Exploring the determinants of starting a firm by scientists

Name: Amalie Brødsgaard Jakobsen (5843162), MSc Innovation Sciences
Contact details: a.b.jakobsen2@students.uu.nl
Supervisor: Frank J. van Rijnsoever
Second reader: Jarno Hoekman
Research institute: Utrecht University

Universiteit Utrecht

Abstract

For decades, it has been recognized, both academically and politically, that commercialisation of scientific knowledge has a positive impact on regional economy and development. In the wake of this development, concepts as science-based entrepreneurship (SBE) have flourished and received increased focus both from scholars and policymakers. But, since starting a new firm entails several changes, which alters both the scientist's profession and institutional sphere, why do scientists even want to engage in this activity? This is exactly what this study is set out to answer. Specially dedicated to find out what motivates scientists over different stages of SBE and what characterise those who pursue a career as an entrepreneur. To investigate these questions, a quantitative method is employed, linking characteristic from the literature of science-based entrepreneurship, the broader entrepreneurial literature and academic engagement. Both less and more commonly studied influencers in this area of research are discussed, to outline how the entrepreneurial journey is influenced from the initial stage to those succeeding. Based on different sources of data combined in a cross-sectional analysis using ordinal and binary-logit models, robust results from a large sample of 2,810 individual scientists were obtained. The results show that some major influential factors are rather heterogeneous and characteristic for certain stages, but equivalently similarities are found. The incentives of patenting activities, disciplinary background, and academic engagement with entities from the private sector, are all found to be important activities over the course of SBE, but differing in intensity. The present a comprehensive image of science-based entrepreneurs and point towards what lays at the interface between academic and commercial logic, but also between the different stages of science-based entrepreneurship; willingness to start a firm, starting a firm and staying active in the firm.

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1 Introduction

For decades, it has been recognized, both academically and politically, that commercialisation of scientific knowledge has a positive impact on regional economy growth and development (Perkmann et al. 2013; Urbano & Guerrero 2013; Stephan 1996a). After the Bayh-Dole Act in the 1980s in the United States (US), an increase in scientific outreach to society was observed (Etzkowitz et al. 2000; Perkmann et al. 2013; Urbano & Guerrero 2013). In the 1990s, European public research organisations (PROs) also began to increasingly engage with industry, to exploit promising academic knowledge through firm creation. These new firms were an alternative to more common technology transfer (TT) activities from PROs, e.g. contract research, patenting and consultancy (Moray & Clarysse 2005; Pisano 2010; Knockaert et al. 2011; Haeussler & Colyvas 2011).

Scholars have explored how academia adds to economic growth through scientific innovations for years (Stephan 1996a; Miozzo & DiVito 2016; Murray 2004). As a result, the concept of science-based entrepreneurial firms (SBEFs) has received increased focus among scholars and policymakers, especially over the past decade (Van Burg et al. 2008; Henrekson & Rosenberg 2001). However, research shows that it is one of the most individually demanding outreach activities, as it depends upon the scientist to have a certain level of prestige, often referred to as “star scientist” (Stuart & Ding 2006; Gittleman & Kogut 2003). Prestige is essential for maintaining ties to research institutes and mobilize the resources needed for starting a firm (Stuart & Ding 2006; Gittleman & Kogut 2003). Additionally, transitioning from academia to industry means that the scientist will move from an institution with a distinct *‘academic logic’* to an institutional sphere with a *‘commercial logic’* that may conflict with the scientist identity (Jain et al. 2009; Sauermann & Stephan 2013). In academic logic, fundamental knowledge creation, research freedom, peer recognition and open disclosure of research results are common norms and practices (Audretsch & Stephan 1999; Sauermann & Stephan 2013). Whereas within the commercial logic, the focus is more directed towards applied research, financial returns and limited disclosure of ones’ research (Audretsch & Stephan 1999; Sauermann & Stephan 2013). This implies, that when participating in other academic engagement (AE) activities such as, contract research; consultancy; researcher mobility (Colombo et al. 2010; Nilsson et al. 2010; Perkmann et al. 2013), the scientist will not experience the same individual tergiversation as practices and norms do not *per se* change drastically. Empirical evidence support these views, as starting a firm is found to be the least pursued AE activity among scientists (D’Este & Perkmann 2011; Perkmann et al. 2013). Starting a firm can therefore, be considered as the ultimate form of AE in which a scientist can take part.

Despite these changes, the amount of SBEFs are steadily growing. In this context, a variety of scholars has explored which factors are beneficial for SBEF growth and performance, examining; network ties (Murray 2004; Rickne 2006), knowledge transfer (Knockaert et al. 2011) and relations to PRO/ Private research Institute (PRI) (Henrekson & Rosenberg 2001;

Moray & Clarysse 2005). Literature investigating the concept of AE for university-industry (UI) relations has focused on the drivers of formal and informal TT activities. Key factors for AE are presence of; high (individual) academic achievements (Perkmann et al. 2013; Grimpe & Fier 2010), stability in the collaboration (Ankrah et al. 2013) and good quality of technology transfer offices, faculties and incubators (Grimpe & Fier 2010; Haeussler & Colyvas 2011). Similarities have been discovered in the determinants of the two activities. Personal characteristics of scientists, and TT practices are essential for both AE and SBE (Perkmann et al. 2013; Knockaert et al. 2011; Ankrah et al. 2013). Also scientific disciplines are recognised to influence both activities (Haeussler & Colyvas 2011). AE activities are often a predecessor of SBE and may show to be an important input factor for SBEFs (Perkmann et al. 2013).

However, the literature on the topic has some significant limitations. The research on SBE(F) has been relatively silent on which individual characteristics impact the entrepreneurial behaviour of a scientist. While individual-level relations have been tested, no study has aimed for a fine-grained investigation of heterogeneous factors. Literature describing entrepreneurship emerging from within research institutes, such as SBE(F)s, has neglected in-depth research on which individual-level attributes, recognized in entrepreneurship studies as factors affecting outreach activities from research institutes, influences science-based entrepreneurship (Clarysse et al. 2011). The studies that have investigated SBE(F)s at individual-level has up until now, mainly focused on qualitative research, whereas very few studies have delved into a more detailed investigation of testing attributes, from a quantitative perspective (Knockaert et al. 2011). The call for research on a more detailed-level, shifting from a qualitative to a quantitative perspective, can be seen as a maturing of the stage. As theory develops beyond its initial stage, a need for validation is created (Rothaermel et al. 2007; Miranda et al. 2017).

One overreaching factor recognized in both AE and entrepreneurship literature is motivation, as it influences individuals decision to engage in entrepreneurial activities, as starting a firm, and it also effects the performance of new firms (Baum & Locke 2004; Perkmann et al. 2013; Shane et al. 2003). Other factors recognized to effect activities of entrepreneurship and AE are individuals' abilities; knowledge, skills and behaviour (Shane 2000; Clarysse et al. 2011; Perkmann et al. 2013). These abilities are an important explanatory factor for why some individuals recognise entrepreneurial opportunities (Baron & Ensley 2006). However, these factors have not yet been studied comprehensively for individual scientists in SBE(F) literature.

Therefore, while these strands are useful in shaping future work, two overreaching questions remain: What motivational drivers impact the willingness of scientists to start a firm, likelihood of them starting a firm, and staying active in the firm? How does scientist's abilities and opportunities influence these choices? Thus, leading to the following research question:

What is the influence of motivation, abilities, and opportunities on different stages of Science-Based Entrepreneurship?

Scientifically, this study will contribute to our understanding of which specific motivational, ability and opportunity factors are most significant for the willingness, and accomplishment of starting a firm, by scientists. By gaining a fine-grained empirical insight, it will add to a more comprehensive understanding of SBE. By exploring variables which previously have been given little attention in the strand of literature a deepened understanding of the individual science-based entrepreneurs will be gained. Furthermore, this study will answer the called for further research about "*how university governance and public policy can best promote […] commercialization efforts*" (Audretsch et al. 2006, p.63). Thereby, helping policymakers and industry to better target individuals with most entrepreneurial potential and thereby strengthen the field of SBEF.

In section 2, the theoretical framework is presented and conceptualized, to demonstrate how current knowledge will be combined. Section 3, outlines the methods used to answer the research question. Regression models will be employed to analyse existing cross-sectional data from 2,810 scientists, combined with online patent data and inventor privilege data.

2 Theoretical background

As described, the entrepreneurship (Shane & Venkataraman 2000) and university-industry (UI/AE) relation literature (Perkmann et al. 2013; D'Este & Patel 2007) will create the foundation for identifying factors associated with the activity of commercially exploiting scientific research in form of setting up a firm. By doing so, the activity of moving from university to industry through the agency of entrepreneurship, will be explored. The literature review and framework by Perkmann et al. (2013) on AE, provides a detailed overview of these strands of literature.

