e.g. TTO and department) and external (e.g. patent attorney and consultant) parties could offer some support to overcome this obstacle. The available time resources for academics are assumed to be fixed. Perceived disposable time resources could have an influence on the propensity to engage in academic patent behavior as it is expected to help the formulation of individual control beliefs regarding engagement in academic patent behavior.

4. Methodology

The methodology section describes how this research is executed and what the rationale is behind the application of procedures and methods necessary to identify, select, process and analyze data. By means of this section the study can be replicated and the reader can evaluate the validity and reliability of the research.

4.1 Research Design

The research approach has an exploratory character as it discovers what influences a phenomenon (Saunders et al., 2009) with the intention to discover first careful insights on what perceived organizational and individual factors enlarge and reduce the propensity to engage in academic patent behavior within a specific Dutch academic context. An exploration of these factors leads to an inductive way of working to keep an open mind and generate new insights that emerge from collected data. A process of induction seems to be the most suitable as knowledge around this phenomenon is limited when considering previous studies on academic patenting at an academic-level of analysis. Saunders et al. (2009) argue that a qualitative method is the most suitable for explorative studies, because it aims to increase the understanding of situations or phenomena from an insider's point of view, the academic researcher here. Under research are the beliefs, perceptions and experiences of academic researchers and how this influences their propensity to engage in academic patent behavior. In this sense, the outcome of this research provides a description and analysis of the research subject without limiting the

scope and the nature of participants' responses. In line with the research design it is possible to develop a survey instrument, explain relationships and create a foundation for further research.

4.2 Literature Study

A review of past relevant publications is a pivotal task in any research as it provides an adequate basis for designing, executing, contrasting and positioning someone's research (findings) (Webster & Watson, 2002). A literature review procedure is necessary to identify, select, process and analyze all relevant publications from multiple sources (Saunders et al., 2009). This literature review had the aim to provide a comprehensive overview of possible factors that influence academic patenting on an academic-level of analysis. After iterative dialogues between student and the first supervisor, the scope of the research was established which provided a solid starting point for a literature review. A list of constructs was recognized based on the main research question to establish a list of key words. Key words and additives include the dependent variable, the level of analysis, the context and the independent variable.

Key words (dependent variable and associations)	Patent behavio?r. (OR) Propensity to patent*. Motivat* to patent*. Intent* to patent*. Engag* in patent*. Decision to patent*. Tendency to patent*. To patent or not. Patenting. Patent* production.
Additives	• *Level of analysis*: academic*, inventor*, scientist*, researcher*, individual, personal. • *Context*: universit*, academi*, facult*, public research organization*. • *Independent variable*: antecedent*, predictor*, determinant*, driver*, encourage*, barrier*, hinder*, motivat*, incentiv*, obstacle*, inhibit*, factor*.

Extensive literature search was conducted between July 2017 and September 2017. Materials relevant to the research subject being explored were found by electronic scientific search engines as Google Scholar, Web of Science and Scopus. Scientometrics, Journal of Technology Transfer and Research Policy were identified as relevant journals. Once individual key words around patent behavior have been checked, subsequent searches used a combination of key words and additives using Boolean logic. No limitations to publication dates were applied and articles written in other languages than English were excluded. After a first literature search, "snowball sampling" was adopted by forward, backward and hand-searched citation screening to identify a pool of relevant articles. It was also useful to identify complementary literature on impact factors for technology transfer, academic entrepreneurialism and research commercialization. To determine the relevancy of identified literature for review the face validity was considered by reading the title, key words and abstract. This created a sample of literature that was further analyzed by reading the full text. Suitable literature had to devote attention to factors that influence the propensity to engage in (academic) patent behavior and had to be of sufficient scientific quality. Eventually, all suitable literature was integrated and referred to in this study.

4.3 Context

In this section relevant information is provided about the universities of technology in the Netherlands as background for the context in which research takes place.

Universities' mission

According to the Dutch Association of Universities (VSNU) Dutch universities are among the world's best when it comes to research productivity and quality[12]. In general, it is assumed that research at universities of technology is characterized by usefulness-driven research questions and an intended fundamental approach to answer these questions. When considering practice this kind of research regularly results in new (fundamental) technological developments and inventions. In this sense, the TU Delft (TUD), TU Eindhoven (TUE), University of Twente (UT) and Wageningen University & Research (WUR) as the four universities of technology in the Netherlands that are engaged in numerous technical-scientific research disciplines are considered as source of innovative knowledge that contributes to a sustainable society and a booming economy. Together they are a member of the self-established 4TU.federation which intends to foster innovation and business by concentration of universities' strengths in education, research and valorization[13]. Valorization is now one of universities' core tasks as it is officially included in the laws in the Netherlands. Universities act on that by targeted policy and regulations, funds, partnerships and professional support offices to optimize valorization of university generated knowledge, research results and inventions. The use of knowledge from research at knowledge institutions like universities is important for society to deal with the societal challenges and act upon economic opportunities. Patents can play an important role in effective deployment of research results when inventions could be commercially exploited due to new relevant industrial applications. Besides selling and licensing IP, it is about the formation and growth of spin-offs arising from university IP. Annual reports regarding 2016 of the 4TU.federation and the universities themselves shows that valorization by means of patenting, technology transfer and spin-off/start-up is a mission for all four universities to enable and stimulate further research and development, establish linkages and interactions with the business community and translate academic knowledge and inventions into economically and socially valuable innovations and business on an continual basis from which the university, the business community and the (regional) society can benefit

Research funds

The basis for academic research is financial resources. In the Netherlands the spectrum of research finance consist of three types:

- *the first flow of funds* consist of a direct government contribution to perform statutory obligations in the field of education, research and knowledge valorization;
- *the second flow of funds* consist of grants from the Dutch Organization for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW). These grants are distributed among researchers and research institutions on the basis of competition to do special research projects;
- *the third flow of funds* consist of additional income as contract research/education, business income, collecting box funds and subsidies from the ministries and EU.

Universities' IP policy and patent regulations

University-level IP policy and patent regulations provide guidance on issues regarding the creation and exploitation of patents. Dutch universities of technology deem it desirable to make employees more aware of existing legal regimes and policies, their rights and duties regarding academic IP and the resulting process description of disclosing, protecting and exploiting academic IP. When analyzing universities' policies and regulations and the latest collective labor agreement for Dutch universities relevant points were found. Although most of the aspects were harmonized, some minimal irrelevant differences were there. Appendix 1 provides information about the general aspects, invention disclosure, transfer and retention of rights and financial arrangements.

Universities' support offices

Although difference in duration all universities have an established tradition of technology transfer and spin-off activity through dedicated support offices: TU Delft Valorization Centre (TUD), TU/e Innovation

[12] Dutch Universities Rakings retrieved from http://www.vsnu.nl/en_GB/f_c_rankings.html at 13-11-2017.
[13] 4TU Mission retrieved from https://www.4tu.nl/en/about_4tu/mission-amibitons-core-values/ at 13-11-2017.

Lab (TUE), Business Development Team at Novel-T (UT) and StartLife (WUR). Their aim is to facilitate and promote valorization and entrepreneurship to translate academic knowledge and inventions into economically and socially valuable innovations and business on a continual basis to contribute to a sustainable society and booming economy. They provide support for and guidance in invention disclosure, patenting, patent licensing/transfer and spin-off formation. All support offices are located near their university and are embedded in business-science parks in Delft, Eindhoven, Enschede and Wageningen. Via their website, social media or other communication and presence they inform about for example: the office team and expertise, office responsibilities and service provision, the applicable implementing IP regulations and procedures at university, events, IP workshops, university's IP portfolio or office track record and success cases. By means of public relations TTO visibility is ensured while trying to positively influence the perceptions people held about the TTO.

4.4 Population and Sampling

The group of Dutch universities of technology considered as source of innovative knowledge is selected as context for this study. In general, it is assumed that research at universities of technology is characterized by usefulness-driven research questions and an intended fundamental approach to answer these questions. When considering practice, this kind of research regularly results in new (fundamental) technological developments and inventions. It seems most relevant to consider academic researchers at universities of technology, as the likelihood and the number of technological inventions seems to be the highest there and the urge to optimize valorization of academic inventions is high to improve socio-economic contribution to society.

Fields of research vary in their degree of technology development opportunities and patentability of research outcomes, as some results of R&D shall not be considered as invention and there are exceptions to patentability. In this sense, academic researchers working in fields and projects with the opportunity to develop technological inventions from research and the possibility to patent research outcomes are most suitable and relevant to be studied. The population of this study is demarcated as the group of academics doing technology-oriented research at the Dutch universities of technology within the 4TU.federation.

In case of qualitative research theoretical sampling is widely applied to generate new insights into phenomena and the underlying mechanisms that explain effects (Saunders et al., 2009). Here it is appropriate to select a sample on the basis of the knowledge about the population and the purpose of the study. As not all people in the population think alike it is good to interview a variety of people that represent diverse views to obtain a certain breadth of perception and opinion. Sampling for maximum variation, an application of theoretical sampling, was used by selecting participants that show variation on patenting experience. Patenting experience is defined as the amount of previous involvement in a patent procedure. Upfront this patenting experience can be discovered by checking the name of academic researchers in patent databases or it could be simply asked (and checked) in the first contact. To sample for maximum variation I included academic technology-oriented researchers with all degrees of patenting experience at the four universities of technology. This resulted in much variety as possible to gain a complete picture on the impact factors and ensure the validity of the survey instrument.

Data from academics with much patenting experience (more than 3 patents registered as inventor) and low patenting experience (≤ 3 patents registered as inventor) were relevant as they talked from their personal past experience and demonstrate their beliefs and perceptions about facilitators/hindrance and stimulators/discouragement. A patent database was consulted to create a list with potential relevant and suitable participants. The study attempted to include equal numbers per university category and included as much variety as possible on other related factors, like gender, age, research field, academic rank, etc. This resulted in 13 academic researchers that were willing to participate. Finding willing academic researchers was a difficult task because they had concerns regarding confidentiality and anonymity, because of pending patent applications or their sensitive opinions and perceptions about the organization. The last interviews revealed the same things and issues that have previously been identified and no new insights emerged such that theoretical saturation

occurred. All participants were involved in research and development at university and were required to identify inventions and undertake action to disclose their patentable invention to the TTO. Academic inventors were expected to, to the best of his ability, support patenting and patent exploitation with complementary know-how.

	TUD	TUE	UT	WUR
Academics with much patenting experience (P)	3	2	2	1
Academics with less or no patenting experience (LP)	1	2	1	1

Table 2. Distribution of participants according to patenting experience and university

4.5 Measurement

Measurement instruments were designed with the goal to gain insights regarding the impact factors on the propensity to engage in academic patent behavior by uncovering the beliefs, perceptions and experiences of academic researchers working at Dutch universities of technology within the 4TU.federation. To promote increased validity of results targeted behavior is specified. Academic patent behavior is considered as undertaking of actions directed at the realization of a (potential) patent from research within an academic context. As the theory of planned behavior is applied, an elicitation phase with semi-structured interviews is very important to gather data to identify which pertinent and central outcome, normative and control beliefs exist for the target population under study and how these beliefs are actually formed and influenced (Ajzen, 1991). Semi-structured interviews provided necessary flexibility in addition to a pre-defined structure to gather focused, qualitative and textual data. This flexibility ensured that the scope and nature of participants' responses were not limited which resulted in contextual, nuanced and authentic responses. The content of the pre-formulated questions was guided by research questions and insights gained during the literature study. These insights also helped to group relevant measurement constructs into domains (see appendix 2). Appendix 2 served as input for formulating interview questions and ordering them in an interview protocol (see appendix 3). This resulted in 33 pre-formulated questions, some designed to get short and superficial answers and others to get lengthy and in-depth answers. As said the interviews provided the flexibility to not ask some pre-formulated questions or ask even more questions for elaboration of responses to increase the relevancy and richness of data. To gather relevant data, it is pivotal to formulate the right questions in the right way. When formulating questions the following principles were applied:

- *unbiased formulation* to avoid leading answers;
- *understandable language*;
- *open style* to get lengthy, in-depth and descriptive responses;
- *concise formulation*: keep it as short and specific as possible;
- *neutral framing*: no strong positive and negative association;
- *generality*: respondent can take it in several directions and leave room for unexpected things;
- *simplicity*: not too complicated, too detailed or too difficult to answer.

The phrase "tell me about…" was often used to start a question as invitation for the interviewee to tell a story and as informal command to start talking. Standard questions like "how does this perception/belief/experience influence your intention to realize a patent?" and "why (not)?" elicited the informational foundations regarding the individual propensity to engage in academic patent behavior. Some questions (partly) consider the same issue, which contributed to the reliability of participants' responses.

4.6 Data Collection

The inner life of academics cannot be objectively recorded through scientific observation, although it can be subjectively perceived and indicated by introspection and understanding. Semi-structured interviews provided an adequate balance between guidance and flexibility to collect relevant and rich

data from academics. This section considers the interview protocol, the interview preparation and the interview execution.

4.6.1 Interview Protocol

An interview protocol (see appendix 3) was used for assisting data collection and determined the logical structure of the conversation with ample opportunities for “unexpected information”. The protocol is more than a list of pre-formulated interview questions and extends to the interview process, including a script of what the executive researcher would say before and at the end of the interview besides some prompts to collect informed consent and reminders about what the executive researcher wants to collect data. A protocol made sure that something that needed to be told or asked wasn’t forgotten. The script regarding the beginning of the interview considers all the necessary information about the executive researcher, research and the interview.

Participants were honestly and completely informed upfront such that participants based their voluntary and rational decision to participate in the research project on full informed understanding of the nature and aim of the study and potential risks, discomfort, adverse effects and benefits involved. The rights of the participant and the duties of the executive researcher were stated in a special created form which was sent upfront to give the participant enough time to read through the form and ask as many questions via email about the research and consent as needed. The person was only interviewed when the informed consent form was signed in duplicate.

The substantive part of the interview protocol started with the basics about personal background with the intention to warm up the interviewees and built trust. After that, the following interview was divided in three sections: engagement in patent behavior, organizational level factors (university-wide, TTO and department) and individual-level factors (personal background, enablement and motivation). At the end of the interview there was a question if there was anything that wasn’t covered felt important to add. After that, there was a word of appreciation for participating and it was agreed upon that the executive researcher could contact the interviewee if he had further questions for clarification or elaboration and that the interviewee could contact the executive researcher in case of further questions. A couple of reviews were done with random people to discover shortcomings and improve the interview protocol.

4.6.2 Interview Preparation

The interviews took place in person. Firstly, selected academics were contacted via email with the question if they wanted to be interviewed as part of this research. After a “yes” it was agreed upon a moment and place. The executive researcher ensured that the participant blocked off plenty of uninterrupted time for an interview and that the participant could be interviewed in a quiet, semi-private place (mostly the office room). The interview protocol was sent upfront such that participants got familiar with the questions and could already think about possible answers.

When people feel understood they are more willing to share. To have a smooth and productive conversation the executive researcher read about and practiced his interviewing, listening and interpretation skills. To collect all the exact words spoken by the interviewees a recording device was used, such that the executive researcher could focus on the interviewee and its responses.

4.6.3 Interview Execution

The executive researcher had to ensure that the interview sessions were smooth and productive such that relevant and rich data was collected in an ethical manner. Essential was to make a good connection and build trust with the participants such that they wanted to share their information. To build and amplify the connection the executive researcher was fronting the interviewees, made appropriate eye-contact with the interviewees and used the triple nod. A safe, informal and open interview environment was created and maintained in which interviewees could honestly speak their minds. Despite using a pre-determined set of questions, the order and content of the questions were not followed blindly at all times dependent on the specific case of the interviewee. When the interviewee gave an answer relating to a question that had not been asked yet, the question was not repeated later. The executive researcher

intended to keep the interview focused in accordance with the interview protocol as much as possible and desirable to avoid tangents. Although he was able and willing to make on the spot revisions to the interview protocol and be open for dialogue and surprises to maintain flexibility and to let the interview be like a normal conversation. Interruption of interviewees was kept to a minimum, for example when something came up a note was made by the executive researcher and he came back to the idea later. The executive researcher tried to show "empathic neutrality" in word and attitude as much as possible towards the interviewees to create vicarious understanding without judgement. In this way the executive researcher did not embarrass the interviewees and it lowered the influence of the executive researcher on interviewees' responses.

The executive researcher asked the question, listened to the interviewee's response and tried to understand this response. Based on the executive researcher's evaluation of the response follow-up questions were constructed while listening carefully. To tap into respondents' life worlds the mirroring technique was followed by using the same words and phrases the interviewee uses to construct a question or make a comment. To make the interviews more comprehensive, detailed and extended interviewees were stimulated to tell as much as possible by means of applying probing techniques: *detail-oriented probing* (e.g. "who? When? Where?"), *elaboration/explanation probing* (e.g. "could you tell more about…?"/ "Why do you (not)…?"), *clarification probing* (e.g. "what exactly do you mean by…?"), *silence probing* (remain silent and waiting the interviewee to continue), *uh-huh probing* (stimulate interviewee to continue by making affirmative but neutral comments) and *echo probing* (mirroring the last response and ask the interviewee to continue).

4.7 Data Analysis

Qualitative data processing is as much art as science and there is not a pre-scribed way that guarantees success. On the basis of the recorded interviews a transcription was made afterwards by the executive researcher himself to be able to analyze the masses of textual data. Transcription was the activity that resulted in the systematic representation of the recorded spoken data of each interview in a written form in a MS word-document ready to be inserted in data analysis software. Every participant got an alias, a code which is only known by the executive researcher. By means of this code textual data could be used in the analysis and report while maintaining the anonymity of the participants. The code consists of a structured combination of participant's university (TUD, TUE, UT or WUR) + participant's patenting experience (P = much patenting or LP = low or none patenting) + number of the interview (for example UT-P-3).

Reviewing interview responses was important to gain insights and discover patterns from the masses of textual data which pointed to discovering and understanding the impact factors for the propensity to engage in academic patent behavior. A key method was coding which was the analytical process in which the textual data was disaggregated, labelled and categorized at a nominal-level. As no pre-existing theoretical frameworks (with coding schemes) exist the codes were suggested by the executive researcher's examination and questioning of the data in combination with indications from existing literature. The data analysis process consisted of three steps: open coding, axial coding and selective coding. Open coding was basically reading the text, disaggregate and demarcate text fragments and label concepts to these text fragments. By means of open coding tentative codes were created and assigned to relevant text fragments. A code was only picked when it fitted the data. Codes were examined for their properties (see table 3).

Open Code	**Properties**	**Examples of participants' words**

Table 3. Demonstration of the used framework for open coding concerning this research.

Axial coding was basically the reanalysis of the results of open coding intended to find relevant, general concepts by identifying the relationships and patterns between the open codes (see table 4). By means of axial coding open codes were putted into categories with an umbrella code. A code was applied to only one category and categories were exclusive and comprehensive. Within and among

interviews there was a constant comparison to discover similarities and differences. In case of differences possible underlying reasons were investigated.

Open Codes	Axial codes (categories)	Selective code (core concept)

Table 4. Demonstration of the used framework to come to a selective code based on axial codes filled with open codes concerning this research.

Selective coding was basically the reanalysis of the results if open and axial coding intended to find the central themes by identifying the core concepts that organized the other concepts and categories that had been identified in the masses of textual data. The data was selectively coded such that the data that related to the central codes were identified. Qualitative data analysis Atlas.ti 8 was used to enhance the efficiency of data analysis, although it was not a substitution of the interpretative nature of coding. By means of the coding process described above the masses of collected and transcribed textual data could be analyzed and made sense of. It provided first careful insights regarding the impact factors for the propensity to engage in patent behavior among academic researchers within the context of the universities of technology in the Netherlands. These insights are instrumental as input for constructing a survey instrument for further quantitative research.

4.8 Survey Instrument Construction

By means of a survey, a standardized self-completion questionnaire, quantifiable data can be collected. To gather relevant and reliable data it is pivotal to construct a survey instrument in the right way regarding content, wording, etc. In this sense, survey construction is done by (1) formulating an effective introduction and end, (2) determining the content of the survey based on what needs to be measured (i.e. variables) and putting it in a logical whole, (3) formulating questions/statements based on the variables under study and choosing response formats for these questions/statements.

Based on the literature study and gathered insights from collected data in this research the content of a survey instrument could be determined concerning the (sub)categories loaded with variables. Variables are presented within possible categories and with measure description and type of measurement (see table 5).

Category	Variable	Measure description	Type of measurement
Organizational factors: university-wide	Patent Procedure	Academic's perception about the patent procedure facilitating patent behavior	Statement Ordinal
	Royalty Sharing Scheme	Academic's perception about the royalty sharing scheme stimulating patent behavior	Statement Ordinal

Table 5. An example of the way variables are presented for survey construction.

Based on table 5 statements and response formats for these statements are developed to reveal the individual beliefs and perception about relevant factors. Here statements are proposed and participants have to select the response that best characterized how he or she feels about the statement using Likert's 5 response scale format (strongly disagree – strongly agree). Likert's 5 response scale format seems to be less frustrating and confusing and therefore could increase respond rates and respond quality (Saunders et al., 2009). A 7-likert scale is also possible when it is considered as a more reliable and valid response format for respondents to express their views. An example is given in table 6.

Organizational factors, University-wide:
University's formulated procedure for invention disclosure and patenting is effective in facilitating the realization of patents from research by academics.
□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

University's formulated royalty sharing arrangement is effective in stimulating the realization of patents from research by academics. □ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

Table 6. Example of survey statements and response formats based on table 5.

The influence of perceived factors on the propensity to engage in academic patent behavior can be determined by asking the participants what they think the effect is on academic patent behavior. The factors are categorized based on the fact if they facilitate/hinder or stimulate discourage academics to realize patents from research. Participants are asked to select the response from the Likert's 5 response scale format that best characterized what he or she thinks the effect is of the factor. An example is given in table 7.

What is the <u>effect</u> of the following factors on the realization of a patent from research?

University's procedure of invention disclosure and patenting.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
University's royalty sharing scheme	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

Table 7. Example of survey statements and response formats based on table 5.

Besides asking participants about their beliefs, perceptions and experience the survey asks them also about how they would react or what they would do in described situations. An example is given in table 8.

What would you do when the realization of patents from research is not (sufficiently) fostered by the university? *A. Not disclosing the invention internally and no further involvement in the exploitation of it.* *B. Not disclosing the invention internally but being involved in other ways (than patenting) to exploit it.* *C. Disclosing the invention internally but no involvement in patenting.* *D. Disclosing the invention internally and being involved only in other ways (than patenting) to exploit it.* *E. Disclosing the invention internally and being involved in patenting.*

Table 8. Example of questions and responses regarding preferred behavior in specific situations.

4.9 Ethics

The executive researcher was aware of the code of ethics for research in social and behavioral sciences involving human participants as accepted by the Deans of Social Sciences in the Netherlands in January 2016[14]. He had the intention to, to the best of his ability, to behave ethically by:

- honestly and completely informing participants timely and upfront such that participants based their voluntary and rational decision to participate in the research project on full informed understanding of the nature and aim of the study and potential risks, discomfort, adverse effects and benefits involved;
- honestly answering all participants questions to the best of my ability;
- respectful treatment of participants during data collection;
- not exploiting participants and participants' data and not faking or manipulating data;
- adequate references to published sources and no plagiarism;
- respecting the confidentiality of participants' data (will only be presented on an aggregate level), ensuring the protection of participants' data and guaranteeing the anonymity of participants to the fullest to anyone besides the executive researcher.

[14] Retrieved from https://bmslab.utwente.nl/wp-content/uploads/2017/03/DSW_code-ethics-social-and-behavioural-sciences-jan16.pdf at 15-01-2018.

5. Results

In this chapter the results of the interviews in combination with the literature study are considered on an aggregated level as input for constructing a survey instrument. Firstly, results on engagement in academic patent behavior are considered. Secondly, results on the formation of academic's propensity to engage in academic patent behavior are described. After that, the content of the survey instrument is introduced and explained. The relevant organizational and individual factors are introduced and explained as variables that can be categorized and measured to be included in the survey instrument. Lastly, the population for which this survey instrument would be suitable is defined and framed.

5.1 Engagement in Academic Patent Behavior

This study is not built on the notion of only patenting or patent production of people but on patent behavior. Academic patent behavior is a new concept built on a process-oriented notion and conceptualized with a process (see section 3.1). To validate the academic patent behavior concept and getting more insight in the paten behavior process respondents was asked to describe exactly what they would do after invention identification. That academic patent behavior is a valid concept and can be seen as a process that can be displayed by the following example:

"After the identification of an invention I want to know if it is new so I start searching in databases for patents and scientific publications also (!) and analyze them to be able to contrast it with my discovery. I would probably discuss it with my direct colleagues and supervisor and ask them for some help and support, because a group knows more than one. Besides that, I need to find out if there are possibilities for commercialization which is often not that easy and obvious as scientist but required to write down in the standardized disclosure form of the university. Therefore, I would contact the Business Development Team here in the Gallery, the renovated building. This team also decides if it wants to patent the invention, so it is good to team up with it and disclose the invention to it (…) and if it wants to apply and fund the application I would need some attorney to write down a concise and right patent application and handle the application to get the patent granted. I know from experience that there will be only patented if there is a good business case for the patent." (UT-P-2)

By combining the findings from literature and universities' documents and the insights from the interviews the patent behavior process within an academic context can be conceptualized in a general way[15]:

- **Patent idea generation** consist of invention creation/identification, determination of patentability and commercial relevance of the invention, consultation with department and TTO for support and assistance and filling out the standardized invention disclosure form.

  ➔ *Follow-up: inventor's decision to disclose to the rightful claimant.*

- **Patent idea promotion** consist of formal invention disclosure, interaction with decision makers to convince them to do a patent application and arranging commitment to get access to financial resources to cover patent costs.

  ➔ *Follow-up: patent decision (by rightful claimant)*
  1st option: strategic partner to apply and fund from partner's budget
  2nd option: TTO's decision to apply and fund from university's patent fund.
  3rd option: departmental decision to apply and fund from departmental budget.
  4th option: inventor's decision to apply and fund from own money (or investor).

[15] Be aware this is the expression of a general academic patent behavior process. For example, the process can be stopped earlier as it is dependent on decisions, academic inventors can by-pass TTO or a strategic partner by not disclosing the invention to it or certain phases or actions are unnecessary or done by industry partners as part of a strategic partnership. The process is often not executed alone but in a team of (co)inventors which may require actions to coordinate and collaborate.

- **Patent idea realization** consist of interaction with the department, TTO and/or strategic partner for support and assistance, writing down a patent application, consultation of a patent attorney, paying patenting costs and handling the formal application procedure(s).

In the next section results are provided when it comes to how academics form their propensity to engage in academic patent behavior.

5.2 Formation of Academics' Propensity to Engage in Academic Patent Behavior

The core subject of this research is the individual propensity to engage in academic patent behavior (see section 3.1). The theory of planned behavior seems to explain how academics form their propensity to engage in academic patent behavior when considering the results of the literature study and the interviews. The interviews show strong evidence that academic patent behavior is a volitional decision that is underlined by a process of perceiving and considering background factors on an organizational and individual level that act as informational foundation for salient individual beliefs about (expected) outcomes, the personal context and personal control regarding academic patent behavior. As seen in figure 3. (p. 26) the cognitive demonstration of these individual beliefs results in an attitude, subjective norm and perceived behavioral control that determine the individual propensity to engage in academic patent behavior.

A **personal attitude towards academic patent behavior** refers to the degree to which someone has a favorable or unfavorable evaluation of the desirability of academic patent behavior itself or the desirability of the outcomes of academic patent behavior. The interviews showed that academic patent behavior cannot be clearly understood and explained without considering the consequences of their behavior as academics use and interpret cues to determine what the (expected) outcomes are (for themselves and others). The coding process provided some insights when it comes to (expected) outcomes of academic patenting:

- Regardless of outcomes academics may have different beliefs about the appropriate relationship between science and academic entrepreneurship.
- Often respondents didn't know about certain possible outcomes which provides the insight that academics need to be firstly aware of the possible consequences of academic patent behavior. To consider outcomes of academic patenting it seems helpful that academics are sufficiently aware of the functions of patents (patent awareness).
- Outcomes are perceived on different levels: societal, scientific community, university-wide, TTO, departmental, personal.
- There are personal outcomes that are related to performing academic patent behavior (e.g. better job performance appraisal), the production of patents (e.g. reputation enhancement) and the exploitation of patents (indirect monetary gains as result of royalty sharing agreement).
- Outcomes can differ in their degree that they stimulate or discourage academic patent behavior. Academics can be also indifferent or unsure about outcomes.
- Personal outcomes can have an intrinsic and extrinsic nature. Both intrinsic and extrinsic motivations can exist besides each other.
- Extrinsic outcomes can be categorized in outcomes for knowledge protection/dissemination, organization of research, funding of research, interactions with industry, society, personal well-being and personal welfare.
- Outcomes can be related (e.g. reputation enhancement leads to monetary gains or interactions with industry).
- Academic are sensitive to diverse outcomes with varying importance depending on their own personal background, current situation and organizational context.

Academics ask themselves here: *how worthwhile is engagement in academic patent behavior for me?* They answer this question by weighting positive and negative consequences of engagement in academic patent behavior. Besides that, there may be ambivalence such that an academic may hold contradictory or mixed beliefs towards the outcomes of academic patent behavior (e.g. limits, restricts

or delays communication with others (giving-up open science norm) vs. exploiting of an invention by patenting (socio-economic contribution to society)).

The **subjective norm regarding academic patent behavior** refers to the social pressure or freedom a person perceives to engage in academic patent behavior. The interviews showed that academic patent behavior cannot be clearly understood and explained without considering its social context as academics use and interpret contextual cues to determine what is normal and expected from them. The coding process provided some insights when it comes to important referent groups:

- University administration takes/has a position regarding academic patent behavior which is observable via clues that are provided by:
    - the mission statement;
    - latest annual report;
    - the IP(R) strategy/policy;
    - the patent regulations;
    - the royalty sharing arrangement or distributed income arrangement;
    - the perceived university-wide climate;
    - TTO's income drive;
    - patent reputation (supported by communication about patent (portfolio) success).
- The department takes/has a position regarding academic patent behavior which is observable via clues in the direct work environment such as:
    - the perceived departmental culture (i.e. norms and values) related to expected support and hinder from colleagues;
    - patenting peers;
    - the perceived rewards at departmental-level;
    - the perceived attitude of the direct supervisor.

Academics ask themselves here: *to what degree do I feel empowered to engage in academic patent behavior when considering my (direct) work environment?* In larger organizations as universities there may be co-existing or conflicting sub-cultures across departments. Be aware that the incompatibility of different climates and cultures on different organizational levels may possibly confound academics' beliefs of what is supported, expected and rewarded and may hinder or delay engagement in academic patent behavior.

The **perceived behavioral control regarding academic patent behavior** refers to the perceived ease or difficulty of performing academic patent behavior. It reflects the evaluation of the necessities to perform academic patent behavior as well as the expected barriers and obstacles that could hinder it. The interviews showed that academic patent behavior cannot be clearly understood and explained without considering its personal situation and context as academics use and interpret individual and contextual cues to determine if they are sufficiently capable and supported to perform academic patent behavior. Academic patent behavior requires specific competences, resources and support. The coding process provided some insights when it comes to important control factors. The following pivotal control factors were found:

- perceived autonomy (freedom to allocate time and attention);
- perceived disposable time resources;
- perceived flexibility to handle different academic and commercial duties and interests;
- being in the right position (rank/reputation);
- perceived capability to determine the patentability of an invention;
- perceived capability to determine the commercial opportunities and attractiveness of an invention;
- perceived capability to write down a patent application;
- perceived capability to handle a patent procedure;

The coding process provided some insights when it comes to overcoming obstacles by:

- perceived TTO support and assistance (although there could be perceived problems of interacting with the TTO, known as TTO barriers);
- perceived departmental support (although there could be perceived departmental hinder);
- perceived access to necessary external support (agents, experts and attorneys);
- perceived access to financial resources (industry partner, patent fund or investor).

Academics asks themselves here the questions: (1) *to what degree am I capable of realizing a patent looking at my personal situation and organizational context and (2) to what degree do I have access to (complementary) support to overcome possible obstacles?* It can be argued that the more necessities to perform academic paten behavior a person possesses or has access to, and the fewer the expected obstacles are the greater the perceived control over academic patent behavior.