The framework by Perkmann et al. (2013) focuses on "*knowledge-related collaboration by academic researchers with non-academic organisations"* (p. 424) and shows that the factors, which have proven to be best predictors of AE, are; individual level factors and the institutional factor of scientific discipline. However, individual factors as motivation and abilities are highlighted by Perkmann et al. (2013), showing promising results for future research on AE. Abilities as scientific productivity, academic experience and motivation, are highlighted as influencers of commercialisation. Within the entrepreneurship literature these factors are also acknowledged, since the inventors are essential, especially in new firms. The individual factors associated with entrepreneurship are broadly, motivational factors such as; desire for achievement and financial rewards, and ability related factors as; social and human capital (Shane 2003, chap.5; Kim et al. 2006; Murray 2004; Goethner et al. 2012; Perkmann et al. 2013). Furthermore, motivations are recognized as being "*important explanatory mechanisms for a variety of entrepreneurial behaviors"*(Carsrud & Brännback 2011, p.20). Additionally, institutional factors as social structure and national policies, show to have impact on entrepreneurial activities, because they likely affect the behaviour of individuals across different institutions and are a part of shaping scientists' identity (Fayolle 2014, chap.3; Jain et al. 2009).

The independent variables are going to be categorized, as scientists like i.e. Battilana et al. (2009) and Ajzen (1991) have done in earlier research. Building on academic engagement (UI relations) and (Science-Based) Entrepreneurship literature, I propose three key categories for individual level investigation on SBE: Motivation, abilities and opportunities (Fig. 1).

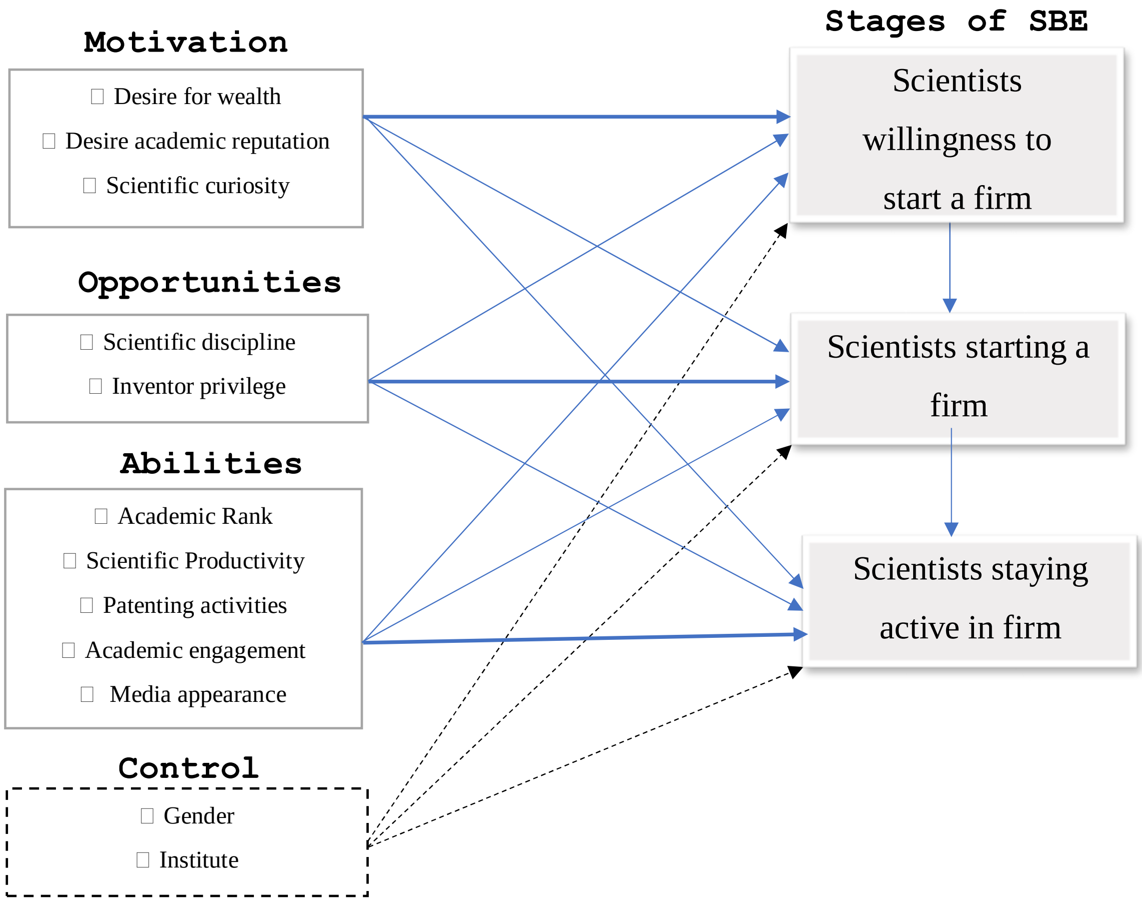

Figure 1. Conceptual model of Science-Based Entrepreneurship

The conceptual model, figure 1, depicts how factors at individual level are anticipated to affect the entrepreneurship at different stages: pre-entrepreneurship, initiating entrepreneurship and persistent engagement in entrepreneurship. The first stage is the willingness of the scientists to undertake the activity of becoming an entrepreneur, in form of starting a firm, in the future, both self-reported factors as motivation and fact-based measurements could influence the outcome of this stage. The same applies for the two following stages, starting a firm and staying active in the firm started. From a literature perspective, all stages could likely be affected by the factors presented on the left side and this study will disclose which factors are most influential and to which degree. In the following sub-section, all three dependent variables will be described separately, followed by the independent variables: motivation, abilities and opportunities.

2.1 Dependent variables

2.1.1 Scientists willingness to start a firm

The first dependent variable of this study is the scientists willingness to pursue a career as an entrepreneur. A well-known factor used as indicator of an individuals' willingness to perform an activity is motivation, as it influence future behaviour (Ajzen 1991). Additionally, it is identified that researchers willingness is a driving factor for individuals to engage in commercially exploiting an invention through firm creation (Lockett et al. 2005; O'Shea et al. 2008). Willingness can in some cases be the initial step towards, or the final factor that make people pursue the uncertain path of entrepreneurship. Therefore, this dependent variable refers to scientists degree of willingness or desire to start a firm.

2.1.2 Scientists starting a firm

The second dependent variable is an activity affected by the initial step of willingness to start a firm. It focuses on those scientists who have actually taken the leap into the industry sphere and started a firm. Basic conceptualisation of pursuing entrepreneurial opportunities is described by several scholars to be when someone is starting a business (Carsrud & Brännback 2009, p.319). By investigating this variable in extension of entrepreneurial willingness, a more comprehensive picture of the entrepreneurial process will be achieved. In this study, this dependent variable refers to all scientists, both from PRO, PRIs and other research institutes.

2.1.3 Scientists staying active in firm

The last dependent variable of this study is nested within the forgoing variable of starting a firm, namely the activity of staying active in the firm. Even though the ultimate entrepreneurial activity could be understood as being starting a firm, it is also important to know what makes scientist stay active in the firm(s) they start. There are several well-documented reasons to why scientists may exit from their firm, i.e. merger or acquisition by larger enterprises (Bonardo et al. 2010). Also, failure in form of bankruptcy or high market competition (Colombo et al. 2010), lack of sufficient funds or pursuing a different career path, are seen to be reasons for exits from entrepreneurship. However, by also knowing what drives continuous engagement in entrepreneurial firms, it can help overcome obstacles in competitive regional or local environment. This dependent variable will investigate what distinguishes these scientists from the rest, and which factor(s) are strongest and most characteristic.

2.2 Independent variables

Before going on, there must be given a validation of the interrelation between individual-level attributes and (SB-) Entrepreneurship. Therefore, to provide a more explicit illustration of the independent variables, an overview of selected studies are given on the following page in Table 1, before an in-depth explanation of each is unfolded. This table depict individual-level factors that have been supported in multiple studies as influencers of academic entrepreneurship and SBEF/entrepreneurship.

Table 1. Literature overview of individual-level factors found to influence AE and SBEF/Entrepreneurship

	Academic Engagement	*SBEF/ Entrepreneurship*
Motivation	**<u>Desire for wealth</u>** •Seeking Supplement/secure funds influence UI collaborations (Lee 2000) •Seeking higher personal income & •Seeking IPRs influence commercialisation activities (D'Este & Perkmann 2011)	• Desire for Wealth influence entrepreneurial behaviour (Shane 2004, p.158) (A.Ent[1]) • Desire for financial rewards motivates (IV)[2] scientists to commercialise research. (Lam 2010) • Successful (academic) entrepreneurship "can never be about money" – the lowest response among all categories in the study – based on follow up to study of successful spinoffs (Hayter 2015, p 1010)
	<u>Desire for personal achievements</u> • Gain insight into one's own research influence UI collaborations (Lee 2000) • Seeking research income influence the frequency of engagement in TT activities (D'Este & Perkmann 2011)	• Desire for reputational reward motivates especially (III/IV)[2] scientists to engage in research commercialisations (Lam 2010) • Desire for personal achievement, (Morales-Gualdrón et al. 2009) (A.Ent)
	<u>Scientific curiosity</u> • A wish to field-test one's own research influence UI collaborations (Lee 2000)	•Desire to apply knowledge (Morales-Gualdrón et al. 2009) (A.Ent) •Personal curiosity motivates (III)[2] scientists & •Desire for knowledge application motivates (III/IV)[2] scientists (Lam 2010) •Entrepreneurial curiosity is positively influencing entreprenurial self-efficacy (Jeraj & Marič 2013)
Opportunity	**<u>Scientific discipline</u>** • Importance of specific knowledge transfer channel can be explained to a large degree by the variance across scientific disciplines (Bekkers & Bodas Freitas 2008) • Social scientists and clinical	• Scientists from life science heavily rely on patenting for knowledge transfer industry, whereas basic and applied disciplines use more various channels (publishing, patenting, collaborations etc.) (Larsen 2011) • *Researchers from applied fields, are more likely*

[1] "A.Ent." is an abbreviation of *Academic Entrepreneurship*. Reflecting that the study refers to the phenomena of scientists starting a firm as Academic Entrepreneurship.

[2] Lam (2010) distinguish between traditional (I), Pragmatic traditional (II), Hybrid (III) and entrepreneurial (IV) scientists. In his study, some of the factors are specifically motivating different groups of scientists, indicated by the roman numbers.

	researchers are more likely to use partnering with industry (labour mobility) as knowledge transfer channel (Perkmann et al. 2013) • Faculties in applied disciplines are more likely to support various transfer activates than faculties in basic or social science (Lee 1996)	*to engage in entrepreneurial activities (Perkmann et al. 2013)*
	Inventor privilege	
	• The regulations of intellectual property (IP) ownership for university-generated knowledge vary between countries, especially effecting patenting (Perkmann et al. 2013)	• Systems in which universities maintain the legal ownership of inventions, is not optimal, if seeking to encouraging entrepreneurship & • University spin-out companies need more legal support mechanisms to improve performance, compared to non-university startups (Grimaldi et al. 2011)
Abilities	**Academic rank**	
	• Researchers academic status, always has a positive and significant impact on university-industry interactions (UK) (D'Este & Patel 2007) • Seniority/being an experienced researcher, is positively related to engagement with (industry) collaborations (Perkmann et al. 2013)	• Through career trajectory, social capital is built, which enhance scientists' opportunities outside academia, as it embed skills and network (Murray 2004) • College graduates are twice as likely to become nascent (start-up new firm) entrepreneurs as people with lower educations (Kim et al. 2006) • Academic status enhance the likelihood that a scientist will found a spinoff (Shane 2004) (A.Ent)
	Scientific productivity	
	• Publication productivity, star scientists, are attractive partners for firm scientists to collaborate with (Zucker et al. 2002) • Individuals with high scientific productivity is more likely to pursue engagement and *commercialisation* activities (Perkmann et al. 2013)	• Research productivity of university (faculty) scientists remains stable even after they start a firm (Lowe & Gonzalez-Brambila 2007) • Co-publications increase the likelihood of scientists to patent and become an entrepreneur (Audretsch et al. 2006) (A. Ent)
	Academic engagement	
	-	• Participating in product development, contract research and external research projects is positively related to start-ups among university employees (Karlsson & Wigren 2012) • Previous joint working experiences reduce cognitive distance between commercial and technical people and enhance post-founding performance of SBEF (Knockaert et al. 2011) • The likelihood of starting a firm increase with proportion of linkages and interactions with scientists, the industry segment and (commercial) firms (Audretsch et al. 2006) (A.Ent)
	Patenting activities	

• **Patent experience** have a positive and significant effect on the decision to engage in informal technology transfer (Grimpe & Fier 2010)	• If an individual is in possession of a patent, it increases the likelihood of them engaging in entrepreneurship (Shane et al. 2003) (A.Ent) • *Having commercialisation experience, has a positive effect on future patenting and entrepreneurship activities (Perkmann et al. 2013)* • Use **patent frequency** as an indicator of inventiveness in technology-based spinoff firms (Dahlstrand 1997) • **A** patent represent a novel contribution to the current state of knowledge and here the related citations can represent the **patents impact** on new knowledge creation (Jaffe et al. 1993)[3]
<u>Media appearance</u>	
	• Social media (twitter) can serve as a marketing channel for entrepreneurs, to develop i.e. company branding, along with potential effect on opportunity recognition (Fischer & Reuber 2011)[4] • Having conveyed a body of research in media (TV/Newspapers) has a positive relation to start-ups among university employees, though not statistically significant *(sample of 2006*) (Karlsson & Wigren 2012)

[3] The study focuses on knowledge spillover in geographical locations and how patent citations influence new novel research and their particular significance for local development and innovativeness.

[4] Study is based on general entrepreneurship as there at this point in time, isn't any studies investigating either science-based or academic entrepreneurship that including this factor of media - to the best of knowledge.

2.2.1 Motivation

The category of *motivation* is likely to influence the scientist's willingness and intention to engage in the establishment of a firm (Lam 2010). Motivation differs across scientists due to individual life experiences. It is important to look at motivation, as it's a proven influential driver in people who pursue entrepreneurship. Shane et al. (2003) describe it as *"motivations influence the transition of individuals from one stage of the entrepreneurial process to another"* (p.275). Moreover, an individual's motivation is in some cases seen to change over the stages of entrepreneurship. From being more externally driven e.g. by monetary desires in the pre-entrepreneurship phase, to rely more on internal drivers e.g., self-realisation and curiosity motives after the firm has been founded (Walker & Brown 2004; Staniewski & Awruk 2015). The *motivational* factors are expected to impact relationships of the willingness of a scientist to start a firm. Factors of motivation influence the future behaviour of scientists, which make it an explanatory aspect in describing why some scientists are willing to step out of their familiar environment (Ajzen 1991). However, for the following activities of starting a firm and staying active in the firm, some influence from selected factors are also to be expected, but for the willingness, these factors are main influencers. Here the most salient motivational drivers recognised for AE and (SB-) entrepreneurship, will be defined.

2.2.1.1 Desire for wealth

Studies on entrepreneurship have looked at many factors of motivation in an attempt to find the perfect one(s). One of the more traditional factors found in entrepreneurship literature is the desire for wealth (Shane 2004; Morales-Gualdrón et al. 2009; Goethner et al. 2012). The desire for wealth can surface for several reasons e.g. the scientist seeing a potential for earnings in their research or scientists who are at a later stage of their career start seeing a potential in exploiting their intellectual capital build up during their career (Shane 2004; Morales-Gualdrón et al. 2009). So, the more an individual desire wealth, the higher the likelihood that they engage in the initial stages of commercialisation to exploit accumulated tacit knowledge (D'Este & Perkmann 2011). However, later in their self-employment career, literature on entrepreneurship has seen a trend suggesting that monetary rewards is not what leads individuals to stay involved (Hayter 2015). Hayter (2015) found in his study that there is a high opportunity cost associated with starting a spinoff, and that individuals could have realized higher earnings by pursuing other opportunities. The follow-up study based on interviews of successful entrepreneurs who had spun-out from research, evidenced that among other, this motivation defiantly evolve over time. Furthermore, there is an increasing number of firms seeking to earn a profit from science, both through licensing and spinoffs (Pisano 2010). This generate a higher competition, creating an uncertain environment for monetary rewards at later entrepreneurial stages (Pisano 2010). Therefore, the desire for (higher) wealth, is more likely to have a positive influence on the willingness of a scientist to start a firm, but possibly having a negative or no influence on the activity of actually pursuing entrepreneurship and staying active in the firm(s). Thus, leading to the following hypothesis:

Hypothesis 1

There is a positive relationship between the desire for wealth and (a) the willingness to start a firm. But, a negative relationship between desire for wealth and (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

2.2.1.2 Enhance academic career

The second motivational factor is using entrepreneurship as a way to enhance academic status. Starting a firm will provide the founder with new knowledge that can be a tool for scientists to advance further in their academic career (Morales-Gualdrón et al. 2009; Lam 2010). Gaining reputation and recognition through knowledge creation and IP is not an unknown practice within entrepreneurship. Engaging in a commercialisation activity helps scientists expand their network, which may lead to an increase in scientific status (Krabel & Mueller 2009; Hayter 2015). This means that scientists who are motivated to start a firm will likely have a wish to enhance ones' career prospects, which may be directly or indirectly related to the willingness of starting a firm (Rizzo 2015; Lam 2010). However, the outlook on the possibility to pursue something in the future in order to benefit one's position, and the actual execution of such drastic commercialisation activity as starting a firm, are two different objectives. Wanting to pursue a career in academia may have a contrary effect on the outreach activity of starting and staying active in a firm, due to its ramification of leaving academia. It entails that the scientist is permanently shifting from an academic to a commercial logic, which endorses other values (Audretsch & Stephan 1999; Sauermann & Stephan 2013). Thus leading to the following hypothesis:

Hypothesis 2

There is a positive relationship between desire to enhance academic career and (a) the willingness to start a firm. But a negative relationship between desire to enhance academic career and (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