This all provides the careful insight that the propensity to engage in academic patent behavior is a function of salient personal beliefs about (expected) outcomes, the personal context and personal control that in turn are influenced by background factors within or beyond a person that together hinder, arouse and sustain the realization from patents from research within an academic context. This provides the basis for constructing a survey instrument. In the next section the content of the survey instrument is introduced and explained.

5.3 The Content of the Survey Instrument

The content of the survey instrument is based on findings from the literature study and the insights from data analysis. This section identifies, explains and categorizes relevant factors to be measured in further quantitative research. The following aspects need to be included in the survey instrument (as visualized in figure 6):

- revelation of academic's perception and beliefs about relevant organizational and individual impact factors (which could possibly explain the perceived effect on the propensity to engage in academic patent behavior);
- revelation of academic's perception about the effect of relevant organizational and individual factors on engagement in academic patent behavior (see arrows);
- measurement of constructs relevant to engagement in academic patent behavior.

First of all there is an introduction of the variables to control for in the personal background section. Secondly, variables around engagement in academic patent behavior are introduced and explained. Next the relevant organizational and individual factors about which the potential respondents have to provide their personal beliefs and perceptions are introduced and explained. Lastly the personal perceptions about the effect of relevant organizational and individual impact factors for academic patent behavior are introduced and explained. The survey instrument with an introduction and end can be found in appendix 4.

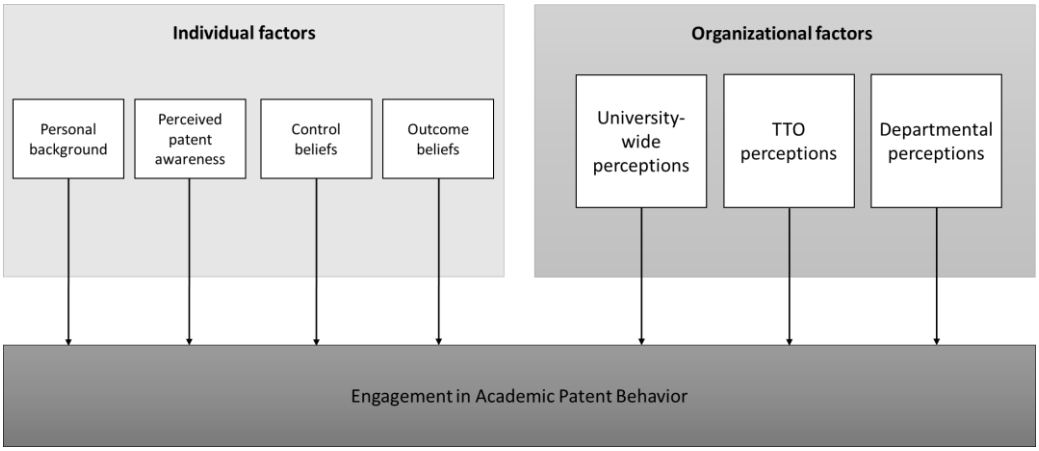

Figure 6. Underlying conceptual model for the survey instrument

5.3.1 Personal Background

To gain insight in the personal background four categories are developed: personal characteristics, current work, current research and personal experience.

5.3.1.1 Personal Characteristics

This includes inseparable characteristics of the academic like gender, age and nationality.

Category	Variable	Measure description	Type of measurement
Personal characteristics	Gender	The gender of the academic	Question Nominal
	Age	The current age of the academic	Question Ratio
	Nationality	The current nationality or nationalities of the academic	Question Nominal

5.3.1.2 Current Work

This includes information about academic's work environment and conditions.

Category	Variable	Measure description	Type of measurement
Current work	University of Technology	The Dutch university of technology the academic currently works for	Question Nominal
	Department	The department the academic currently works for	Question Nominal
	Academic rank	The academic rank the academic currently has	Question Nominal
	Type of contract	If the academic has a permanent or non-permanent contract	Question Nominal
	Type of job	If the academic has a part-time or full-time job	Question Nominal
	Time Spent at Work	Academic's perception about the time he/she spends on possible work activities (administration, teaching, research, publishing, patenting, industry interaction, research commercialization and spin-off)	Question Ratio

5.3.1.3 Current Research

This includes information about academic's current research, opportunities, funding and partnerships.

Category	Variable	Measure description	Type of measurement
Current research	Field of science	The field of science research falls in	Question Nominal
	Scientific discipline	The scientific discipline the research falls in	Question Nominal
	Relevance of patenting	Academics perception about the importance of patenting within scientific discipline	Statement Ordinal
	Opportunities for invention	Academic's perception about opportunities for (patentable) inventions that come from research	Statement Ordinal
	Opportunities for commerce	Academic's perception about the opportunities for commercial exploitation provided by research	Statement Ordinal
	Research funding	App. total amount of research funding	Question Ratio

	Industry funding	Share of industry funding	Question Ratio
	Public funding	Share of public funding	Question Ratio
	Type of public funding	Type(s) of public funding	Question Nominal
	Strategic partnerships	If research involves (strategic) partnerships with industry	Question Nominal

5.3.1.4 Personal Experience

This includes information about the relevant experiences the academic has or has not.

Category	**Variable**	**Measure description**	**Type of measurement**
Personal experience	Educational qualification	Academic's highest received educational qualification	Question Nominal
	Patent education	If academic received education about patenting and patents	Question Nominal
	Academic experience	How long engaged in academic research	Question Ratio
	Patent experience	If the academic was involved in a patent procedure	Question Nominal
	Corporate experience	If the academic worked in a large organization in industry	Question Nominal
	Industry interaction experience	If the academic engaged in possible industry activities (contract research, contract education, consultancy, collaborative projects, partnerships, patent sale/licensing and spin-off formation) in the last 10 years	Question Nominal

5.3.2 Engagement in Academic Patent Behavior

Academic patent behavior is defined in the survey as all individual actions directed at the realization of a (potential) patent from research within an academic context. To gain insight into academic patent behavior four categories are developed:

- individual patent awareness by which the definition of Pitkethly (2012) is applied to gain insight about personal knowledge about patent law, patent procedures, patent documents and the functions of patents. As shown by literature patent awareness is a necessary antecedent for performing patent behavior;
- individual propensity to engage in academic patent behavior to gain insight personal beliefs regarding patenting and perceived propensity to do an (internal) invention disclosure and be involved in a patent procedure;
- individual production to collect "hard data" about publishing, inventing, patenting and patent exploitation;
- individual knowledge valorization at university to gain insight in the willingness and preferences to valorize generated academic knowledge.

5.3.2.1 Individual Patent Awareness

Category	Variable	Measure description	Type of measurement
Individual patent awareness (Pitkethly, 2012)	Knowledge about patent law	Academic's perception if he or she has sufficient knowledge about patent law	Statement Ordinal
	Knowledge about patent procedures	Academic's perception if he or she has sufficient knowledge about paten procedures	Statement Ordinal
	Usage of patent documents	Academic's perception if he or she makes use of patent documents	Statement Ordinal
	Awareness about functions of patents	Academic's perception if he or she is sufficiently aware of the functions of patents	Statement Ordinal
	Patent regulations and royalty sharing awareness (added)	Academic's perception about his or her awareness about university's patent regulations and royalty sharing arrangement	Statement Nominal

5.3.2.2 Individual Propensity to Engage in Academic Patent Behavior

Category	Variable	Measure description	Type of measurement
Individual propensity to engage in academic patent behavior	Opinion integration science and patenting	Academic's opinion about the integration of science and patenting within academia	Statement Ordinal
	Perceived effectiveness of patents	Academic's perception about the effectiveness of patents as instruments to appropriate benefits from an invention	Statement Ordinal
	Perceived ineffectiveness of patents	Academics perception about the significant limitations of patents	Question Nominal
	Effect of worthwhileness on willingness to try and put effort	Academic's perception about the effect of perceived worthwhileness (positive vs. negative outcomes) of realizing a patent on the willingness to try and put effort to realize a patent	Statement Ordinal
	Perceived worthwhileness	Academic's perception about the worthwhileness of realizing a patent at university	Statement Ordinal
	Motivation to realize a patent	Academic's perception about his or her motivation to realize a patent if the opportunity was there	Statement Ordinal
	Invention disclosure propensity	Academic's perception about his or her propensity to do an (internal) invention disclosure	Question Ordinal
	Involvement in patent procedure propensity	Academic's perception about his or her propensity to be involved in a patent procedure	Question Ordinal
	General patent propensity	Academic's perception about his or her propensity to take actions directed at the realization of a (potential) patent	Question Ordinal

	Planned behavior when realizing a patent is worthwhile	Academic's behavioral response regarding invention disclosure, involvement in patenting and involved in other ways (than patenting) to exploit it when patent behavior is (personally) worthwhile	Question Nominal
	Planned behavior when realizing a patent is not worthwhile	Academic's behavioral response regarding invention disclosure, involvement in patenting and involved in other ways (than patenting) to exploit it when patent behavior is not (personally) worthwhile	Question Nominal

5.3.2.3 Individual Production

Category	**Variable**	**Measure description**	**Type of measurement**
Individual production	Generated inventions	App. total amount of inventions done (by which the academic helped to develop)	Question Ratio
	Internal invention disclosure done	App. total amount of internal invention disclosures done (by which the academic is named as inventor or co-inventor)	Question Ratio
	Filed patent applications	App. total amount of filed patent applications (in which the academic is named as inventor or co-inventor)	Question Ratio
	Granted patents	App. total amount of granted patents (in which the academic is named as inventor or co-inventor)	Question Ratio
	Exploited patents	App. total amount of granted patents (in which the academic is named as inventor or co-inventor) that are exploited (i.e. licensed, sold or spin-off)	Question Ratio
	Scientific publications	App. total number of published articles in scientific journals as author or co-author	Question Ratio

5.3.2.4 Individual Knowledge Valorization

Category	**Variable**	**Measure description**	**Type of measurement**
Individual knowledge valorization	Willingness to valorize	The degree to which the academic is willing to become involved in the exploitation of generated academic knowledge	Statement Ordinal
	Preferences for valorization means	The degree to which the academic prefers to exploit generated academic knowledge by suggested means	Question Ordinal

5.3.3 Perceived Relevant Organizational Impact Factors

The interviews showed that academic patent behavior cannot be clearly understood and explained without considering the organizational context as academics use and interpret contextual cues to form perceptions about climate at different organizational-levels. Here it is relevant to gain insight in the personal perceptions and beliefs of academics about possible relevant organizational impact factors on university-wide, TTO and department-level.

5.3.3.1 University-wide

Category	Variable	Measure description	Type of measurement
University-wide	Administration's expectation	Academic's perception if administration expects patent behavior	Statement Ordinal
	Mission statement	Academic's perception if mission statement justifies and provokes patent behavior	Question Ordinal
	Internal procedure	Academic's perception about the effectiveness of the formulated internal procedure for invention disclosure and patenting on facilitating patent behavior	Statement Ordinal
	Royalty sharing arrangement	Academic's perception about the effectiveness of the formulated royalty sharing arrangement on stimulating patent behavior	Statement Ordinal
	Patent reputation	Academic's perception about the successfulness of the university in realizing patents	Statement Ordinal
	Patent benefits for university	Academic's perception about ensuring substantial benefits for the university by realizing patents	Statement Ordinal
	Organizational climate	Academic's perception about the orientation of the organization towards patent behavior	Statement Ordinal
	Planned behavior when patent behavior is not fostered by university	Academic's behavioral response regarding invention disclosure, involvement in patenting and involved in other ways (than patenting) to exploit it when patent behavior is not (sufficiently) fostered by university	Question Nominal

5.3.3.2 Technology transfer office at or connected to the university

TTO's professionalism, barriers and income-drive are constructs to capture employees' perception of TTO effectiveness (based on Huang et al., 2011). The subcategories TTO effectiveness, TTO professionalism, TTO barriers and TTO income-drive are loaded below with relevant measures.

5.3.3.2.1 Perceived TTO effectiveness

Subcategory	Variable	Measure description	Type of measurement
Perceived effectiveness	Facilitation invention disclosure	Academic's perception about the effectiveness of the TTO to facilitate invention disclosure	Statement Ordinal
	Facilitation patent procedure involvement	Academic's perception about the effectiveness of the TTO to facilitate academic's involvement in a patent procedure	Statement Ordinal
	Interaction worthwhileness	Academic's perception about worthwhileness of enabling and interacting with the TTO to pursue the realization of a patent	Statement Ordinal
	Planned behavior when interaction cost outweigh the provided benefits	Academic's behavioral response regarding invention disclosure, involvement in patenting and involved in other ways (than patenting) to exploit it when interaction cost outweigh the provided benefits	Statement Ordinal

5.3.3.2.2 Perceived TTO professionalism

Subcategory	Variable	Measure description	Type of measurement
Perceived professionalism	Visibility	Academic's perception about visibility of the TTO within the university community	Statement Ordinal
	High quality service provision	Academic's perception about TTO's provision of high quality education, advice and assistance to academics regarding invention disclosure and patenting	Question Ordinal
	Capacity	Academic's perception about TTO's capacity to handle invention disclosures and patent procedures	Statement Ordinal
	Competence to consider invention disclosures	Academic's perception about TTO's competence to consider invention disclosures (to make an adequate patent decision)	Statement Ordinal
	Access to external parties	Academic's perception about TTO's access to external parties that could provide effective support for doing an effective patent application	Statement Ordinal

5.3.3.2.3 Perceived TTO barriers

Subcategory	Variable	Measure description	Type of measurement
Perceived barriers	Difficulty to interact	Academic's perception about the difficulty to interact with the TTO	Statement Ordinal
	Misunderstanding	Academic's perception about misunderstandings with the TTO	Statement Ordinal
	Bureaucracy	Academic's perception about TTO as bureaucratic organization	Statement Ordinal
	Unfairness	Academic's perception about unfair (patent) decisions	Statement Ordinal

5.3.3.2.4 Perceived TTO income drive

Subcategory	Variable	Measure description	Type of measurement
Perceived income drive	Requirement for commercial opportunities	Academic's perception about the requirement to provide commercial opportunities regarding a (patent) application	Statement Ordinal
	Only patent when attractive business case	Academic's perception about TTO's decision to patent only when there is a viable and attractive business case regarding the exploitation of the patent (application)	Statement Ordinal
	Willingness to cover patent costs	Academic's perception about TTO's willingness to cover patent costs	Statement Ordinal
	Planned behavior when TTO doesn't patent	Academic's preferred behavioral response when TTO decides to not fund and apply for a patent	Question Nominal

	Income generation	Academic's perception about TTO's performance to generate income from patents (licensing)	Statement Ordinal
	Value creation	Academic's perception about TTO's performance to create business value (spin-off formation)	Statement Ordinal

5.3.3.3 Department

Individuals are socially embedded in the direct work environment. Four relevant categories are developed to get insight in academic's perception about the direct work environment: departmental culture (i.e. norms and values), departmental support and hinder, departmental rewards and the (overall) departmental climate.