2.2.1.3 Satisfy intellectual curiosity

Doing research is often about revealing what's behind the questions or problems facing us. As described by Lam *"the desire to engage in creative puzzle solving is the hall mark of a dedicated scientist"* (2010, p.11). Scientists who are more willing to become an entrepreneur, are seen to be motivated by advancing and applying knowledge, engage in challenging activities and by getting answer to satisfy personal curiosity (Lam 2010; Lee 2000; Morales-Gualdrón et al. 2009). Indviduals pursue a sciencientific path because they are curious to find out what is behind technological or societal activities and systems. But it does not only hold for sciences, because the nature of entrepreneurship is also affected by such curiosity. Curiosity to pursue unknown paths, creative thinking and strategic planning, are leading to entreprenurial self-efficacy (Jeraj & Marič 2013). Wennekers & Thurik (1999) describe the activity behind entrepreneurship as *"the roots of invention are to be found in curiosity"*(p.40). By linking the activities of science and entreprenuship, points towards curiosity as an important 'driving' power for individuals in both segments. Therefore, this factor becomes an interesting aspect to take into consideration when looking at motivational factors for starting and staying active in a firm as well, as it can be a way to answer all three incentives. Thus, leading to the following hypothesis:

Hypothesis 3

There is a positive relationship between scientists who seek to satisfy intellectual curiosity and (a) the willingness to start a firm, (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

2.2.2 Opportunities

The second category, *opportunity*, is referring to institutional opportunities in form of legislations and academic sphere, in the surrounding environment which the individual operates. As formulated in the research by Hebert & Link (2011) *"because entrepreneurship is present in all settings, it is the different institutional structures that generate the variances in wealth creation across societies"* (p.34). One way of pursuing entrepreneurial opportunities are by starting a firm (Carsrud and Brännback 2009). individual's opportunities and abilities are often complementary, as recognition of entrepreneurial opportunities increases with individuals embedded abilities (Baron & Ensley 2006). *Here first t*he factors of opportunities will be outlined, and are expected to particularly hold for the dependent variable; starting a firm. Testing it for all relationships across the different stages of SBE, will provide a novel insight into how, or if, these factors evolve over the time of commercialisation. The hypothesised relationships will be described in the following sections.

2.2.2.1 Scientific discipline

Scientific discipline is the specific branch of knowledge given to the scientists through their educational program (e.g., engineering or Biology). Scientific disciplines are an important explanatory factor for opportunity recognition, varying across institutions (Lockett et al. 2005)[5]. Scientific discipline is proven to be an important element in the selection of knowledge transfer channels between universities and industry (Bekkers & Bodas Freitas 2008). For some disciplines, commercialisation activities are seen to be more attractive channels for knowledge transfer than in other (Perkmann et al. 2013; D'Este & Perkmann 2011). It is therefore relevant to investigate if some disciplines are more likely to engage in starting a new firm compared to others. Literature suggests that scientists with applied science backgrounds as biomedicine, (chemical) engineering and material science are more likely to favour commercialisation channels for their knowledge transfer, whereas scientists from basic research do not (Bekkers

[5]In the study by Locket et al (2005) they even call for additional future research at individual-level to understand what abilities is required in developing successful spinoffs, and to which extend those vary across disciplines.

& Bodas Freitas 2008; Louis et al. 2001; Lee 1996; Perkmann et al. 2013). Furthermore, within the field of medical research, non-clinical scientists are found to be more keen on commercialising their research than their clinical colleagues (Louis et al. 2001). The evidence suggests that scientists who research within a field of more tangible character, applied sciences, are more likely to start a firm. Therefore, it is relevant to study the degree of influence that each discipline has on every stage of SBEF. However, it is expected to hold in particular for the dependent variable 'starting a firm', because of its proven effect on opportunity recognition. Thus, leading to the following hypothesis:

Hypothesis 4

There is a positive relationship between scientists with an applied science background and (a) the willingness to start a firm, (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

2.2.2.2 Inventor privilege

Next to scientific disciplines are national policies. Policies are seen to have a great impact on the individual's decision to engagement in commercialisation activities, as it shapes the norms and rules influencing the researchers environment (Perkmann et al. 2013). Notably, after the Bayh-Dole Act of 1980, the creation of firms increased in the US, as rights over inventions designed within universities from federal research grants, went from being a federal property to university property (Etzkowitz et al. 2000; Grimpe & Fier 2010; Grimaldi et al. 2011). Soon after its initiation, the inventors too felt a part of the profit by law (Etzkowitz et al. 2000). However, in many countries outside the US, this law was only to be realized more than 20 years later (Grimpe & Fier 2010). Having a national policy supporting universities and inventors privilege increases the likelihood of scientists to engage in commercialisation activities (Grimaldi et al. 2011). When scientists have the legal possibility to transfer their own research, the choice largely lays in the hand of the individual (Nilsson et al. 2010). Therefore, by distinguishing between countries where inventors have (shared) legal rights over their inventions and those where inventions belong to PRO, PRI or federal government, its impact on the activity of starting a firm, can be measured. Thus, it's expected that scientists who belong to a country with shared or full inventor privilege are more likely to start a firm.

The two streams of literature (AE and (SB)E) are rather silent on how such policy factor affect the different phases of entrepreneurship (arising from within PROs and PRIs) and this calls for further research (Lockett et al. 2005; Grimaldi et al. 2011). It will, therefore, be tested how inventor privilege may influence the scientists' choice of staying active in the firm(s). However, nothing would suggest that this factor is significantly influencing the willingness to start a firm. The internalised characteristic of the first stage of SBE, suggest that individual motivation play the most decisive role, if external factors are held constant (Shane et al. 2003). By testing these assumptions, a novel insight will be gained into how this factor may influence the later stages of entrepreneurship.

Hypothesis 5

There is no relationship between being from a country with shared- or full inventor privilege and (a) the willingness to start a firm. But a positive relationship between being from a country with shared- or full inventor privilege and, (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

2.2.3 Abilities

The second category, *abilities*, refers to the skills and experiences embedded within the scientist, which shape their identity and attitude towards entrepreneurship. Abilities are acknowledged in the wider entrepreneurial literature as an explanatory variable of why some individuals are more likely to engage in entrepreneurial activities, compared to their non-entrepreneurial peers (Clarysse et al. 2011). There is reason to believe that the more context specific factors, are also explanatory for science-based entrepreneurs, as proposed for commercialisation in Perkmann's (2013) framework. This has until now, been given little attention in studies on entrepreneurship from within research institutes (Clarysse et al. 2011). Factors of abilities are expected to be strongly influencing the success and survival of a science-based firm. Factors as social competences (e.g., extensive networks, reputation, abilities to interact with others and across disciplines) and legitimacy, are proven to be significant explanatory individual factors ensuring new venture success (Baron & Markman 2003; Rao et al. 2008). Internal legitimacy can be present by having extensive knowledge about the newest scientific ideas, being able to convey scientific knowledge to stakeholders outside the academic sphere, and demonstrating the ability to communicate it to a broader audience (Rao et al. 2008). Therefore, having a large network, established communication platforms, reputation in form of e.g., a portfolio of large or acknowledged publications and patents, are abilities which will be particularly fruitful for scientists to stay active in the firm. Even though these factors are expected to have a considerable impact on the success of a science-based firm, certain abilities are also expected to be important for an individual in order to realise the opportunity of starting a firm. Following, the most noteworthy abilities recognised for AE and (SB-) entrepreneurship will be outlined, along with the relationships expected between the factors and the dependent variables.

2.2.3.1 Academic rank

Academic rank can be defined as the position at which the scientists are currently employed, which can be termed as the path to a full professorship (Van Rijnsoever & Hessels 2011). An increase in rank can therefore be seen as an reward of a scientists' research success and an advancement of their career (Van Rijnsoever & Hessels 2011). Prior research has shown that *"the willingness of people to pursue entrepreneurial opportunities depends on such things as (…) their career experience"* (Shane et al. 2003, p.260). Through improvement of ones' career

and the experience that follow, individuals aquire resources and skills which make them better equipped to exploit entrepreneurial opportunities (Shane 2003, chap.4). Murray (2004) found in her research, that a scientist's career trajectory is an influential driver for SBEFs success as it ensures the firms entrance, through support from ones' scientific community. As the scientists' career advances, so does their networks and ties with industry (Van Rijnsoever & Hessels 2011; Krabel & Mueller 2009). Through those networks scientists can obtain intangible resources in form of i.e. reputation in ones' community, which is not available for people from outside such sphere (Witt 2004). This reputation and embeddedness, which follows an increase in academic rank, is therefore likely to also possitivly influence scientists choice to engage in commercialisation activities. Thus, it is expected that the likelihood of a scientist engaging in spin-off activities and successfully staying starting in a firm, increase with academic rank (Kim et al. 2006; Shane 2004; D'Este & Patel 2007). However, the willingness to take the leap into the private sector or technology transfer, has shown to be a more attractive career path for younger scientists (Duberley et al. 2007). There is uncertainty involved in both career paths, but for researchers who are at an early stage of their academic career, staying at the university will result in short-term postdoctoral research contract, which may be less or equally attractive to the alternatives (Duberley et al. 2007). This point towards that a significant relationship would be expected for scientist's with junior university positions, also meaning it will be decreasing as the rank increase, however, evidence is varying. Research have also suggested that younger scientists are more careful to not risk their reputation and career capital, while also lacking essential skills and experience required for such arduous journey (Göktepe-Hulten & Mahagaonkar 2010; Krabel & Mueller 2009). Consequently, no significant relationship is expected for the willingness of pursuing entrepreneurship.
Thus, leading to the following hypothesis:

Hypothesis 6

There is no relationship between academic rank and (a) the willingness to start a firm. But a positive relationship between academic rank and (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

2.2.3.2 Scientific productivity

The second independent variable in the category of abilities is academic productivity. With this, I refer to publications and the impact of the publications (publication citation rate) of the individual scientist (Larsen 2011). Both outputs are important measurements. Where the first directly measure the scientist's productivity (number of papers), the citation rate measures the impact of that productivity (Hirsch 2005). Citations can be described as the bibliometric fossil of a scientist's work (Gittleman & Kogut 2003). Such evaluations can be the way to distinguish *´good science´* from that of a more quantitative character, as citations reflect acknowledgment, prestige, and position in the scientific community (Gittleman & Kogut 2003). Scholars have identified that both before and at time of engaging in starting a new firm, scientist's publication activities are higher than their peers (Lowe & Gonzalez-Brambila 2007). Also at later stages, scientists who are more involved in commercialisation activities tend to have an increased publication output in comparison with non-commercially engaged scientists (Markman et al.

2008; Lowe & Gonzalez-Brambila 2007). Having a high publication output fosters reputation and can serve as a signal to potential commercialisation partners, as it makes them more attractive partners for firms to collaborate with (Grimpe & Fier 2010). Therefore, it is expected that scientists who demonstrate high scientific productivity are more willing to pursue entrepreneurial paths, more likely to start a firm and stay active in the firm (Lowe & Gonzalez-Brambila 2007; Perkmann et al. 2013). Thus, leading to the following hypothesis:

Hypothesis 7

There is a positive relationship between scientific output and (a) the willingness to start a firm, (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

2.2.3.3 Patenting activities

Patenting experience is a common measure in entrepreneurship literature, often used to indicate the efficiency, innovativeness or research field of the applicant(s), faculty or region (Clarysse et al. 2011; Murray 2004; Stephan 1996a). It has been acknowledged that patent measurements are especially useful indicator for science-based firms, as they have high tendency of patenting (Rickne 2006). A patent is an intellectual property (IP) transfer activity, that protects an invention against commercial exploitation by others (D'Este & Perkmann 2011; Perkmann et al. 2013). Patenting is a relevant factor to take into consideration in this study because it is found that *"the possession of a patented technology make individuals more likely to engage in the entrepreneurial process"* (Shane et al. 2003, p.275). It is proven that patenting increase the likelihood of scientists' engaging not only in commercialisation, but also in informal technology transfers activities (Grimpe & Fier 2010; Audretsch et al. 2006). So, by engaging in patenting of ones' research, scientist's wish to become an entrepreneur increases, as they gain awareness of their research's' business potential (Park et al. 2017; Shane et al. 2003; Goethner et al. 2012). Furthermore, engaging in patenting activities increase collaboration activities, thus creating more network ties, which potentially lead to an increased support from the community which the scientists are embedded in. Moreover, when scientists patent, it benefits their academic prestige, which also serves as a signal to potential commercialization collaborators in industry (Grimpe & Fier 2010). Thus, patenting scientists are expected to be more likely to be motivated to start a firm, establishing a firm and stay active in the firm.

Patenting frequency is something which has not been given much attention in either AE or Entrepreneurship literature up until this moment. But as described, having experience with patenting is seen to positively influence entrepreneurship. Goethner et al. (2012) put attention toward factors as habits, which are known to impact behaviour - being an important determinant of individuals' decision to engage in i.e. entrepreneurship. For this reason, the independent variable of patent activity, will be split in three, in order to investigate how this factor may influence scientists decision to start and stay active in the firm. Scholars have been analysing habits by looking at individuals frequency of past behaviour (Conner & Armitage 1998). Few studies including patent frequency have argued that it is a good indicator of inventiveness of spinoffs (Dahlstrand 1997). Indicating a fruitful measure by looking at patent frequency of a scientist, as a potential predictor of innovativeness potential. Such high innovativeness potential, reflecting frequent involvement in commercialisation actives in the past, is likely to be a qualified indicator of future success for starting and staying active in the firm. Therefore, a higher patenting frequency compared to peers, is expected to increase the likelihood of a scientist discovering an entrepreneurial opportunities and engagement in the field, hence starting a firm and staying active in the firm.

Patents held by scientists can be seen as a bridge between two regimes, namely the market and the academic, in which it can be evaluated (Etzkowitz et al. 2000). The abovementioned patent measurements are quantitative and point towards the productivity of a scientist in the commercialisation sphere. However, by measuring performance from a qualitative perspective different insights can be gained, into ***patents impact*** in the regimes. Importance of a research papers and inventions, whether connected to patents or publications, have commonly been measured by counting the number of citations connected to the authoring entity (Stephan 1996b; Jaffe et al. 1998). Therefore, citations is a way to gain recognition and reputation, which is often strived for within the academic community and beyond, as described in section **Error! Reference source not found.**. The citations of patents are however, albeit different from those of publications. First of all, they are controlled by a patent examiner who determines whether they are relevant and must be included in the patent. Furthermore, with every citation included, the extent of the patent is reduced and so is the inventors monopoly (Jaffe et al. 1993). When a citation is included in a patent it reflect much more impact, because it means that the cited patent holds essential knowledge upon which the existence of the patent is build (Jaffe et al. 1993). Therefore you see much less, but yet more influential citations in patents. Such qualitative measure hold especially for further success of a firm, as patents weighted by their citations can be interpreted as a measurement of field expertise and excellence. The impact of patent citations on willingness to engage in entrepreneurship is not clear, as the question is relatively unexplored in the literature. However, evidence will fall shorts on explaining why scientists will be willing to start a company, as the specific measure of patent impact is not found described in theory to be of essential importance to internal-motivations. Because, knowledge and technological transfer is possible through multiple other more common and easily accessible channels (Bekkers & Bodas Freitas 2008). A more general measure is detected for higher patent productivity among scientist's with ties to industry, rather than those with stronger connection to academia (Dietz & Bozeman 2005). Therefore, no significant relations is expected between patent impact and the willingness of a scientist to start a firm, but rather between the more generic measure of patent experience.

Hypothesis 8

There is a positive relationship between patenting experience and a scientist's (a) willingness to start a firm, but no relationship to patent frequency and patent impact. But a positive relationship between patenting experience, patent frequency & patent impact and (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

2.2.3.4 Academic engagement

Not alone is tangible experience as patenting found to increase researchers desire to pursue an entrepreneurial career, but also the more intangible experiences as networking in form of academic engagement with industry (Goethner et al. 2012). AE include the activities *"collaborative research, contract research, consulting and other forms of knowledge exchange"* (Perkmann et al. 2013, pp.425–426). In order to engage in commercialisation activities, a scientist must first get access to resources, which is often gained by engaging with individuals or organisations who are in possession of such assets (O'Gorman et al. 2008). For opportunities to be recognized and entrepreneurs to be successful, networking and organizing resources are considered to be of utmost importance (Landström & Johannisson 2001). Having experience with industry collaboration help in the search of such resource supportive partners. Therefore, by engaging in both industry and academic collaborations, there is a plausible impact on a scientist's choice to participate in commercialisation activities later in time, as it ensures support from communities and people with a commercial background (Perkmann et al. 2013; Karlsson & Wigren 2012; Knockaert et al. 2011). Such support may be impossible to obtain for people not embedded in the field (Audretsch et al. 2006; Murray 2004; Goethner et al. 2012). This creates an advantage for the scientist and thus make them more likely to pursue entrepreneurial opportunities. However, many researchers engage with industry throughout their career in order to support their academic research and development, not specifically with the intention to commercialize (D'Este & Perkmann 2011). This means, that their academic engagement activities cannot exclusively be consider a measure of future commercialisation desires. Engaging with different types of organizations may be partly responsible for future activities as well. Because it evidence that scientists from different backgrounds prefer varying channels and different degrees of engagement, especially with industry (D'Este & Patel 2007). Therefore, scientists who are academically engaged are more likely to start a firm and staying active in the firm, but it is not expected to impact a scientist's willingness to start a firm.

Hypothesis 9

There is a no relationship between academic engagement and (a) the willingness to start a firm. But a positive relationship between academic engagement and (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

2.2.3.5 Media appearance

A more recently emerging practice, likely influencing the engagement in entrepreneurship, addressed by a handful of scholars is *media appearances*. The term media in this context covers a range of different mass communication tools as; television, radio and newspaper, but also the more recently adjacent 'social media' as Facebook and LinkedIn. For several years it has been a reality that social media are fundamentally changing the way people communicate and interact, but nevertheless been a relative silent factor in entrepreneurship studies (Edosomwan et al. 2011; Fischer & Reuber 2011). Just over the latest decade, medias like Twitter and Facebook have increased exponentially in number of active users (Statista 2017b; Statista 2017c). Due to this widespread use, media appearances are an interesting factor for consideration when evaluating behaviour (Fischer & Reuber 2011). The few empirical evidence on this factor's influence has e.g. shown that channels as Twitter can help entrepreneurs capture opportunities, hence starting a firm, and develop both personal and firm branding (Fischer & Reuber 2011). Other interesting aspects of media is being recognized, for example how it can potentially be a supporter for entrepreneurs to overcome the liability of newness (Karlsson & Wigren 2012). Furthermore, having internal legitimacy and reputation, demonstrate to stakeholders that the founding scientist(s) of a new firm, possesses the ability to convey scientific knowledge to successfully commercialised innovation (Rao et al. 2008). Even though social media is a relatively new upcoming platform for communication, television is still the most used media worldwide (Statista 2017a). Despite the platform, (social) media can help break down newness, communication and marketing barriers, and is becoming a continuously increasing part of many individuals and firms everyday activities (Edosomwan et al. 2011). So, being active and visible on media help individuals overcome entrance barriers and create a favourable image that can possibly help the new firm survive. Thus, scientists who are visible in media, have a favourable position towards starting a firm and staying active in the firm. However, for the dependent variables of 'willingness to start a firm', no effect of this factor have been demonstrated, upon until this point, in the literature. Research has mainly addressed the factor of overcoming the barrier between the public and private sector, therefore, presumably not affecting the internal motivation of a scientist, before the actions of firm creation is in motion.

Hypothesis 10

There is no relationship between being active on media and (a) the willingness to start a firm. But a positive relationship between being active on media and (b) likelihood of starting a firm, and (c) likelihood of staying active in the firm.

Studies on AE and Entrepreneurship, have found that individual-level determinants e.g. co-publications and choice of transfer channels, can be influenced by factors such as location and organisational characteristics (Audretsch et al. 2006; Bekkers & Bodas Freitas 2008). However, in Perkmann et al. (2013) review, organisational-level and demographic factors do not show any significant impact on commercialisation activities. Nevertheless they are surrounding factors which may affect individual level determinants. Therefore gender and the scientist affiliated organization type, will be controlled for. This is to increase the reliability of the individual-level relations by controlling for third-party factors from other levels (see operationalisation table page 26-27).

3 Methodology

3.1 Research design

This study uses cross-sectional data, which combines historical data and prospective case analysis, based on 3145 standardised survey respondents, PATSTAT patent data and inventor privilege data (Moray & Clarysse 2005). By combining survey data with patent data, a reliable empirical foundation will be obtained to prove or reject the conceptual model. The study has a deductive quantitative nature, where a representative sample out of a large population (science-based entrepreneurs) are used to test relations between dependent and independent variables (Bryman 2012). The cross-sectional design is used to test existing differences or similarities among a variety of science-based entrepreneurs and their non-entrepreneurial peers at a specific point in time.

Since all measurements used in this study are supported by academic literature, where a certain degree of consensus about its overall applicability is detected, there is reason to believe that it is good predictors of the concepts involved. Therefore, it is reasonable to assume the integrity of the study's conclusions are valid (Bryman 2012). However, it is important to address the overall *internal validity;* the degree to which the observed relations and effects of the independent variables are reliable and not caused by other factors (Bryman 2012). In cross-sectional research designs, there will always be shortcomings of causality. Referring to how infer the results are to conclude a causal relationship, as it's difficult to prove that the variation is not occurring due to something external (Bryman 2012, chap.3). In this type of research design (quantitative) it is better to refer to relationships and not causalities (Bryman 2012, chap.15). Another relevant factor to address is the *measurement validity,* to consider whether the predictors of the concept it intent to predicted, really does reflect the relation. As mentioned, a majority of the individual factors and characteristics included in this study have proven its value of predicting different stages of entrepreneurship or commercialisation (Perkmann et al. 2013; D'Este & Perkmann 2011; Shane 2004; Goethner et al. 2012; Audretsch et al. 2006; Murray 2004). Thus, the criteria of internal validity meet the standards for this type of research designs, as measurements are regarded as valid by some of the most acknowledge researchers in their field and widely used.

Furthermore, this study draws evidence from a large sample (3145 subjects) from various (1741) institutes, making it possible that the results are *generalizable* to its broader population. This supports the *external validity* of the study (Bryman 2012). However, its generalizability to other populations may be debatable, as it draws from the specific case of scientists. However, its applicability to other scientific entrepreneurial settings as; University Spinoffs, R&D spinoffs and firms started from other research-based settings, could be considered. But, most studies on Science-Based Entrepreneurial Firms (SBEFs) are proven to draw empirical evidence mainly from single countries, combined by a handful where the US and UK population stand out (Rasmussen et al. 2012). Whereas this study draw empirical data from more than 60 countries, giving additional credibility to the generalizability.

3.2 Sample and data collection

Parts of the data used in this study is derived from existing survey data obtained through a research group at Utrecht Universities' faculty of 'geosciences'. This data is combined with secondary patent and inventor privilege data. By doing so a robust, triangulated and comprehensive data set is obtained to analysis the hypothesis. This method of sampling will "*provide information at individual level* ***in*** *retrospective but not* ***only*** *self-reported, thereby* ***limiting*** *problems of reporting-bias*" (D'Este et al. 2010, pp.13–14) (bold text added).

The first source of data is the survey, originally aimed at collecting information about researcher's collaborations. The sampling strategy of this survey, was to collect data from authors in the two most scientifically influential parts of the world: North America and Western Europe (Florida 2005). The author data was retrieved from the Web of Science's database in 2016 and survey data was collected in spring 2017. Scientist received an email in February 2017 with an invitation to participate in the confidential survey. The full survey questionnaire can be found in *Appendix I*. The response rate, out of the effective sampling population of 42,964, was 7.3% which account for 3,145 researchers who filled in a usable questionnaire. The sampling strategy lead to include corresponding authors from more than the two geographic areas that were originally intended. Explanations for this could be, that the author moved, co-authors of the papers is affiliated in other areas or the corresponding author could have a double affiliation. This lead to a sample with respondents who has residence across the world, reportedly; 31.3% from North America, 51.5% from countries in Western Europe and 17.2% are from other countries (the largest share being from China (2.6%) and Brazil (1.7%)).

The second data source, concerning the independent variables about patents activities are collected based on matching the names of the scientists from the survey, with the names of inventors on patents registered in the European Patent Office (EPO). Before the data could be collected, the full names of the scientists were required. For this, the program R were used, applying the package *"RScopus"* to extract the full names of the scientists from the online database Scopus, using their author id - extracted from the survey data. Not all names were able to be matched, which required desk-research, which entails searching online for their name, based on their email address and discipline of work. After this name-search was completed, the patent data could be collected from PATSTAT online (EPO 2017). However, as the survey data is based on the last five years of academic activities, the patent data is correspondingly applied to this timeframe, which amount to patents filled from 2012 until and including 2016. This resulted in two nominal variables. The patent data is stretching from zero patents filed to the maximum number of patents filed per year detected among the researchers from the survey (*see table 3*). In addition to collecting the number of patents, the citations per patents was also collected, to measure the impact of the patents, and is reflected in the total amount of patents for all patents filed in the same timeframe as aforementioned. A timeframe of five-years are also desirable for analysing patents impact, because if they have not received any citations within such time, a patent is unlikely to be remembered (Gittleman & Kogut 2003). The total amount of citations is applied so that the patent measurements will not contingent on identical criteria's. Furthermore, the average number of patents per year is used to measure the frequency of the patenting activity, whereas the impact of the citations is used to measure the total influence of that activity.

The third data source (*Inventor Privilege*) is obtained, by matching the researchers from the surveys' reported country of work, with the data on countries with (shared) inventor privilege reported by the OECD (OECD 2003, p. 26). Some of the participants in the survey had not reported their country of work, therefore it had to be identified manually by desk-research. Here the email and discipline of work, was used to identify which institute they are affiliated to and where it is located, and this is the location used to determine this measurement. This results in binary values, which represent whether the researcher is working in a country with full/shared (1) or no inventor ownership[6] (0) of IPs developed in PROs or on federal research grants (OECD 2003).

After outlining the different data collection methods, consistency of all the variables employed in this study can be addressed. Here is referred to the *internal reliability* of the data and due to the sampling strategies used in this study, variables are presumably stable over time (Bryman 2012). First of all, for the survey data the internal consistency and quality was ensured by employing a unique login system to prove identity. After the survey period ended, the responses were linked to the author profiles on Scopus using the program 'R', reassuring reliability of the respondents. Secondly, the patent data collected from PATSTAT online (EPO 2017), are from an acknowledged and globally used search engine for patents. However, it cannot be expected that all patents in the world are registered in the database, but by combining them with self-reported data from the survey and a large range of variables, it will reduce the risk of overlooking important individual characteristics.