Departmental Culture

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Culture	Attitude of direct supervisor	Academic's perception about the position the supervisor has towards the realization of patents	Statement Ordinal
	Patenting as indicator for scholarship	Academic's perception about the importance of the realization of patents as indicator for scholarship	Statement Ordinal
	Social pressure	Academic's feeling of pressure within the department to realize patents	Statement Ordinal
	Patenting peers	Academic's perception about the presence of colleagues that patent(ed)	Statement Ordinal

Departmental support and hinder

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Support and hinder	Support	Academic's perception about the sufficiency of support for patent behavior in the direct work environment	Statement Ordinal
	Ways of support	Academic's perception about the presence of certain support measures in the direct work environment • Provision of education (around patent law, use of patent documents, patent procedures and the functions of patents). • Provision of time and energy of colleagues to assist in administrative tasks. • Provision of patent knowledge by experienced colleagues or supervisor. • Provision of skills to consider commercial opportunities and attractiveness of the invention by colleagues or supervisor. • Encouragement and mental support of colleagues or supervisor. • Provision of access to colleagues' or supervisor's network. • Provision of financial resources (to cover patent costs).	Question Nominal

		• Ensuring credibility from authoritative colleagues or supervisor to “sell the issue” to decision makers. • (In)formal power of colleagues or supervisor to influence decision making about patenting.	
	Hinder	Academic’s perception about the degree of hindrance for patent behavior in the direct work environment	Statement Ordinal
	Ways of hinder	Academic’s perception about the presence of certain hindrance in the direct work environment • Lack of (complementary) knowledge and skills. • Lack of willingness or motivation to support. • Lack of capacity to support. • Conflict-seeking behavior of colleagues. • Counteraction of colleagues (e.g. exclusion). • Bad evaluation of colleagues. • Open science mentality within direct work environment. • Pressure to publish as fast as possible to generate quick income. • Discouragement of or forbidden by direct supervisor.	Question Nominal

Departmental Rewards

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Rewards	Patent benefits for department	Academic’s perception about the provision of substantive benefits to his or hers department because of realization of patents	Statement Ordinal
	Part of job assignment	Academic’s perception about the inclusion of patenting in his or hers job assignment	Statement Ordinal
	Part of job performance appraisal	Academic’s perception about the inclusion of patent behavior when discussing job performance	Statement Ordinal
	Stimulation	Academic’s perception about the provision of rewards on a departmental-level when he or she takes action to realize patents • A positive impact on my job design (e.g. different tasks, more responsibility or more autonomy). • A positive impact on my job security (e.g. lower possibility to get fired or contract extension). • A positive impact on job performance (appraisal). • An increase in the amount of research I am involved in at my department. • Access to high quality research at my department. • Freedom to choose my own research. • A one-time gratification.	Question Ordinal

		• Structural salary increase. • More resources, training and facilities for executing my research. • Recognition and appreciation for inventive achievement. • An improvement of my relationship with my colleagues. • An improvement of my relationship with my direct supervisor. • Feelings of keeping up with (patenting) colleagues. • Feelings of outperforming colleagues. • An increase in credibility within my department. • An improvement of my personal reputation within the department. • An increase in my informal power within the department.	

Departmental Climate

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Overall climate	Departmental climate	Academic's perception about the orientation of the department towards the realization of patens	Statement Ordinal
	Planned behavior when department doesn't foster patent behavior	Academic's behavioral response regarding invention disclosure, involvement in patenting and involved in other ways (than patenting) to exploit it when patent behavior is not (sufficiently) fostered at department-level	Statement Ordinal

5.3.4 Perceived Relevant Individual Impact Factors

The interviews showed that academic patent behavior cannot be clearly understood and explained without considering the individual factors as academics use and interpret cues about themselves. Here it is relevant to gain insight in the perceptions and beliefs of academics about behavioral control and academic patenting outcomes. To gain insight in academic's perception and beliefs two categories are developed and loaded with variables.

5.3.4.1 Perceived behavioral control

This category shows the perceived ease or difficulty of performing academic patent behavior. It reflects academic's evaluation of the necessities to perform academic patent behavior.

Category	**Variable**	**Measure description**	**Type of measurement**
Perceived behavioral control	Autonomy	Academic's perception about the necessity to ask for approval to realize a patent	Statement Ordinal
	Spare time resources	Academic's perception about his or her available time resource to realize a patent	Statement Ordinal
	Flexibility to handle different duties and interests	Academic's perception about his or her flexibility to handle different duties and interests that come with education, research and patenting	Statement Ordinal

	Position	Academic's perception if he or she is in the position with regard to rank or reputation to realize a patent	Statement Ordinal
	Capability to determine the patentability	Academic's belief about his or her capability to determine the patentability of an invention	Statement Ordinal
	Capability to determine commercial relevance	Academic's belief about his or her capability to determine the commercial opportunities and attractiveness of an invention	Statement Ordinal
	Capability to write down a patent application	Academic's belief about his or her capability to write down a patent application	Statement Ordinal
	Capability to handle a patent procedure	Academic's belief about his or her capability to handle a patent procedure	Statement Ordinal
	Need for support	Academic's perception about his or her need for support to realize a patent	Statement Ordinal
	Access to external support	Academic's perception about his or her access to complementary external support (agents, support or attorneys)	Statement Ordinal
	Access to financial resources	Academic's perception about his or her access to financial resources to realize a patent (industry partner, patent fund or investor)	Statement Ordinal

5.3.4.2 Perceived outcomes of academic patenting

The interviews showed that academics act on the basis of perceived outcomes of academic patent behavior. It can be assumed that an academic is rational by weighting positive and negative consequences of engagement in academic patent behavior. Personal outcomes can have an intrinsic and extrinsic nature (which can exist besides each other). Intrinsic outcomes refer to the consequences from realizing patents itself while extrinsic outcomes refer to consequences that have a source beyond a person. In this sense, two categories were developed: intrinsic outcomes and extrinsic outcomes of academic patenting.

Intrinsic outcomes of academic patenting

Category	**Variable**	**Measure description**	**Type of measurement**
Intrinsic outcomes (i.e. feelings)	Doing good (altruism)	Academic's perception if patenting provides feelings of doing good (e.g. patent benefits for the department, university or society)	Statement Ordinal
	"Solving the puzzle"	Academic's perception if patenting provides feelings of satisfaction by "solving the puzzle" to realize a patent from research	Statement Ordinal
	Keeping duty to valorize	Academic's perception if patenting provides feelings of keeping duty to valorize academic knowledge as third task of universities	Statement Ordinal
	Meaningfulness	Academic's perception if patenting provides feelings of meaningfulness	Question Nominal
	Validation of personal competence	Academic's perception if patenting provides feelings of validation of personal competence	Statement Ordinal

	Personal development and growth	Academic's perception if patenting provides feelings of personal development and growth	Statement Ordinal

Extrinsic outcomes of academic patenting

The number of extrinsic outcomes of academic patenting was high. To make it clearer and more organized seven subcategories were developed. Extrinsic outcomes can be categorized in outcomes for knowledge protection/dissemination, organization of research, funding of research, interactions with industry, society, personal well-being and personal welfare.

Patenting impact on knowledge protection/dissemination

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Knowledge protection/ dissemination	Validation of invention	Academic's perception if patenting supports the validation of the invention that came out of research	Statement Ordinal
	Invention protection	Academic's perception if patenting protects the invention (from predatory behavior) to appropriate the benefits from the invention	Statement Ordinal
	Compliance with contract	Academic's perception if patenting is necessary to handle in compliance with contracts with strategic partners to protect an invention	Statement Ordinal
	Restricting communication	Academic's perception if patenting restricts free communication with colleagues and peers	Statement Ordinal
	Hinder publication/dissemination	Academic's perception if patenting hinders the publication/dissemination of the knowledge that underlines an invention (as it possibly requests secrecy and withholding of data)	Statement Ordinal
	Positive impact on scientific publication	Academic's perception if patenting has a positive impact on scientific publication about executed research	Statement Ordinal

Patenting impact on organization of research

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Organization of research	Freedom to choose research	Academic's perception if patenting provides freedom to choose own research	Statement Ordinal
	Development of further/new research	Academic's perception if patenting enables and stimulates the development of further/new research	Statement Ordinal
	Amount of research involved in	Academic's perception if patenting helps to increase the amount of research he or she is involved in	Statement Ordinal
	Less basic research	Academic's perception if patenting leads to less priority on basic research (and more on applied research)	Statement Ordinal
	Lucratively of research	Academic's perception if patenting direct research to areas that are more (financially) lucrative	Statement Ordinal

	Quality of research	Academic's perception if patenting reduces the quality of his or hers research	Statement Ordinal

Patenting impact on funding of research

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Funding of research	Industry funding attraction	Academic's perception if patenting helps to attract industry funding	Statement Ordinal
	Public funding attraction	Academic's perception if patenting helps to attract government/public funding	Statement Ordinal
	Internal funding attraction	Academic's perception if patenting helps to attract internal funding	Statement Ordinal
	Crowd funding attraction	Academic's perception if patenting helps to attract crowd funding	Statement Ordinal
	Income generation	Academic's perception if patenting helps to generate income/funds from exploiting the invention	Statement Ordinal

Patenting impact on interaction with industry

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Interactions with industry	Facilitation of collaborative R&D projects	Academic's perception if patenting facilitates the development of collaborative R&D projects	Statement Ordinal
	Signaling competence to attract sponsored research	Academic's perception if patenting signals competence and inventiveness to industry, helping to attract sponsored research	Statement Ordinal
	Promotion of consultancy and education activities	Academic's perception if patenting helps to promote consultancy and education activities in the industry	Statement Ordinal
	Facilitation of partnerships	Academic's perception if patenting facilitates partnerships to gain access to the resources, knowledge and facilities of industry partners	Statement Ordinal
	Facilitation of the exploitation of the invention (by industry)	Academic's perception if patenting facilitates the exploitation of the invention by industry	Statement Ordinal

Patenting impact on society

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Society	Inspiring others to patent	Academic's perception if patenting inspires others to patent (academic) research	Statement Ordinal
	Bringing the invention to societal use	Academic's perception if patenting facilitates the dissemination of the knowledge and the invention, bringing it to societal use	Statement Ordinal

	Facilitation of (industry) standards	Academic's perception if patenting facilitates the setting of important (industry) standards	Statement Ordinal
	Promotion of advancement of technology	Academic's perception if patenting promotes advancement of technology by inspiring circum- and inventiveness	Statement Ordinal
	Appropriating returns	Academic's perception if patenting helps to appropriate return to public research activity/investment	Statement Ordinal
	Provision of opportunities to existing businesses	Academic's perception if patenting provides opportunities to innovate and grow to existing businesses	Statement Ordinal
	Facilitation the formation of start-ups	Academic's perception if patenting facilitates the formation of start-ups	Statement Ordinal
	Provision of jobs to society	Academic's perception if patenting provides job to society (in the long-term)	Statement Ordinal
	Facilitation of higher industrial productivity	Academic's perception if patenting facilitates a higher industrial productivity	Statement Ordinal

Patenting impact on personal well-being

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Personal well-being	Unbearable stress	Academic's perception if patenting creates unbearable stress	Statement Ordinal
	Conflicts of time	Academic's perception if patenting creates conflicts of time	Statement Ordinal
	Conflicts of commitment and interests	Academic's perception if patenting creates conflicts of commitment and interests	Statement Ordinal
	Conflicts with the direct work environment	Academic's perception if patenting creates conflicts with the direct work environment	Statement Ordinal
	Conflicts with scientific peers	Academic's perception if patenting creates conflicts with scientific peers	Statement Ordinal
	Conflicts with the university	Academic's perception if patenting creates conflicts with the university (TTO or administration)	Statement Ordinal
	Conflicts with family	Academic's perception if patenting creates conflicts with family	Statement Ordinal
	Increasing patent awareness	Academic's perception if patenting helps to increase awareness about patens and patenting	Statement Ordinal
	Provision of appreciation for inventive achievement	Academic's perception if patenting provides appreciation for inventive achievement	Statement Ordinal
	Establishing priority	Academic's perception if patenting helps to establish priority as inventor to gain visibility and credit	Statement Ordinal

	Ensuring recognition	Academic's perception if patenting ensures recognition from scientific peers	Statement Ordinal
	Personal status and reputation	Academic's perception if patenting improves personal status and reputation	Statement Ordinal
	Personal network	Academic's perception if patenting improves the personal network	Statement Ordinal
	Positive impact on job	Academic's perception if patenting has a positive impact on the job (e.g. more autonomy, responsibility or security)	Statement Ordinal
	Positive impact on job performance	Academic's perception if patenting has a positive impact on the job performance (appraisal)	Statement Ordinal
	Keeping up with (patenting) colleagues	Academic's perception if patenting provides feelings of keeping up with (patenting) colleagues	Statement Ordinal
	Outperforming colleagues	Academic's perception if patenting provides feelings of outperforming colleagues	Statement Ordinal
	Informal power	Academic's perception if patenting increases informal power within the department	Statement Ordinal
	Relationship with colleagues	Academic's perception if patenting improves the relationship with colleagues	Statement Ordinal
	Relationship with direct supervisor	Academic's perception if patenting improves the relationship with the direct supervisor	Statement Ordinal

Patenting impact on personal welfare

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Personal welfare	Personal costs	Academic's perception if patenting provides personal costs	Statement Ordinal
	Direct monetary rewards	Academic's perception if patenting provides direct monetary rewards (e.g. gratification or salary increase)	Statement Ordinal
	Distributed income	Academic's perception if patenting provides distributed income from patent exploitation	Statement Ordinal
	Promotion opportunities	Academic's perception if patenting provides opportunities for promotion	Statement Ordinal
	Career opportunities	Academic's perception if patenting provides career opportunities (offers from higher-ranked universities or industry).	Statement Ordinal
	License-out opportunities	Academic's perception if patenting provides opportunities to license-out the invention	Statement Ordinal
	Sell opportunities	Academic's perception if patenting provides opportunities to sell the invention	Statement Ordinal
	Start-up opportunities	Academic's perception if patenting provides opportunities to start-up by	Statement Ordinal

		(exclusively) commercializing the invention itself	
	Long-term monetary gains	Academic's perception if patenting enables personal monetary gains in the long-term by capitalizing on provided promotion, career and start-up opportunities	Statement Ordinal

5.3.5 The Perceived Effect of Organizational and Individual Factors

Till now we discussed the measurement of how academics think about relevant organizational and individual impact factors for academic patent behavior. In the next two sections measurement constructs are introduced, explained and categorized to reveal academic's perception about the effect of relevant organizational and individual factors on his or hers engagement in patent behavior within an academic context[16]. Data analysis provided the insight that the effect of organizational and individual factors could be categorized to the degree to which a factor:

- makes it more or less easy (to take action) to realize a patent from research: facilitation or hindrance of academic patent behavior (subsection 5.3.5.1);
- makes it more or less attractive (to take action) to realize a patent from research: stimulation or discouragement of academic patent behavior (subsection 5.3.5.2).

5.3.5.1 Perceived Facilitation or Hindrance of Engagement in Academic Patent Behavior

This part examines factors that makes it more or less easy for the academic (to take action) to realize a patent from research. Therefore, the question is *to what degree facilitate or hinder the following factors academics (to take action) to realize a patent from research in their situation at university?*

As facilitation and hinder can be present on different levels two categories are taken: organizational- and individual-level facilitation and hindrance. A 5 Likert scale is applied to reveal academic's perception about the degree to which a factor facilitates, hinders or has no effect regarding his or her engagement in academic patent behavior.

Organizational-Level

Category	**Variable**	**Measure description**	**Type of measurement**
Facilitation or hindrance	Patent regulations	Academic's perception to what degree university's procedure of invention disclosure and patenting facilitates or hinders engagement in patent behavior	Question Ordinal
	TTO professionalism	Academic's perception to what degree the service and assistance offered by the TTO facilitate or hinder engagement in patent behavior	Question Ordinal
	TTO barriers	Academic's perception to what degree problems with the TTO facilitate or hinder engagement in patent behavior	Question Ordinal
	Departmental support	Academic's perception to what degree departmental support facilitates or hinders engagement in patent behavior	Question Ordinal
	Departmental obstruction	Academic's perception to what degree departmental hinder	Question Ordinal

[16] stating that the personal background (5.2.1) and the individual patent awareness (5.2.2) are factors to control for by revealing possible significant correlations with academic patent behavior.

		facilitates or hinders engagement in patent behavior	

Individual-level

Category	**Variable**	**Measure description**	**Type of measurement**
Facilitation or hindrance	Autonomy	Academic's perception to what degree academic's autonomy facilitates or hinders engagement in patent behavior	Question Ordinal
	Spare time resources	Academic's perception to what degree academic's spare time resources facilitate or hinder engagement in patent behavior	Question Ordinal
	Flexibility to handle different duties and interests	Academic's perception to what degree academic's flexibility to handle different tasks facilitates or hinders engagement in patent behavior	Question Ordinal
	Position	Academic's perception to what degree academic's position facilitates or hinders engagement in patent behavior	Question Ordinal
	Competence to determine the patentability of an invention	Academic's perception to what degree academic's competence to determine patentability facilitates or hinders engagement in patent behavior	Question Ordinal
	Competence to determine the commercial relevance	Academic's perception to what degree academic's competence to determine commercial opportunities and relevance facilitates or hinders engagement in patent behavior	Question Ordinal
	Competence to write down a patent application	Academic's perception to what degree academic's competence to write down a patent application facilitates or hinders engagement in patent behavior	Question Ordinal
	Competence to handle a patent procedure	Academic's perception to what degree academic's competence to handle a patent procedure facilitates or hinders engagement in patent behavior	Question Ordinal
	Access to complementary external support	Academic's perception to what degree academic's access to external support facilitates or hinders engagement in patent behavior	Question Ordinal
	Access to financial resources	Academic's perception to what degree academic's access to financial resources to cover patent costs facilitates or hinders engagement in patent behavior	Question Ordinal

5.3.5.2 Perceived Stimulation or Discouragement of Engagement in Academic Patent Behavior

This part examines factors that makes it more or less attractive for the academic (to take action) to realize a patent from research. Therefore, the question is *to what degree stimulate or discourage the*

following factors academics (to take action) to realize a patent from research in their situation at university?

As stimulation and discouragement can be present on different levels two categories are taken: organizational-level stimulation or discouragement and individual-level stimulation and discouragement. A 5 Likert scale is applied to reveal academic's perception about the degree to which a factor stimulates, discourages or has no effect regarding his or hers engagement in academic patent behavior.

Organizational-level

Category	**Variable**	**Measure description**	**Type of measurement**
Stimulation or discouragement	Expectations from university's administration	Academic's perception to what degree the expectations from university's administration stimulate or discourage engagement in patent behavior	Question Ordinal
	University's mission statement	Academic's perception to what degree university's mission statement stimulates or discourages engagement in patent behavior	Question Ordinal
	University's royalty sharing scheme	Academic's perception to what degree university's royalty sharing agreement stimulates or discourages engagement in patent behavior	Question Ordinal
	University's patenting reputation	Academic's perception to what degree university's patenting reputation stimulates or discourages engagement in patent behavior	Question Ordinal
	TTO income drive	Academic's perception to what degree TTO income drive stimulates or discourages engagement in patent behavior	Question Ordinal
	Departmental culture	Academic's perception to what degree the prevailing culture in the direct work environment stimulates or discourages engagement in patent behavior	Question Ordinal
	Colleagues that patent(ed)	Academic's perception to what degree patenting colleagues stimulate or discourage engagement in patent behavior	Question Ordinal
	Attitude of your direct supervisor	Academic's perception to what degree the attitude of the supervisor stimulates or discourages engagement in patent behavior	Question Ordinal
	Rewards on a departmental-level	Academic's perception to which rewards on a departmental-level stimulate or discourage engagement in patent behavior	Question Ordinal

Individual-level

Here, two subcategories of intrinsic outcomes and extrinsic outcomes of academic patenting were created to map the factors that stimulate or discourage academic patent behavior.

Intrinsic outcomes of academic patenting

Subcategory	Variable	Measure description	Type of measurement
Intrinsic outcomes	Doing good (altruism)	Academic's perception to which degree "patenting provides feelings of doing good" stimulates or discourages engagement in patent behavior	Question Ordinal
	"Solving the puzzle"	Academic's perception to which degree "patenting provides feelings of satisfaction by solving the puzzle" stimulates or discourages engagement in patent behavior	Question Ordinal
	Keeping duty to valorize	Academic's perception to which degree having feelings of keeping duty to valorize stimulates or discourages engagement in patent behavior	Question Ordinal
	Meaningfulness	Academic's perception to which degree "patenting provides feelings of meaningfulness" stimulates or discourages engagement in patent behavior	Question Ordinal
	Validation of personal competence	Academic's perception to which degree "patenting provides feelings of validation of personal competence" stimulates or discourages engagement in patent behavior	Question Ordinal
	Personal development and growth	Academic's perception to which degree getting feelings of personal development and growth stimulates or discourages engagement in patent behavior	Question Ordinal

Extrinsic outcomes of academic patenting

Extrinsic outcomes can be categorized in outcomes for knowledge protection/dissemination, organization of research, funding of research, interactions with industry, society, personal well-being and personal welfare.

Outcomes for knowledge protection/dissemination

Subcategory	Variable	Measure description	Type of measurement
Knowledge protection/ dissemination	Validation of invention	Academic's perception to which degree "patenting support the validation of the invention that came out of research" stimulates or discourages engagement in patent behavior	Question Ordinal
	Invention protection	Academic's perception to which degree "patenting protects the invention (from predatory behavior) to appropriate the benefits from the invention" stimulates or discourages engagement in patent behavior	Question Ordinal

	Compliance with contract	Academic's perception to which degree "patenting is necessary to handle in compliance with contracts with strategic partners to protect an invention" stimulates or discourages engagement in patent behavior	Question Ordinal
	Restricting communication	Academic's perception to which degree "patenting restricts free communication with colleagues and peers" stimulates or discourages engagement in patent behavior	Question Ordinal
	Hinder publication/dissemination	Academic's perception to which degree "patenting hinders the publication/dissemination of the knowledge that underlines an invention" stimulates or discourages engagement in patent behavior	Question Ordinal
	Positive impact on scientific publication	Academic's perception to which degree "patenting has a positive impact on scientific publication about executed research" stimulates or discourages engagement in patent behavior	Question Ordinal

Outcomes for the organization of research

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Organization of research	Freedom to choose research	Academic's perception to which degree "patenting provides freedom to choose own research" stimulates or discourages engagement in patent behavior	Question Ordinal
	Development of further/new research	Academic's perception to which degree "patenting enables and stimulates the development of further/new research" stimulates or discourages engagement in patent behavior	Question Ordinal
	Amount of research involved in	Academic's perception to which degree "patenting helps to increase the amount of research he or she is involved in" stimulates or discourages engagement in patent behavior	Question Ordinal
	Less basic research	Academic's perception to which degree "patenting leads to less priority on basic research (and more on applied research)" stimulates or discourages engagement in patent behavior	Question Ordinal
	Lucratively of research	Academic's perception to which degree "patenting direct research to areas that are more (financially) lucrative" stimulates or discourages engagement in patent behavior	Question Ordinal

	Quality of research	Academic's perception to which degree "patenting reduces the quality of my research" stimulates or discourages engagement in patent behavior	Question Ordinal

Outcomes for the funding of research

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Funding of research	Industry funding attraction	Academic's perception to which degree "patenting helps to attract industry funding" stimulates or discourages engagement in patent behavior	Question Ordinal
	Public funding attraction	Academic's perception to which degree "patenting helps to attract government/public funding" stimulates or discourages engagement in patent behavior	Question Ordinal
	Internal funding attraction	Academic's perception to which "patenting helps to attract internal funding" stimulates or discourages engagement in patent behavior	Question Ordinal
	Crowd funding attraction	Academic's perception to which degree "patenting helps to attract crowd funding" stimulates or discourages engagement in patent behavior	Question Ordinal
	Income generation	Academic's perception to which degree "patenting helps to generate income/funds from exploiting the invention" stimulates or discourages engagement in patent behavior	Question Ordinal

Outcomes for interactions with industry

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Interactions with industry	Facilitation of collaborative R&D projects	Academic's perception to which degree "patenting facilitates the development of collaborative R&D projects" stimulates or discourages engagement in patent behavior	Question Ordinal
	Signaling competence to attract sponsored research	Academic's perception to which degree "patenting signals competence and inventiveness to industry, helping to attract sponsored research" stimulates or discourages engagement in patent behavior	Question Ordinal
	Promotion of consultancy and education activities	Academic's perception to which degree "patenting helps to promote consultancy and education activities in the industry" stimulates or discourages engagement in patent behavior	Question Ordinal

	Facilitation of partnerships	Academic's perception to which degree "patenting facilitates partnerships" stimulates or discourages engagement in patent behavior	Question Ordinal
	Facilitation of the exploitation of the invention (by industry)	Academic's perception to which degree "patenting facilitates the exploitation of the invention by industry" stimulates or discourages engagement in patent behavior	Question Ordinal

Outcomes for society

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Society	Inspiring others to patent	Academic's perception to which degree "patenting inspires others to patent (academic) research" stimulates or discourages engagement in patent behavior	Question Ordinal
	Bringing the invention to societal use	Academic's perception to which degree "patenting facilitates the dissemination of the knowledge and the invention, bringing it to societal use" stimulates or discourages engagement in patent behavior	Question Ordinal
	Facilitation of (industry) standards	Academic's perception to which degree "patenting facilitates the setting of important (industry) standards" stimulates or discourages engagement in patent behavior	Question Ordinal
	Promotion of advancement of technology	Academic's perception to which degree "patenting promotes advancement of technology by inspiring circum- and inventiveness" stimulates or discourages engagement in patent behavior	Question Ordinal
	Appropriating returns	Academic's perception to which degree "patenting helps to appropriate return to public research activity/investment" stimulates or discourages engagement in patent behavior	Question Ordinal
	Provision of opportunities to existing businesses	Academic's perception to which degree "patenting provides opportunities to innovate and growth to existing businesses" stimulates or discourages engagement in patent behavior	Question Ordinal
	Facilitation the formation of start-ups	Academic's perception to which degree "patenting facilitates the formation of start-ups" stimulates or discourages engagement in patent behavior	Question Ordinal
	Provision of jobs to society (in the long-term)	Academic's perception to which degree "patenting provides job to society (in the long-term)" stimulates or discourages engagement in patent behavior	Question Ordinal

	Facilitation of higher industrial productivity	Academic's perception to which degree "patenting facilitates a higher industrial productivity" stimulates or discourages engagement in patent behavior	Question Ordinal

Outcomes for personal well-being

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Personal well-being	Unbearable stress	Academic's perception to which degree "patenting creates unbearable stress" stimulates or discourages engagement in patent behavior	Question Ordinal
	Conflicts of time	Academic's perception to which degree "patenting creates conflicts of time" stimulates or discourages engagement in patent behavior	Question Ordinal
	Conflicts of commitment and interests	Academic's perception to which degree "patenting creates conflicts of commitment and interests" stimulates or discourages engagement in patent behavior	Question Ordinal
	Conflicts with the direct work environment	Academic's perception to which degree "patenting creates conflicts with the direct work environment" stimulates or discourages engagement in patent behavior	Question Ordinal
	Conflicts with scientific peers	Academic's perception to which degree "patenting creates conflicts with scientific peers" stimulates or discourages engagement in patent behavior	Question Ordinal
	Conflicts with the university	Academic's perception to which degree "patenting creates conflicts with the university" stimulates or discourages engagement in patent behavior	Question Ordinal
	Conflicts with family	Academic's perception to which degree "patenting creates conflicts with family" stimulates or discourages engagement in patent behavior	Question Ordinal
	Increasing patent awareness	Academic's perception to which degree "patenting helps to increase patent awareness" stimulates or discourages engagement in patent behavior	Question Ordinal
	Provision of appreciation for inventive achievement	Academic's perception to which degree "patenting provides appreciation for inventive achievement" stimulates or discourages engagement in patent behavior	Question Ordinal
	Establishing priority	Academic's perception to which degree "patenting helps to establish priority as inventor to gain visibility and credit" stimulates or discourages engagement in patent behavior	Question Ordinal

	Ensuring recognition	Academic's perception to which degree "patenting ensures recognition from scientific peers" stimulates or discourages engagement in patent behavior	Question Ordinal
	Personal status and reputation	Academic's perception to which degree "patenting improves personal status and reputation" stimulates or discourages engagement in patent behavior	Question Ordinal
	Personal network	Academic's perception to which degree "patenting improves the personal network" stimulates or discourages engagement in patent behavior	Question Ordinal
	Positive impact on job	Academic's perception to which degree "patenting has a positive impact on the job" stimulates or discourages engagement in patent behavior	Question Ordinal
	Positive impact on job performance	Academic's perception to which degree "patenting has a positive impact on the job performance (appraisal)" stimulates or discourages engagement in patent behavior	Question Ordinal
	Keeping up with (patenting) colleagues	Academic's perception to which degree "patenting provides feelings of keeping up with (patenting) colleagues" stimulates or discourages engagement in patent behavior	Question Ordinal
	Outperforming colleagues	Academic's perception to which degree "patenting provides feelings of outperforming colleagues" stimulates or discourages engagement in patent behavior	Question Ordinal
	Informal power	Academic's perception to which degree "patenting increases informal power within the department" stimulates or discourages engagement in patent behavior	Question Ordinal
	Relationship with colleagues	Academic's perception to which degree "patenting improves the relationship with colleagues" stimulates or discourages engagement in patent behavior	Question Ordinal
	Relationship with direct supervisor	Academic's perception to which degree "patenting improves the relationship with the direct supervisor" stimulates or discourages engagement in patent behavior	Question Ordinal

Outcomes for personal welfare

Subcategory	**Variable**	**Measure description**	**Type of measurement**
Personal welfare	Personal costs	Academic's perception to which degree "patenting provides personal	Question Ordinal

		costs" stimulates or discourages engagement in patent behavior	
	Direct monetary rewards	Academic's perception to which degree "patenting provides direct monetary rewards" stimulates or discourages engagement in patent behavior	Question Ordinal
	Distributed income	Academic's perception to which degree "patenting provides distributed income from patent exploitation" stimulates or discourages engagement in patent behavior	Question Ordinal
	Promotion opportunities	Academic's perception to which degree "patenting provides opportunities for promotion" stimulates or discourages engagement in patent behavior	Question Ordinal
	Career opportunities	Academic's perception to which degree "patenting provides career opportunities" stimulates or discourages engagement in patent behavior	Question Ordinal
	License-out opportunities	Academic's perception to which degree "patenting provides opportunities to license-out the invention" stimulates or discourages engagement in patent behavior	Question Ordinal
	Sell opportunities	Academic's perception to which degree "patenting provides opportunities to sell the invention" stimulates or discourages engagement in patent behavior	Question Ordinal
	Start-up opportunities	Academic's perception to which degree "patenting provides opportunities to start-up" stimulates or discourages engagement in patent behavior	Question Ordinal
	Long-term monetary gains	Academic's perception to which degree "patenting enables personal monetary gains in the long-term by capitalizing on provided opportunities" stimulates or discourages engagement in patent behavior	Question Ordinal

5.4 A Suitable Population for the Survey Instrument

By means of a survey, a standardized self-completion questionnaire, quantifiable data can be collected, relationships can be statistically tested and empirical results could be generalized from a sample to a wider population in future quantitative research. Sampling is the selection of a subset of individuals from within a framed population to estimate characteristics of the whole population (Saunders et al., 2009). The population for this survey instrument is the group of academics directly involved in technology-oriented research at Dutch universities of technology (within 4TU.federation):

- ✓ Likelihood and the number of technological inventions seems to be the highest there
- ✓ Urge to optimize valorization of academic inventions is high to improve socio-economic contribution to society.

- ✓ Academics are required to identify inventions and undertake action to disclose their patentable invention to the TTO and expected to, to the best of his or her ability, support patenting and patent exploitation.

Most interesting are the scientific fields with:

- research with *technology development opportunities* (as patents protect mostly technological inventions). Think of technology-oriented basic and applied research;
- research with the *possibility to patent* (as there are exceptions to patentability, e.g. patenting software in the E.U.);
- research within *advanced emerging growth areas* (provides possibly many or radical inventions, e.g. nanotechnology).
- research with *high R&D investment* (as patent could be a mean to appropriate returns);
- research *close to market or society* (as patent could be a mean to disseminate or exploit the invention).

6. Discussion

In this section the outcomes of the study are considered and contrasted. Firstly of all insights of this research are discussed. Also the academic and practical implications are considered. Next we describe the limitations of this research and introduce suggestions for future research.

6.1 Insights on Academics' Propensity to Engage in Academic Patent Behavior

This research validated the academic patent behavior concept which is built on a process-oriented notion to operationalize it and identify specific steps within this process of patent idea generation, promotion and realization. Instead of studying academic patenting on aggregated levels this research is on an academic-level of analysis and focuses on the propensity to engage in academic patent behavior, namely the individual intention to undertake actions directed at the realization of a (potential) patent from research within an academic context. It is assumed that the degree of intention shows how hard academics are willing to try or how much effort they want to put to perform academic patent behavior. This implies that the stronger the intention, the more likely is their engagement in academic patent behavior, although the habituation of past behavior reduces gradually the influence of intention on behavior as it becomes less rational and more of a learned response. One necessary antecedent for engagement in academic patent behavior is individual patent awareness, as someone needs to be aware of patents to obtain and use patents to the fullest.