Another important quality aspect of quantitative research is the one of its *replicability*. To which degree the outcomes of the research can be reproduced in the future by others (Bryman 2012, chap.3). In studies like this where cross-sectional data is used that is based on observation of many subjects at one point in time, replicability and thereby also e*xternal reliability* is quite easy to ensure. Replicability is assured as far as its possible, by clearly defining how respondents are selected, lineout measures of the concepts and defining sampling strategy and method used to analyse the data (Bryman 2012). All these specifications are met in this study evidencing that external reliability and replicability are present.

[6] Ownership can be divided between or belong exclusively to; institution (PROs/PRIs), the Inventor(s) and the government.

3.3 Operationalisation

The operationalisation table (2) depicts the twelve independent variables, the three dependent variables and their respective derived values and measurements. Parts of the survey data is based on Likert scale values ranking between 1-5 (strongly disagree to strongly agree), or on scale list data, where the most correct affiliation was indicated by the researchers themselves. The control variables; gender and the scientists affiliated institute, help ensure that the effect of the independent variables on the dependent variable aren't caused by outside factors, which aren't included in the study. The independent variable scientific productivity, are represented by two measurements; paper count & h-index. This has been practiced in previous studies measuring scientific productivity, to cover the different facets and impacts of publication work (Larsen 2011). Therefore, to best represent this factor two measurements were included.

Table 2. Operationalization table

Dependent variables label	***Description***	***Value***	***Measure***
1.Scientist Willingness to start firm	Strongly disagree to Strongly agree	1 to 5	Likert scale (ordinal)
2.Firm Start	"*Have you ever started a firm? If so, how many firms have you started*?" 0: No 1: Yes, 1 firm 2: Yes, 2 firms 3: Yes, > 2 firms	0 to 3	Categorical scale (ordinal / nominal)
3.Active Scientist	Yes - No	1 or 0	Binary
Independent variables label	**Description**	**Value**	**Measure**
Desire Wealth	"*Increase my personal wealth*" Strongly disagree to strongly agree	1 to 5	Likert scale (ordinal)
Enhance academic career	"*Strive for academic career*" Strongly disagree to Strongly agree	1 to 5	Likert scale (ordinal)
Intellectual Curiosity	"*Satisfy intellectual curiosity*" Strongly disagree to Strongly agree	1 to 5	Likert scale (ordinal)
Scientific discipline	"*Which areas of science are you active in?*" *(multiple answers allowed)* 1: Physical sciences 2: Engineering 3: Life sciences 4: Social sciences 5: Humanities	1 to 5	Categorical scale (ordinal)
Inventor privilege	Yes - No	1 or 0	Binary

Academic Rank	1: Bachelor student 2: Master Student 3: Junior researcher 4: PhD student 5: Post-doctoral researcher 6: Senior researcher 7: Assistant professor 8: Associate professor 9: Professor 10: Non-academic staff 11: Other	1 to 11	Categorical scale (ordinal)
Scientific Productivity	1. Paper Count 2. H-Index	0-∞ 0-∞	Scale (nominal)
Patent Experience	1. Yes - No	1 or 0	Binary
Patent Frequency	2. Patent held, divided by year(s)	0-∞	Scale (nominal)
Patent Impact	3. Amount of citations on all patents held	0-∞	Scale (nominal)
Academic engagement	*"During the past two years, while working in academia, which activities did you conduct with the following parties?" (multiple answers allowed)* 1: From within own or other research institute 2: Newly established firm(s) 3: SMEs or Large firms 4: Governmental bodies 5: NGOs 6: Consortium of private, public and scientific partners	1 to 8	Categorical scale (ordinal)
Media appearance	*"Over the past five years, how often have you appeared in media that reached out to more than 50.000 people? This could be through news-paper articles, radio, television or popular webpages"* 1: Never 2: 1-2 times 3: 3-5 times 4: 6-10 times 5: > 10 times	1 to 5	Categorical sale (ordinal)
Control variables label	**Description**	**Value**	**Measure**
Gender	Yes – No ~ (not female – female)	1 or 0	Binary
Scientists affiliated institute	1: General university 2: University of technology 3: (Academic) hospital 4: University of applied science 5: Public research institute 6: Private research institute	1to 7	Ordinal

7: Other

3.4 Data analysis

After cleaning the data, 2,810 total observations were found to be applicable to this study. In these cases data on all variables are available consistently. Regression models is applied to statistically analyse the relationships between the dependent and independent variables. As the nature of this study is quantitative and the dependent variables are all ordinal numbers (binary being the simplest ordinal sequence), an ordinal logit model (OLM) was the most suited model for the first two dependent variables. OLM is applicable when outcome variables are categorized on a single dimension, as the Likert scale. Furthermore, OLM does not assume that the distance between the categories of the dependent variable is equal, which in this case is essential. But to test the hypothesis for the scientists who are still active in a firm they started (dependent variable three), a binary logit model (BLM) is employed, as it only has two categories; active or not active.

In order to test the model fit of the OLM, the Chi-square, $(Chi)^2$, and parallel assumption will be tested. Testing the parallel assumptions, means that the constrained and the fitted ordinal logit model are compared, to test for significance. By doing so, the outcome variable is treated as a nominal value in relation to the chosen independent variable, and must be tested for all independent variables in the model. Furthermore, a $(Chi)^2$ test is applied for all models in RStudio. The $(Chi)^2$ test is used in ordinal logit models to test the coefficient, to ensure that the coefficients of the independent variables are not all zero. Chi-square tests are in studies with large data sets, seen to be a more reliable measurement, compared to i.e. the anova test, to evaluate goodness-of-fit in logistic regressions (McHugh 2013).

Accounting for both OLM and BLM, the independent variables are tested for potential multicollinearity by calculating the variance inflation factors (VIF) (Kabacoff 2011, chap.8). As a general rule, the value of $\sqrt{VIF}$ should not be above two (or VIF greater than 5), else there is a strong suggestion that multicollinearity is present and, therefore, the variables don't improve the model. The full dataset of the BLM will also be tested for its distribution and (adjusted) R-squared (R^2) to identify the goodness of fit, which will help ensure that the model fits the data (Hoetker 2007). Additionally, Nagelkerke's R^2 is tested for the BLM, to display the model's power of explanation (Nagelkerke 1991). Similar to the OLM the coefficients are tested, here using a likelihood-ratio chi-square $LR(Chi)^2$ for the binary logit model by applying a *"lrtest"* function to the models in Rstudio.

Several models are designed to test if any significant correlation is present between the variables. The model which will be applied to all three dependent variables are:

Model 1: Dependent variables only with control variables (cv)
Model 2: Dependent variables with main influential factor group[7] + cv
Model 3: Dependent variables with motivational and ability factors + cv
Model 4: Full model - Dependent variables with all three categories of factors + cv

[7] As specified in the theory section, the main influential factor groups are as followed: Willingness to start a firm = Motivational factors; Starting a firm = Opportunity factors; Staying active in firm = Ability factors.

4 Results

This section gives an overview of the findings. The data presented in table 3, will be presented in matching results tables, following the procedures; OLM and BLM. First, the outcome of 'willingness to start a firm' is presented using an OLM to outline the results. Secondly, the same procedure is used for the dependent variables 'starting a firm', wherefrom results is also presented. Lastly, using a BLM shows the results for the outcome 'staying active in the firm'.

Table 3. Descriptive statistics

		Range	Mean	S.D.
Dependent variables				
Motivation to start a firm	N= 2,810	1 to 5	1.88	
Started firms	N = 405	0 to 3	1.93[8]	
Active in firm	N= 233	0 or 1	0.08[6]	
Motivational factors				
Wealth		1 to 5	2.64	1.15
Enhance career		1 to 5	3.81	0.91
Intellectual curiosity		1 to 5	4.49	0.61
Opportunity factors				
Inventor privilege		0 or 1	47%	0.50
1. SD[9]: Physical sciences		0 or 1	26.8%	0.44
2. SD: Engineering		0 or 1	18.9%	0.39
3. SD: Life sciences		0 or 1	47.3%	0.50
4. SD: Social sciences		0 or 1	19.7%	0.40
5. SD: Humanities		0 or 1	3.1%	0.17
Ability factors				
Academic rank		1 to 11	7.38	1.72
H-index		0 to 139	15.2	15.2
Publications		0 to 1869	67.79	102.08
Patent experience		0 or 1	24%	0.43
Patent frequency		0 to 7	0.07	0.33
Patent impact		0 to 15	0.09	0.73
1.AE[10] Research		0 or 1	99%	0.12
2. AE Newly established firms		0 or 1	28%	0.45
3. AE Private		0 or 1	42%	0.49
4. AE Governmental bodies		0 or 1	45%	0.50
5. AE NGOs		0 or 1	32%	0.47
6. AE Consortium		0 or 1	38%	0.49
Media		1 to 5	2.10	1.21
Control variables				
Gender (Female 0, Male 1)		0 or 1	69.7%	0.46
Institute: General University		0 or 1	63.7%	0.48
Institute: University of technology		0 or 1	10.5%	0.31
Institute: Academic hospital		0 or 1	16.3%	0.37
Institute: University of applied science		0 or 1	7.9%	0.27
Institute: Public research institute		0 or 1	26.9%	0.44
Institute: Private research institute		0 or 1	50.2%	0.22
Institute: Other		0 or 1	1.2%	0.11

[8] Out of total sample of 2,810 observations.