This study shows that the theory of planned behavior (Ajzen, 1991) seems to adequately explain how academics form their propensity to engage in academic patent behavior as the interviews showed that academic patent behavior cannot be clearly understood and explained without considering organizational and individual factors as academics use and interpret cues about their context and themselves. In this sense, the formation of academics' propensity is underlined by a process of perceiving and considering organizational and individual factors that act as informational foundation for salient individual beliefs about (expected) outcomes, the personal context and personal control regarding engagement in academic patent behavior. Analysis provided the insight that the effect of organizational and individual factors could be categorized to the degree to which the perceived factor:

- makes it *more or less easy* (to take action) to realize a patent from research: facilitation or hindrance of academic patent behavior;
- makes it *more or less attractive* (to take action) to realize a patent from research: stimulation or discouragement of academic patent behavior.

As seen in figure 3. (p. 26), the cognitive demonstration of individual beliefs result in an attitude, subjective norm and perceived behavioral control that determine the propensity to engage in academic patent behavior. It couldn't be proven but it seems that the more favorable the personal attitude, the more empowering social norms and the greater the perceived behavioral control the higher the propensity to engage in academic patent behavior. It is good to claim that the relative importance of these three determinants need to be estimated. To exploit inventive academic research via (worthwhile)

patents as entrepreneurial university, academics must engage in academic patent behavior. One could carefully say there is engagement in academic patent behavior if:

- academics feel capable to realize patents from research (i.e. control beliefs);
- academics feel empowered to realize patents from research (i.e. normative beliefs)
- academics perceive that realization of patents from research is worthwhile (positive vs. negative consequences) for them or others (i.e. outcome beliefs);
- academics perceive an effective, coordinated and aligned context (university-wide, TTO and department) oriented towards the realization of patents from research:
    - academics are educated and informed to establish or increase awareness about patents, patent information, patenting, patent (portfolio) success and patent benefits within the academic context;
    - the realization of patents from research is sufficiently enabled by minimizing the barriers and obstacles and improving the ease and present support by which this can be done;
    - the realization of patents from research is encouraged, clearly expected and sufficiently and adequately extrinsically and intrinsically stimulated.

It is good to point out that organizational context influence to what degree academics feel capable, feel empowered and perceive worthwhileness regarding the realization of patents from research.

6.2 Academic Implications

This research acts upon gaps in knowledge (1) as it is one of the limited studies that have tackled the phenomenon of academic patenting from the inventor-level of analysis (Azoulay et al, 2007) and (2) as it builds upon previous studies that identified some individual and organization aspects that correlated with patent production within academia (a.o. Huang et al., 2011). It is positioned within the domain of IP management science which intends to get a better understanding on how to create the right conditions to convert results of R&D into worthwhile IPRs as effectively and efficiently as possible. By means of this explorative research we are able to:

- validate the academic patent behavior concept which is built on a process-oriented notion to operationalize it and identify specific steps within this process;
- opening up the psychological black box on how academic's propensity to engage in academic patent behavior is formed (by application and validation of the theory of planned behavior for academic patent behavior) and visualize the formation of this propensity in a conceptual process model which links individual and contextual factors to academic patent behavior which was demanded as future research (Moutinho et al., 2007);
- have first careful insights on what perceived organizational and individual factors could enlarge and reduce the propensity of 4TU academics to engage in academic patent behavior;
- construct a survey instrument for further (quantitative) research on academics' propensity to engage in academic patent behavior.

6.3 Practical Implications

This section considers how this research can improve business and societal outcomes. It has practical implications for universities' administration, TTOs, departmental managers and academic researchers.

Implications for universities' administration

To live up to "the third task" it seems necessary to consider how academics form their intention to engage in patent behavior at university. Insight into the psychology and considerations of academics regarding engagement in academic patent behavior could help to develop new policy instruments or provide a basis for making policy recommendations. Based on the discovered organizational factors in this research policy makers and managers could evaluate and possibly improve relevant conditions on different organizational levels to increase facilitation and stimulation and reduce hindrance and discouragement of academic patent behavior. After all, the function of IP management within academia is to create the right conditions such that the generation of worthwhile patents through academics is sufficiently and adequately enabled, supported, guided and stimulated and misappropriation or non-

appropriation of commercially attractive academic inventions is reduced (to a zero point). Relevant matters that could be considered on a university-wide-level are:

- Consistent and clear communication of administration's expectation to realize worthwhile patents from research;
- University's mission statement clearly stating the importance of academic patenting and translate this to policies, practices and daily operations;
- Consistent and clear communication about university's patent regulations and royalty sharing arrangement to create awareness among academic researchers about it;
- Effectiveness of the internal patent procedure to facilitate the realization of patents;
- Effectiveness of the royalty sharing arrangement to stimulate the realization of patents. Policy makers often assume that academics are only sensitive to financial incentives provided by a royalty sharing agreement related to the exploitation of generated knowledge and inventions. This study showed that academics are not (only) motivated by money which implies that royalty sharing may not or less effective in stimulating academic patent behavior. In addition to expected distributed royalty income when a patent is exploited, several (direct) incentives and rewards (on departmental-level) should be in place to increase the likelihood of realizing patents by academics.
- Creation of conditions that provoke and maintain academics' intrinsic motivation for engagement in academic patent behavior.
- Emphasizing of university's patent (portfolio) success to create a positive patent reputation;
- Ways (e.g. yearly prizes) to put academic patentees in the spot lights internally and externally to provide them with desired visibility and recognition;

Implications for TTOs

This research provides insight on how academics take the decision to enable and interact with the TTO at or connected to the university to pursue the realization of a patent. Academic researchers do this based on their perception of TTO effectiveness (based on Huang et al., 2011) which is captured by perceived TTO professionalism (visibility, high quality service, capacity, etc.), perceived TTO barriers (bureaucracy, discomfort, unfairness, etc.) and perceived TTO income drive (required commercial relevance, covering patent costs, performance to generate income or create value). These constructs help TTOs to evaluate themselves or let them be evaluated by academics which could possible improve TTO professionalism, lower TTO barriers and optimize TTO income drive. This could result in more invention disclosures, lower bypassing of the TTO and more and better involvement in patent procedures by academics.

Implications for departmental managers

This research could help departmental managers to understand how the department and supervisors can cultivate and foster academic patent behavior by means of:

- shaping a departmental culture that values the realization of patents;
- organizing sufficient and adequate departmental support for the realization of patents;
- lowering departmental hindrance for the realization of patents;
- implementing fair, sufficient and valued rewards on a departmental-level.

A strong climate oriented towards the realization of patents could be created within the department such that academic researchers (1) understand that academic patent behavior is appropriate and desired within the direct work environment and (2) form a collective sense of support, expectations and rewards on a departmental-level regarding academic patent behavior.

Implications for academic researchers and inventors

This research could help to establish or increase awareness among academic researchers and inventors about patents and patenting, the necessary capabilities and resources to realize a patent, available internal and external support regarding the realization of patents, possible hindrance regarding the realization of patents and possible intrinsic and extrinsic outcomes of academic patenting. This could

enable academics to form informed perceptions about the possible outcomes, perceived behavioral control and the organizational context regarding academic patent behavior.

6.4 Limitations

Limitations within research come from either the decisions that are made during the research process or things that cannot be influenced such that we had to live with them. This sections describes the limitations that came with setting the research question, research design, literature study, data collection and data analysis.

Setting the research question

This research focused on discovering perceived organizational and individual factors that influence the propensity to 4TU academics to engage in academic patent behavior. This brings multiple limitations as the study focuses on:

- the propensity to engage in academic patent behavior and not academic patent production;
- the perception and beliefs of academics (academic-level of analysis);
- an academic context and not industry;
- a Dutch 4TU context and not all Dutch universities;
- organizational and individual factors and not including inter-organizational and institutional factors.

It is assumed that academics make conscious and rational choices about how to act in their work, especially about patent behavior as it is under volitional control and academics possess high discretion despite rules and regulations. The conceptual model has no predictive value, but is a representation and suggestion to show and explain how academics form their intention to engage in academic patent behavior.

Research design

As the research has an explorative and qualitative character it is possible to come to first careful insights regarding engagement in academic patent behavior. Although it is not possible to statistically test relationships and generalize empirical results from a sample to a wider population.

Literature study

Scientific literature on academic patenting on an academic-level of analysis is limited. Therefore, it was also useful to identify complementary literature on impact factors for technology transfer, academic entrepreneurialism and research commercialization.

Data collection

Semi-structured interviews provided an adequate balance between guidance and flexibility to collect relevant and rich data from academics. With helps of literature and two “experts” self-formulated questions were reviewed to make sure that they are logical and understandable and address the things that needed to be addressed. Semi-structured interviews may lack some consistency and reliability, because the executive researcher could ask different questions and apply different probes. The executive researcher was aware of this and tried to be consistent as possible by following the interview protocol and only deviated when this was desirable with the goal of increasing the validity and richness of data. Besides this there were three other possible biases:

- participants not honestly speaking their minds, although the executive researcher has done everything possible to create and maintain a comfortable and confidential interview context;
- the executive researcher could not control for present participants’ emotions, needs and feelings at the interviews which could possibly influence perceived perceptions and beliefs;
- the influence of the executive researcher on the responses of the participants with his questions or attitude, although the executive researcher has done everything possible to ask the right questions in the right way and show “empathic neutrality” in word and attitude. To increase objectiveness, reduce the impact of assumptions and be ready for surprises the executive researcher took some distance from the research before the interviews.

Data analysis

Qualitative data processing is as much art as science and there is not a pre-scribed way that guarantees success. As no pre-existing theoretical frameworks (with coding schemes) exist the codes were suggested by the executive researcher's examination and questioning of the data in combination with indications from existing literature. As coding is done by the executive researcher only there are some biases which could reduce credibility and trustworthiness of interpretations and results, although reflective memos and informal discussion which respondents was used. In future research coding could be checked by a random person skilled in qualitative analysis but blind to patenting as complementary measure.

6.5 Suggestions for Future Research

There are a number of gaps in our knowledge around (academic) patent behavior which would benefit from additional attention in the form of further research:

1. Studies with an quantitative character on the impact of perceived organizational (i.e. university-wide, TTO and departmental) and individual (i.e. perceived behavioral control, patent awareness, patenting outcomes and personal background) factors on the propensity to engage in academic patent behavior among 4TU academics to statistically test relationships and generalize empirical results from a sample to a wider population. Insight in the propensity could complement limited research that helps to explain variation of patent production among: university (research) departments within universities, universities of technology within the 4TU.federation, universities within a country or universities from different countries or universities and other public research organizations (e.g. TNO).
2. Studies on the propensity to engage in patent behavior on an employee-level within an industrial R&D context in which the patent behavior process may be different (due to different organizational motives, structures, cultures and procedures) and impact factors for it may differ or vary in their effect. Could be interesting to contrast these findings with the findings from the academic context.
3. Studies on adding more relevant factors to the conceptual model in this study with the goal to better explain academics' propensity to engage in academic patent behavior: institutional-level (e.g. national culture), inter-organizational-level (e.g. strategic partner characteristics) or individual-level like personality traits (e.g. risk-attitude).
4. Studies on suitable organizational systems for (academic) patent behavior in *content* and *process*. This entails the development of IP policy and regulations by university administration, implementation of IP practices by the TTO and department management and execution of IP tasks by academics. Ideally, all policies, regulations, practices and operational tasks concerning (potential) IP are organized in an effective, aligned and coordinated manner towards a climate for patenting to foster engagement in (academic) patent behavior.
5. Studies on the mechanisms for appreciation and appropriation of inventive output in (public) research organizations. Besides that, it could be studied to which extent inventions are lost for commercial exploitation because of non- or misappropriation practices in (public) research organizations (Van Reekum, 2006). This study could give input to that regarding insufficient facilitation or stimulation and present hindrance or discouragement.

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Appendices

Appendix 1 – Relevant Points Regarding Patent Regulations of 4TU Universities

General aspects

- employees of the universities are obliged to adhere to what the employer reasonably determines with respect to the patent law;
- executive boards of universities adopt patent regulations with due observance of legal provisions and attach great value to the responsible development and exploitation of academic research (results);
- patent regulations apply to all inventions done by employees of the university within, during or in conjunction with their (research) work (also called academic inventions);
- an inventor is a person who contributed intellectually to the invention. A person who performs experiments, provides support or makes the research possible by financial means is not an (co-)inventor. In case of multiple inventors, the contribution of every inventor could be stated in percentage which influences the potential personal compensation;
- patent regulations aim at protecting academic inventions and licensing and transferring patent rights to a market party to optimize valorization. Revenues are intended to enable further and new academic research and development;
- a patent fund is established to finance patent applications, patent maintenance fees and further related costs;
- executive board mandates financing of patent applications from the patent fund and administration and exploitation of a patent (application) financed from the patent fund to a TTO in compliance with the adopted patent regulations;
- a TTO has the responsibility to collaborate with relevant stakeholders to provoke interest of one or more parties to exploit the patent (application).

Invention disclosure

- reliance is placed on employee's competence and engagement to identify, judge and disclose patentable academic inventions;
- university's employees have the duty to internally disclose the academic invention on which a patent can be obtained (according to the judgement of the inventor) to the TTO and the faculty/research institute while not disclosing the invention in the public domain (e.g. academic publication, oral presentation or online post);
- adequate disclosure means submission of necessary information including a clear explanation of the invention, its patentability and ideas for commercialization. Standardized invention disclosure forms are used to elicit the necessary information that is important for making a patent application decision and preparing a patent application.

Transfer and retention of rights

- a contract with third parties should contain a paragraph which determines the allocation of IP rights;
- inventions done by employees of the university within, during or in conjunction with their research work are (partly) entitled to the university which means that when the TTO claims the rights to the disclosed invention the inventor transfers the rights to the university;
- by timely and adequate invention disclosure the TTO is enabled to make patent decisions within a period to be determined and within the framework of the fulfillment of its and university's statutory tasks (application for legal protection and/or planning for exploitation);
- further, inventor is expected to, to the best of its ability, support patent application and patent exploitation on request of the TTO/university;
- TTO's decision to finance and doing a patent application is based on TTO's evaluation if the disclosed invention is likely to lead to a successful patent application and if there is a compelling business case in which a patent (application) can be exploited;

- when the TTO refuses a patent application the faculty/research institute has the right to apply for a patent for its own benefit, expense and risk;
- when the faculty/research institute refuses a patent application the inventor could request the TTO to return the right to apply for a patent and to exploit patent rights privately for own benefit, expense and risk. With as consequence that the inventor owes a substantial amount of money to the university as the investments done by the university to create the invention come at the expense of the inventor;
- except in cases where important interests of the university oppose this, the inventor is entitled to not comply with the request to disclose and transfer the rights to the university. With as consequence that the inventor owes a substantial amount of money to the university as the investments done by the university to create the invention come at the expense of the inventor.

Financial arrangements

- a contract with third parties should contain a paragraph which determines the sharing of costs and/or revenues around IP (rights);
- when the TTO claims the rights to the disclosed invention the inventor transfers the rights to the university, although the inventor has a right on a reasonable monetary compensation caused by the lack of ownership of the patent;
- revenues received by the university based on the commercial exploitation of an academic patent is distributed according the following principles:
    - the patent and marketing costs incurred which are financed by the inventor, patent fund or the faculty/research institute are deducted from the received revenues;
    - possible remaining revenues are equally divided between the inventor(s) that are written on the invention disclosure form (33 1/3 %), the faculty/research institute at which the inventor(s) worked when the invention was done (33 1/3 %) and the patent fund of the university (33 1/3 %).

Appendix 2 – Measurement Constructs for Formulating Interview Questions

Domain	Relevant Measurement Constructs	
Engagement in patent behavior	- academic patent(ing) objections (Q4) - approach having in mind when identifying an invention within research (Q5) - patent experience (Q6) - experience to not patent deliberately (Q7)	
Organizational -level	*University-wide*	- perceived organizational expectation (Q8) - patent regulations (procedure, royalty sharing…) (Q9) - patent reputation (Q10) - university-wide climate impact on intention (Q11)
	TTO	- awareness and function (Q12) - benefits (Q13) and problems/limitations (Q14) - perceived effectiveness to facilitate and belief impact on intention (Q15)
	Department	- culture (Q16) - support and/or hindrance (Q17) - evaluation and reward supervisor (Q18) - departmental climate impact on intention (Q19)
Individual-level	*Enablement*	- autonomy (Q20) - in combination with other job duties (Q21) - (expected) difficulties and related possible solutions (Q22) - personal belief in own capability and belief impact on intention (Q23) - conditions to facilitate (Q24)
	Motivation	- intrinsic (un)desirability of patenting itself (Q25) - influence on dissemination and publication (Q26) - influence on organization of research (Q27) - influence on funding of research (Q28) - influence on interaction with industry and other institutions (Q29) - influence on recognition and reputation (Q30) - influence on income (Q31) - influence on promotion/career/start-up opportunities (Q32) - conditions to stimulate (Q33)

Appendix 3 – Interview Protocol

Personal introduction

My name is Marc Pijffers and this interview is part of data collection within my master thesis project. I do a double master degree program that consist of

- a MSc in Business Administration at the University of Twente;
- a MSc Innovation Management and Entrepreneurship at the University of Technology Berlin.

Introduction of research

Valorization by means of patenting, technology transfer and spin-off is a third mission for universities to enable and stimulate further academic research, establish linkages with the business community and translate academic knowledge into valuable innovations and business. When considering practice academic research regularly results in new (fundamental) technological developments and inventions that could be commercially exploited due to new relevant industrial applications. Legal protection of developed technologies by means of granted patents ensure that universities are able to market the right to their inventions and make it more attractive for market parties to exploit academic inventions.

Research purpose

Following current policy much reliance is placed on academics' competence and engagement to identify and disclose potential patentable inventions while they are expected to, to the best of their ability, support patenting (and patent exploitation). The purpose of the study is to discover which perceived organizational and individual factors influence the propensity of academic researchers to engage in patent behavior: undertaking of all individual actions directed at the realization of a (potential) patent[17] from research within an academic context.

Interview goal

The goal of the interview is to discover your beliefs, perceptions and experiences and how this influences the propensity to engage in patent behavior. You can speak freely and provide honest answers. Please tell if you don't want to answer or don't know what to answer. That's no problem, don't feel ashamed.

Interview language

This interview will be done in English.

Interview duration

Approximate duration of the interview meeting: 70 min.

Confidentiality and anonymity

I respect the confidentiality of collected data and guarantee your anonymity as participant to anyone other than the executed researcher.

Recording

I would like to record this interview; do you give permission for that? The voice recordings will be transcribed by myself and used for analysis. Besides that, I will take some side-notes.

[17] "A patent is an exclusive registered right to prevent others from commercially making, using, selling or distributing the patented technological invention without permission of the patent owner within a territory and a limited amount of time (max. 20 years)." (WIPO definition)

Participant rights

You are not required to answer and if there is something feel free to ask. You will reserve the right to terminate your participation in this research at any time without giving a reason and without suffering negative consequences.

THE INFORMED CONSENT FORM NEEDS TO BE SIGNED IN DUPLICATE NOW.

Interview structure

The structure of the interview:

1. Personal background
2. Engagement in patent behavior
3. Organizational-level
    1. University-wide
    2. Technology transfer office (TTO)
    3. Department
4. Individual-level
    1. Enablement
    2. Motivation
5. End

Then the interview starts now.

START THE RECORDING DEVICE NOW.

1. Personal Background

Q1 - What is your formal function at university? What are the main duties?

Q2 - To which department do you belong?

Q3 - What is your main research field? How is your research funded?

2. Engagement in patent behavior

Q4 - To what degree do you object to scientists' engagement in realizing patents?

Q5 - *Suppose you identified an invention within your research.* Could you shortly describe what you would do next?

Q6 - To what degree did you engage in actions to realize a patent till now? Could you tell me more about your experience?

Q7 - Did you ever deliberately not patent an academic invention at university?

3. Organizational-level

3.1 University-wide

Q8 - To what extent do you perceive that the university expects you to patent? How was this perception formed?

Q9 - To what degree do you perceive university's formulated patent regulations as effective in *facilitating* and *stimulating* patent behavior?

Q10 - To what degree do you perceive your university as successful in patenting?

Q11 - How university-wide climate influence your intention to realize a patent?

3.2 Technology transfer office

Q12 - Are you aware of a technology transfer/ valorization office at your university? If yes, what is its main function?

Q13 - What are (expected) benefits of interacting with this office regarding the realization of a patent?

Q14 - What are (expected) problems/limitations of interacting with this office regarding the realization of a patent?

Q15 - To what degree do you perceive this office as effective in *facilitating* patent behavior? How does this perception influence your intention to realize a patent?

3.3 Departmental

Q16 - To what degree do you feel (social) pressure in your direct work environment to engage in patent behavior?

Q17 - How is patent behavior *supported* and/or *hindered* in your direct work environment?

Q18 - How is patent behavior *evaluated* and *rewarded* by your supervisor?

Q19 - How does departmental climate influence your intention to realize a patent?

4. Individual-level

4.1 Enablement

Q20 - To what degree do you feel free to decide yourself to take actions in realizing a patent?

Q21 - To what degree would it be possible to realize a patent in combination with other duties (teaching, consultancy, research and publication) in your job?

Q22 - What main difficulties would you expect in realizing a patent at university?

Q23 - If the possibility was there in your current situation, to what degree would you be capable to realize a patent?

Q24 - To your opinion, which conditions must be in place to facilitate/enable patent behavior at university?

4.2 Motivation

Q25 - How would the activity *in itself* of realizing a patent be likeable/desirable for yourself?

Q26 - How would realizing a patent influence the dissemination and publication of knowledge that underlines an academic invention?

Q27 - How would realizing a patent influence your future research activity/directions?

Q28 - How would realizing a patent influence the funding/support for your research?

Q29 - How would realizing a patent influence your interactions with industry and other institutions?

Q30 - How would realizing a patent influence your recognition and reputation?

Q31 - How would realizing a patent influence your income and wealth?

Q32 - How would realizing a patent influence your opportunities in your career and life?

Q33 - To your opinion, which conditions must be in place to stimulate/incentivize patent behavior at a university?

5. End

Anything I haven't covered you feel is important?

Thank you for having me. I really appreciate your participation in my master thesis project.

If I have further questions for clarification or elaboration. May I contact you again?

When you have questions for me, now or in the future, feel free to contact me.

Appendix 4 – The Survey Instrument

Survey

Propensity to engage in patent behavior among 4TU academic researchers

Welcome to this survey.

Thank you for agreeing to take part in this survey about patent behavior among academic researchers that work at one of the four Dutch universities of technology (TU Delft, TU Eindhoven, University of Twente and Wageningen University & Research). Previous patent(ing) experience is not necessary.

Valorization by means of patenting, technology transfer and spin-off is a third mission for Dutch universities of technology to make a socio-economic contribution to society. Following current policies much reliance is placed on academics' competence and engagement to identify and disclose potential patentable inventions while they are expected to, to the best of their ability, support patent procedures (and patent exploitation).

Aim is to discover which organizational and individual factors influence the propensity to engage in patent behavior among academic researchers – *people like you*. Therefore I would like you to ask to fill out this questionnaire to discover your beliefs, perceptions and experiences and how these influence the propensity to engage in patent behavior within your work situation at university.

The survey takes (x) min. to complete.

Be assured that all responses are anonymous, will be handled confidentially and will be shown only on an aggregated level. Please fill in all the questions before moving on to the next page.

Thanks in advance for filling out the questionnaire.

1. Personal Background

1.1 Personal characteristics

What is your gender?

□ *Man* □ *Woman* □ *Other:*

What is your age?

Fill out number of years

What are your nationalities?

1. Select first

2. Select possible second

1.2 Current work

For which Dutch university of technology do you (mainly) work?

□ *TU Delft* □ *TU Eindhoven* □ *University of Twente* □ *Wageningen University & Research*

For which department do your work?

Fill-out name

What is your academic rank at university?

□ *PhD student* □ *Post doc* □ *Academic researcher/employee* □ *Assistant professor* □ *Associate professor* □ *Full professor* □ *Other:*

Do you have a permanent or non-permanent contract?

□ *Permanent contract* □ *Non-permanent contract*

Do you have a full-time or part-time job?

□ *Full-time* □ *Part-time*

How much time (in percentage of 100%) do you spent on the following possible work activities:

Administration	%
Teaching	%
Research	%
Publishing	%
Patenting	%
Industry interactions (e.g. consultancy, contract education)	%
Research commercialization (e.g. licensing IP)	%
Spin-off	%
Other:	%
Other:	%

1.3 Current research

What is your field of science?

□ *Life science* □ *Physical science* □ *Other:*

What is your scientific discipline (e.g. nanotechnology, chemical engineering)?

Fill-out name

Patenting is important in my scientific discipline

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Don't know*

I perceive opportunities to develop (technological) inventions that could be patented from your research?

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Don't know*

I perceive opportunities for commercial exploitation of my research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Don't know*

What is the total amount of received funding for the research you are involved?

Fill out number of euros

What is the approximate percentage of your research funding that comes from industry?

Fill out number %

What is the approximate percentage of your research funding that comes from the government or government agencies?

Fill out number %

If so, what type of public funds for research do you receive? Just select one or multiple types.

□ *Type 1: direct government contribution to perform statutory obligations in the field of education, research and knowledge valorization.*

□ *Type 2: grants from the Dutch Organization for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW).*

□ *Type 3: additional income as contract research/education, business income, collecting box funds and subsidies from the ministries and EU.*

Does your research involve (strategic) partnerships with industry?

□ *Yes* □ *No*

1.4 Personal experience

What is your highest received educational qualification?

□ *Bachelor degree* □ *Master degree* □ *Executive master degree* □ *PhD* □ *Other:*

Did you get education about patenting and patents?

□ *Yes* □ *No* □ *Unsure*

How long are you engaged in academic research?

Fill out the number of years

Do you have patent experience (involved in a patent procedure)?

□ *Yes* □ *No*

Do you have corporate experience (worked in a large organization in the industry)?

□ *Yes* □ *No*

Did you engage in the following industry interaction activities as academic in the last 10 years?

Contract research	□ *Yes* □ *No* □ *Unsure*
Contract education	□ *Yes* □ *No* □ *Unsure*
Consultancy	□ *Yes* □ *No* □ *Unsure*
Collaborative projects	□ *Yes* □ *No* □ *Unsure*
Partnerships	□ *Yes* □ *No* □ *Unsure*
Patent sale/licensing	□ *Yes* □ *No* □ *Unsure*
Spin-off formation	□ *Yes* □ *No* □ *Unsure*

2. Engagement in academic patent behavior

Academic patent behavior is defined as all individual actions directed at the realization of a (potential) patent from research with an academic context. The World Intellectual Property Organization (WIPO) defines a patent as “an exclusive registered right to prevent others from commercially making, using, selling or distributing the patented technological invention without permission of the patent owner within a territory and a limited amount of time (max. 20 years).”

2.1 Individual patent awareness

I have sufficient knowledge about patent law.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I have sufficient knowledge about patent procedures

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I make use of patent documents.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I am sufficiently aware of the functions of patents.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I am aware of and have sufficient knowledge about university’s patent regulations and royalty sharing agreement?

□ *Yes* □ *No* □ *Unsure*

2.2 Individual propensity to engage in academic patent behavior

Science and patenting at university go together.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

Patents are effective instruments to appropriate the benefits from an invention.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

What limits in your perception the effectiveness of patents?

□ A filing process that is too slow for the pace of innovation in an industry.

□ A bad working, partial or unjust judicial system.

□ Enforcement in court may be complex and long-lasting.

□ Difficulty to demonstrate novelty.

□ Difficulty to trace and prove infringements (e.g. patents protecting process inventions).

□ Exceptions to patentability.

□ Legally inventing around by competitors.

□ Low capacity to monitor infringement (e.g. SME or PRO).

□ Unequal possibilities to adequately enforce a patent (SME vs. corporate).

□ Low competence to exploit a patent.

□ Patent costs are too high to finance.

□ Patent costs don't outweigh the benefits.

□ Possibility that patents may be challenged and invalidated in court (as a patent provides a right to exclude others).

□ Malicious practices of patent trolls.

□ Revealing to much valuable know-how caused by requirements for disclosure.

□ Too much weak patents, because of the high propensity of patent authorities to grant patents.

□ Other:

The more worthwhile (i.e. positive vs. negative outcomes) the realization of a patent from research is the more I am willing to try and put effort to realize it.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

Realizing a patent from research at my university is worthwhile (i.e. personal benefits outweigh personal cost) for myself.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I am motivated to realize a patent from research if the opportunity is there.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

What is your perceived propensity to do an (internal) invention disclosure?

□ *Low* □ *Moderate* □ *High* □ *Unsure*

What is your perceived propensity to be involved in a patent procedure to realize a patent from research?

□ *Low* □ *Moderate* □ *High* □ *Unsure*

In general what is your propensity to take individual actions directed at the realization of a patent from research?

□ *Low* □ *Moderate* □ *High* □ *Unsure*

What would you do when realizing a patent from research is worthwhile for you? Select the answer that best suits your behavioral response.

A. Not disclosing the invention internally and no further involvement in the exploitation of it.
B. Not disclosing the invention internally but involved in other ways (than patenting) to exploit it.
C. Disclosing the invention internally but no involvement in patenting.
D. Disclosing the invention internally and being involved only in other ways (than patenting) to exploit it.
E. Disclosing the invention internally and being involved in patenting.

What would you do when realizing a patent from research is not worthwhile for you? Select the answer that best suits your behavioral response.

A. Not disclosing the invention internally and no further involvement in the exploitation of it.
B. Not disclosing the invention internally but being involved in other ways (than patenting) to exploit it.
C. Disclosing the invention internally but no involvement in patenting.
D. Disclosing the invention internally and being involved only in other ways (than patenting) to exploit it.
E. Disclosing the invention internally and being involved in patenting.

2.3 Individual production

App. total amount of invention done (by which you helped to develop)

Fill out number

App. total amount of internal invention disclosures done (in which you are named as inventor or co-inventor).

Fill out number

App. total amount of filed patent applications (in which you are named as inventor or co-inventor).

Fill out number

App. total amount of granted patents (in which you are named as inventor or co-inventor).

Fill out number

App. total amount of granted patents (in which you are named as inventor or co-inventor) that are exploited (i.e. licensed, sold or spin-off formation).

Fill out number

What is the app. total number of published articles in scientific journals as author or co-author?

Fill out number

2.4 Individual knowledge valorization

To what degree are you willing to become involved in the exploitation of generated academic knowledge?

□ *Low willingness* □ *Moderate willingness* □ *High willingness* □ *Unsure*

To which degree do you prefer to exploit generated academic knowledge by the following means?

Secrecy	□ *Low preference* □ *Moderate preference* □ *High preference* □ *Unsure*
(Scientific) publication	□ *Low preference* □ *Moderate preference* □ *High preference* □ *Unsure*
Contract education	□ *Low preference* □ *Moderate preference* □ *High preference* □ *Unsure*
Consultancy	□ *Low preference* □ *Moderate preference* □ *High preference* □ *Unsure*
Collaborative projects	□ *Low preference* □ *Moderate preference* □ *High preference* □ *Unsure*
Partnerships	□ *Low preference* □ *Moderate preference* □ *High preference* □ *Unsure*
Patent (exploitation)	□ *Low preference* □ *Moderate preference* □ *High preference* □ *Unsure*
Spin-off formation	□ *Low preference* □ *Moderate preference* □ *High preference* □ *Unsure*

3. Relevant organizational factors

3.1 University-wide

University administration expects me to realize patents out of research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

University's mission statement justifies and provokes the realization of patents from research by academics.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

University's formulated procedure for invention disclosure and patenting are effective in facilitating the realization of patents from research by academics.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

University's formulated arrangement to distribute patent income is effective in stimulating the realization of patents from research by academics.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

My university is successful at the realization of patents from research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

When I realize patents from research it provides substantive benefits to my university.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

My university has an organizational climate directed at the realization of patents from research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

What would you do when the realization of patents from research is not (sufficiently) fostered by the university? Select the answer that best suits your behavioral response.

A. Not disclosing the invention internally and no further involvement in the exploitation of it.
B. Not disclosing the invention internally but being involved in other ways (than patenting) to exploit it.
C. Disclosing the invention internally but no involvement in patenting.
D. Disclosing the invention internally and being involved only in other ways (than patenting) to exploit it.
E. Disclosing the invention internally and being involved in patenting.

3.2 Technology transfer office (TTO) at or connected to university

A **TTO** is mandated to take patent decisions and charged with the implementation of university's IP policy and patent regulations as it is a formal organizational unit, agent or center responsible for and facilitating the identification, evaluation, protection and exploitation of knowledge generated from the university (e.g. Thursby et al., 2001).

3.2.1 Perceived effectiveness

The TTO is effective in facilitating invention disclosure.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO is effective in facilitating academics to be involved in a patent procedure.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

Enabling and interacting with the TTO to pursue the realization of a patent from research is worthwhile.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

When cost outweigh the benefits of interacting with the TTO to realize a patent from research what would you do? Select the answer that best suits your behavioral response.

A. Not disclosing the invention internally and no further involvement in the exploitation of it.
B. Not disclosing the invention internally but being involved in other ways (than patenting) to exploit it.
C. Disclosing the invention internally but no involvement in patenting.
D. Disclosing the invention internally and being involved only in other ways (than patenting) to exploit it.
E. Disclosing the invention internally and being involved in patenting.

3.2.2 Perceived professionalism

The TTO is visible within the university community.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO provides high quality education, advice and assistance to academics regarding invention disclosure and patenting.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO has sufficient capacity to handle invention disclosures and patent procedures.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO has sufficient competence to consider invention disclosures (to make an adequate patent decision).

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO has sufficient access to external parties that could provide effective support for doing an effective patent application.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

3.2.3 Perceived barriers

It is difficult to interact with the TTO.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I perceive misunderstandings with the TTO.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO is a bureaucratic organization.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO takes unfair (patent) decisions (e.g. only interested in certain mature, profitable and patent-friendly disciplines).

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

3.2.4 Perceived income drive

The TTO requires the inventor to provide possible commercial opportunities regarding a patent (application).

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO only patents an invention when there is sight on a viable and attractive business case regarding the exploitation of the patent (application).

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO is willing to cover all costs to realize a patent.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

What would you preferably do when the TTO decides to not fund and apply for a patent on behalf of the university? Select the answer that best suits your behavioral response.

A. I would ask university's administration to intervene and make an exception.
B. I would ask the decision makers at my department to help me to patent the invention.
C. I would request approval at the TTO to patent the invention with industry partners.
D. I would request approval at the TTO to patent the invention at my own cost and risk.
E. I would exploit the generated knowledge/invention by quick scientific publication to establish priority, contract education or consultancy.
F. I wouldn't do anything.

The TTO has the competence and motivation to generate income (e.g. licensing) from patents.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The TTO has the competence and motivation to create business value (e.g. formation of spin-off) with patents.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

3.3 Department (direct work environment)

3.3.1 Perceived culture

My direct supervisor is positive about the realization of patents from research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The realization of patents as academic is an important indicator of scholarship in my department.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I feel social pressure in my direct work environment to realize patents from research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

There are colleagues in my direct work environment that patented or are patenting.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

3.3.2 Perceived support and hinder

The realization of patents is sufficiently supported by my direct work environment.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

In which ways is the realization of patents supported by your direct work environment? Please select. Multiple answers possible.

□ Provision of education (around patent law, use of patent documents, patent procedures and the functions of patents).

□ Provision of time and energy of colleagues to assist in administrative tasks.

□ Provision of patent knowledge by experienced colleagues or supervisor.

□ Provision of skills to consider commercial opportunities and attractiveness of the invention by colleagues or supervisor.

□ Encouragement and mental support of colleagues or supervisor.

□ Provision of access to colleagues' or supervisor's network.

□ Provision of financial resources (to cover patent costs).

□ Ensuring credibility from authoritative colleagues or supervisor to "sell the issue" to decision makers.

□ (In)formal power of colleagues or supervisor to influence decision making about patenting.

□ Other:

The realization of patents is hindered by my direct work environment.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

In which ways is the realization of patents hindered by your direct work environment? Please select. Multiple answers possible.

□ Lack of (complementary) knowledge and skills.

□ Lack of willingness or motivation to support.

□ Lack of capacity to support.

□ Conflict-seeking behavior of colleagues.

□ Counteraction of colleagues (e.g. exclusion).

□ Bad evaluation of colleagues.

□ Open science mentality within direct work environment.

□ Pressure to publish as fast as possible to generate quick income.

□ Discouragement of or forbidden by direct supervisor.

□ Other:

3.3.3 Perceived rewards

When I realize patents from research it provides substantive benefits to my department.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The realization of patents from research is part of my job assignment.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

The realization of patents from research is discussed at my job performance appraisal

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

How is behavior to realize patents stimulated at department-level? Taking action to realize a patent from research provides me with:

A positive impact on my job design (e.g. different tasks, more responsibility or more autonomy).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
A positive impact on my job security (e.g. lower possibility to get fired or contract extension).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
A positive impact on job performance (appraisal).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
An increase in the amount of research I am involved in at my department.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Access to high quality research at my department.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Freedom to choose my own research.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
A one-time gratification.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Structural salary increase.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
More resources, training and facilities for executing my research.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Recognition and appreciation for inventive achievement.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
An improvement of my relationship with my colleagues.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
An improvement of my relationship with my direct supervisor.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Feelings of keeping up with (patenting) colleagues.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Feelings of outperforming colleagues.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
An increase in credibility within my department.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
An improvement of my personal reputation within the department.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
An increase in my informal power within the department.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

3.3.4 Perceived climate

My department has an organizational climate directed at the realization of patents from research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

What would you do when the realization of patents from research is not (sufficiently) fostered at department-level? Select the answer that best suits your behavioral response.

A. Not disclosing the invention internally and no further involvement in the exploitation of it.
B. Not disclosing the invention internally but being involved in other ways (than patenting) to exploit it.
C. Disclosing the invention internally but no involvement in patenting.
D. Disclosing the invention internally and being involved only in other ways (than patenting) to exploit it.
E. Disclosing the invention internally and being involved in patenting.

4. Relevant individual factors

4.1 Perceived behavioral control to realize a patent

I have to ask formal approval when I want to do an invention disclosure and be involved in a patent procedure.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I have enough time resource to take actions to realize a patent from research within my work.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I am sufficiently flexible to handle different duties and interests that come with education, research and patenting.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I am in a position (rank/reputation) to take actions to realize a patent from research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I am capable of determining the patentability of an invention.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I am capable of determining the commercial opportunities and attractiveness of an invention.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I am capable to write down a patent application.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I am capable to handle a patent procedure.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I need support to realize a patent from research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I have access to (complementary) external support (agents, experts or attorneys).

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

I have access to financial resources (e.g. industry partner, patent fund or investor) to realize a patent from research.

□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

What would you do when you perceive that you are not capable to realize a patent from research? Select the answer that best suits your behavioral response.

A. Not disclosing the invention internally and no further involvement in the exploitation of it.
B. Not disclosing the invention internally but being involved in other ways (than patenting) to exploit it.
C. Disclosing the invention internally but no involvement in patenting.
D. Disclosing the invention internally and being involved only in other ways (than patenting) to exploit it.
E. Disclosing the invention internally and being involved in patenting.

4.2 Perceived outcomes of academic patenting

4.2.1 Intrinsic outcomes of academic patenting

Feelings of doing good (e.g. patent benefits for the department, university or society).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Feelings of satisfaction by "solving the puzzle" to realize a patent out of research.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Feelings of keeping the duty to valorize academic knowledge as third task of universities.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Feelings of meaningfulness.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Feelings of validation of personal competence.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Feelings of personal development & growth.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

4.2.2 Extrinsic outcomes of academic patenting

4.2.2.1 Impact on knowledge protection/dissemination

Support the validation of the invention that came out of research.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Protects the invention (from predatory behavior) to appropriate the benefits from an invention.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Handle in compliance with contracts with strategic partners to protect an invention.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Restricts free communication with colleagues and peers.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Hinders the publication/dissemination of knowledge that underlines an invention (as it possibly requests secrecy and withholding of data).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Has a positive impact on scientific publication about executed research.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

4.2.2.2 Impact on organization of research

Provides freedom to choose my own research.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Enables and stimulates development of further/new research.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Helps to increase the amount of research I am involved in.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Puts less priority on basic research and directs research to areas that are more applied.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Directs research to areas that are more (financially) lucrative.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Reduces the quality of my research.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

4.2.2.3 Impact on funding of research

Helps to attract industry funding.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Helps to attract government/public funding.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Helps to attract internal funding.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

Helps to attract crowd funding.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Permits generating income/funds from exploiting the invention.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

4.2.2.4 Impacts on interactions with industry

Facilitates the development of collaborative R&D projects.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Signals competence and inventiveness to industry, helping to attract sponsored research.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Promotes consultancy and education activities in the industry.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Facilitates partnerships to gain access to the resources, knowledge, facilities and network of industry partners.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Facilitates the exploitation of the invention (by industry).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

4.2.2.5 Impact on society

Inspires others to patent (academic) research	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Facilitates the dissemination of the knowledge and invention, bringing it to societal use.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Facilitates the setting of important (industry) standards.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Promote advancement of technology by inspiring circum- and inventiveness.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Help to appropriate returns to public research activity/investment.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides opportunities to innovate and grow to existing businesses.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Facilitates the formation of start-ups.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides jobs to society (in the long-term).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Facilitates higher industrial productivity.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

4.2.2.6 Impact on personal well-being

Creates unbearable stress.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Creates conflicts of time.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Creates conflicts of commitment and interests.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Creates conflicts with the direct work environment	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Creates conflicts with scientific peers.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Creates conflicts with the university (TTO or administration).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Creates conflicts with the family.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with more awareness regarding patenting and patents.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with appreciation for inventive achievement.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Helps to establish priority as inventor to gain visibility and credit.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

Ensures recognition from scientific peers.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Improves my personal status and reputation.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Improves my personal network.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Positive impact on my job (e.g. more autonomy, responsibility or security).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Positive impact on job performance (appraisal).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with feelings of keeping up with (patenting) colleagues.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with feelings of outperforming colleagues.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Increases my informal power within the department.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Improves the relationship with my colleagues.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Improves the relationship with my supervisor.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

4.2.2.7 Impact on personal welfare

Provides me with personal costs.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with direct monetary rewards (e.g. gratification or salary increase).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with distributed income from exploitation of an academic patent.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with promotion opportunities.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with career opportunities (offers from higher-ranked universities or industry).	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with opportunities to license-out the invention.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with opportunities to sell the invention.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Provides me with start-up opportunities by (exclusively) commercializing the invention myself.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*
Enables personal monetary gains in the long-term by capitalizing provided promotion, career and start-up opportunities.	□ *Strongly disagree* □ *Disagree* □ *Neither agree nor disagree* □ *Agree* □ *Strongly agree* □ *Unsure*

5. Perceived facilitation or hindrance of academic patent behavior

This part examines factors that makes it more or less easy for you (to take actions) to realize a paten from research. To what degree do the following factors facilitate or hinder you (to take actions) to realize a patent from research in your situation at university?

5.1 Organizational-level facilitation or hindrance

University's procedure of invention disclosure and patenting.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
Service and assistance offered by the TTO.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
Obstacles when interacting with the TTO (possible interaction problems, misunderstandings, bureaucracy and unfairness).	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
Support from the direct work environment.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
Obstruction in/from the direct work environment.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*

5.2 Individual-level facilitation or hindrance

5.2.1 Perceived behavioral control

My autonomy to do an invention disclosure and be involved in a patent procedure.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
My spare time resources available to me.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
My flexibility to handle different duties and interests.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
My position (rank/reputation).	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
My competence to determine the patentability of an invention.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
My competence to determine the commercial opportunities and attractiveness of an invention.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
My competence to write down a patent application.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
My competence to handle a patent procedure.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
My access to complementary external support.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*
My access to financial resources to cover patent costs.	□ *Very facilitating* □ *facilitating* □ *Neither facilitating nor hindering* □ *Hindering* □ *Very hindering* □ *Unsure*

Please write down what and how matters need to be improved to (further) facilitate the realization of patents from research by academics at your university.

6. Perceived stimulation or discouragement of academic patent behavior

This part examines factors that makes it more or less attractive for you (to take actions) to realize a patent from research. To what degree stimulate or discourage the following factors you (to take actions) to realize a patent from research in your situation at university?

6.1 Organizational-level stimulation or discouragement

Expectations from university's administration.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
University's mission statement.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
University's royalty sharing scheme.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
University's patenting reputation.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
The drive of the TTO to generate income or value from research/IP.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
The prevailing culture in the direct work environment.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Colleagues in the direct work environment that patent(ed).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Attitude of your direct supervisor.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Rewards on a departmental level.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

6.2 Individual-level stimulation or discouragement

6.2.1 Intrinsic outcomes of academic patenting

Feelings of doing good (e.g. patent benefits for the department, university or society).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Feelings of satisfaction by "solving the puzzle" to realize a patent out of research.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Feelings of keeping the duty to valorize academic knowledge as third task of universities.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Feelings of meaningfulness.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Feelings of validation of personal competence.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Feelings of personal development & growth.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

6.2.2 Extrinsic outcomes of academic patenting

6.2.2.1 Outcomes for knowledge protection/dissemination

Support the validation of the invention that came out of research.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Protects the invention (from predatory behavior) to appropriate the benefits from an invention.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Handle in compliance with contracts with strategic partners to protect an invention.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Restricts free communication with colleagues and peers.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

Hinders the publication/dissemination of knowledge that underlines an invention (as it possibly requests secrecy and withholding of data).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Has a positive impact on scientific publication about executed research.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

6.2.2.2 Outcomes for organization of research

Provides freedom to choose my own research.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Enables and stimulates development of further/new research.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Helps to increases the amount of research I am involved in.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Puts less priority on basic research and directs research to areas that are more applied.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Directs research to areas that are more (financially) lucrative.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Reduces the quality of my research.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

6.2.2.3 Outcomes for funding of research

Helps to attract industry funding.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Helps to attract government/public funding.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Helps to attract internal funding.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Helps to attract crowd funding.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Permits generating income/funds from exploiting the invention.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

6.2.2.4 Outcomes for interaction with industry

Facilitates the development of collaborative R&D projects.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Signals competence and inventiveness to industry, helping to attract sponsored research.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Promotes consultancy and education activities in the industry.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Facilitates partnerships to gain access to the resources, knowledge, facilities and network of industry partners.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Facilitates the exploitation of the invention (by industry).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

6.2.2.5 Outcomes for society

Inspires others to patent (academic) research	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Facilitates the dissemination of the knowledge and invention, bringing it to societal use.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Facilitates the setting of important (industry) standards.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Promote advancement of technology by inspiring circum- and inventiveness.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Helps to appropriate returns to public research activity/investment.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

Provides opportunities to innovate and grow to existing businesses.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Facilitates the formation of start-ups.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides jobs to society (in the long-term).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Facilitates higher industrial productivity.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

6.2.2.6 Outcomes for personal wellbeing

Creates unbearable stress.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Creates conflicts of time.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Creates conflicts of commitment and interests.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Creates conflicts with the direct work environment	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Creates conflicts with scientific peers.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Creates conflicts with the university (TTO or administration).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Creates conflicts with the family.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with more awareness regarding patenting and patents.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with appreciation for inventive achievement.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Helps to establish priority as inventor to gain visibility and credit.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Ensures recognition from scientific peers.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Improves my personal status and reputation.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Improves my personal network.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Positive impact on my job (e.g. more autonomy, responsibility or security).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Positive impact on job performance (appraisal).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with feelings of keeping up with patenting colleagues.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with feelings of outperforming colleagues.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Increase my informal power within the department.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Improves the relationship with my colleagues.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Improves the relationship with my supervisor.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

6.2.2.7 Outcomes for personal welfare

Provides me with personal costs.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with direct monetary rewards (e.g. gratification or salary increase).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with distributed income from exploitation of an academic patent.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with promotion opportunities.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

Provides me with career opportunities (offers from higher-ranked universities or industry).	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with opportunities to license-out the invention.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with opportunities to sell the invention.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Provides me with start-up opportunities by (exclusively) commercializing the invention myself.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*
Enables personal monetary gains in the long-term by capitalizing on provided promotion, career and start-up opportunities.	□ *Very stimulating* □ *Stimulating* □ *Neither stimulating nor discouraging* □ *Discouraging* □ *Very discouraging* □ *Unsure*

Please write down what and how matters need to be improved to (further) stimulate the realization of patents from research by academics at your university.

_____

_____

_____

_____

7. End

Anything I haven't covered you feel is important?

Please fill out.

Thank you for filling out the questionnaire. I really appreciate your participation in this research project.

Do you want to get a notification about the results of this research project?

□ *Yes: please fill out your email:* □ *No*

When you have questions for me, now or in the future, feel free to contact me.