[9] Scientific discipline (SD)

[10] Academic Engagement (AE)

For academic rank, the highest rank obtained is the one applied for the statistical analysis. Academic engagement, and scientific discipline are represented by dummy variables, due to the fact that some scientists are engaged in multiple outreach activities, or worked across a number of disciplines. The same accounts for the control variable institute.

An important precaution to take, is testing the independent variables one-by-one prior to data analysis. The VIF was calculated, ensuring that it is not above 5 and $\sqrt{VIF}$ not above 2, as described in section 3.4. Results show, that all independent variables in the fitted-model is within these critical limits (*Appendix II. VIF Calculations*). This demonstrate that a natural log transformation or dropping variables, will not be necessary. Therefore, as all VIF values are below the critical limit in their natural value, none of them will be transformed nor changed. It proves that none of the independent variables are highly correlated with each other in the fitted-model.

4.1 Ordinal logit model (OLM)

Before running any analysis of an ordinal logit model (OLM), the ordinal outcome categories should be changed into a factor in RStudio, before running the OLM *("polr" function).* When applying statistic regressions, it is always important to ensure a good performance and predictability of the model. Testing variables and models to see whether improvements are possible for the data-set without violating the research is always advisable, even though OLM's are very robust. For example, if rank-deficient, i.e. multicollinearity, is detected in a ordinal-logit model in Rstudio a warning will be displayed and the variables will automatically be dropped to not violate the outcomes. However, testing the model fit is either way essential for any analysis. This study is no exception, and the first way to determine whether an OLM is a good fit for the data, is simply by comparing a null-model with the fitted-model. The null-model only contains one intercept (1), whereas the fitted-model include all parameters. The hypothesis of the null-model is that the effect is equal or there is no difference between the categories, hence no influence at a 0.05 level of significance (Kabacoff 2011). By comparing the residual deviance (RD) of both models, an improved model fit will be indicated by a decrease in RD value from the null-model to the fitted-model. The difference between these models (the decreased value) reflects how much the independent variables improve the fitted-model and, therefore, are valuable in the statistical analysis (Gelman & Hill 2007, p.100). An additional way to also test for this kind of good model fit is by comparing the observed and predicted log-likelihood value. The log-likelihood also measures the variance between the RD of the null-model and the fitted-model.

Secondly, the chi-square $(Chi)^2$ test is employed, and can in addition to the other measurements, show whether the null-hypothesis can be rejected (Kabacoff 2011, chap.10). The chi-square test is used to *"measuring the goodness of fit between the hypothesized structure and the observed data"*(Fornell & Larcker 1981, p.49). If the chi-square of the fitted-model is larger than the critical chi-square value[11] calculated from the confidence interval of 95% ($p<0.05$) and the model's degrees of freedom (df)[12], the null-hypothesis can be rejected. Furthermore, the more significant the p-value of the $(Chi)^2$ is (under $p<0.05$), the more likely it is that a least one of the coefficients in the model is not equal to zero, and therefore do add significance to the model (Kabacoff 2011, chap.13.2).

A third way to test the fit of the ordinal model is by measuring whether the parallel regression assumption is violated for the ordinal logit model. The function *"clm"* was first used in Rstudio, followed by an 'analyse of variance' (ANOVA) test to determine what the difference was between the reduced-fitted-model's and fitted-model's variance components. The ANOVA test *"the statistical significance of added predictors in a linear model"* (Gelman & Hill 2007, p.487). If more of the reduced-fitted-model variables violate the parallel regression assumption, indicated by a significant p-value, then it's advisable to test whether removing variable(s) or using a multinomial logit model would fit the data better. However, applying a multinomial regression, will mean that the information about ordering of the dependent variables category will be lost. The interpretation will not be feasible for the results of this analysis, as an increase in the level of the two first dependent variables, adds value and are explanatory for the outcome. However, measuring the ANOVA provides transparency of the dataset and may reveal significant factors, that are important to investigate in the results of the VIF analysis that evaluate each variable. Furthermore, it has to be accounted for that with a large data set, which includes multiple variables, the validity of this test decrease. This is because the assumption of equal variance i.e. assumption of homoscedastic, may be violated. Here the chi-square test is a qualified substitute or additional resource to ensure the quality of the models when the ANOVA test cannot be relied upon for exclusively analysing the goodness of fit (McHugh 2013). Therefore, the chi-square test is mainly relied upon for goodness of fit. All the results and a more detailed approach of the anova test, are to be found in *appendix III.*

Lastly, McFadden is they last measure used to demonstrate the model's goodness-of-fit (Hu & Lo 2007). McFadden's pseudo R^2 is a measurement for the determination coefficient, R^2, based on the log-likelihood. This means that it compares the variance between the null-model and the fitted-model. Generally, an excellent model fit would be between 0.2 and 0.4 for McFadden's pseudo R^2 tests (Hu & Lo 2007), but ultimately seeing an increase in the value from model one to model four. By using the function *"pP2"* in RStudio the log-likelihood of the fitted-model & the restricted intercept null-model, McFadden's pseudo R^2, and Cragg & Uhler's pseudo R^2 values are produced. Cragg-Uhler's pseudo R^2 is as well a measurement of the difference between the likelihood of the fitted- and null-model, which theoretically lay between values form 0 to 1. The values of the Cragg-Uhler's R^2 test estimates how much of the variance is explained by the variables included in the model. Where 0 would reflect no added explanatory

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[11]Chi-square Distribution Table:
https://people.smp.uq.edu.au/YoniNazarathy/stat_models_B_course_spring_07/distributions/chisqtab.pdf

[12] The degrees of freedom for the models is determined by the number of independent variables included.

power, 1 would be reflecting that the likelihood function of the model is entirely explained (Budd et al. 1996). Ultimately, you would like this value to increase, as it reflect an improved model.

4.1.1 Results for scientists willingness to start a firm

This section examines the importance of relevant individual level factors in relation to the scientists' '*willingness to start a firm'*. First the general statistical models (one to four) are presented, hereafter the more specific results related to each hypothesis will be outlined.
First, examining the goodness-of-fit for the models: The residual deviance (RD) of the OLM null-model for '*willingness to start a firm'* is *RD* =7045.64 and the related log-likelihood =-3518 – with only one intercept (willingness to start firm ~ 1). Evidencing from table 5, model four, the RD and the log-likelihood values of the fitted-model are lower, indicating an improved model. Secondly, the critical values of $(Chi)^2$ for the four models under $p<0.05$, are as followed: df[13] of 8 = 15.51; df of 11 = 19.68; df of 24= 36.42, and a df of 30 = 43.77. None of the $(Chi)^2$ values for the four models of '*willingness to start a firm'* are below the critical values indicating a good model fit. Table 4 and 5 presents an overview.

Table 4. Results of the ordinal logit model predicting 'willingness to start firm' model 1

	M-1		
Control	*Coef.*	*S.E*	*OR*
Gender (Female 0, Male 1)	0.644***	(0.080)	1.904
1.General university	-0.128	(0.086)	0.876
2. University of technology	0.689***	(0.122)	1.992
3. (Academic) hospital	-0.067	(0.100)	0.935
4. Uni applied science	0.262	(0.134)	1.230
5. PRO[14]	0.088	(0.086)	1.092
6. PRI[15]	0.368*	(0.167)	1.445
7. Other institute	-0.251	(0.337)	0.778
Obs.	2,810		
Log-likelihood	-3449		
McFadden's pseudo R^2	0.020		
Cragg-Uhler's pseudo R^2	0.053		
$(Chi)^2$ (df)	135 (8)***		
Res. deviance	6898		
AIC	6922		
1|2	0.304**	(0.11)	
2|3	1.619***	(0.11)	
3|4	3.120***	(0.13)	
4|5	4.717***	(0.18)	

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

13 Degrees of Freedom (df)
14 Public research organisation (PRO)
15 Private research institute (PRI)

Table 5. Results of the ordinal logit model predicting 'willingness to start firm' model 2, 3 & 4.

	M-2			*M-3*			*M-4*		
Motivation	*Coef.*	*S.E*	*OR*	*Coef.*	*S.E*	*OR*	*Coef.*	*S.E*	*OR*
Wealth	0.758***	(0.036)	2.135	0.702***	(0.037)	2.018	0.697***	(0.037)	2.007
Enhance career	0.009	(0.043)	1.009	0.047	(0.044)	1.048	0.066	(0.045)	1.069
Intellectual curiosity	-0.287***	(0.061)	0.750	-0.231***	(0.062)	0.793	-0.217***	(0.063)	0.805
Opportunity									
1. Physical sciences							-0.007	(0.109)	0.993
2. Engineering							0.516***	(0.118)	1.676
3. Life science							0.078	(0.112)	1.081
4. Social sciences							-0.547***	(0.131)	0.579
5. Humanity							-0.151	(0.239)	0.860
Inventor privilege							0.027	(0.078)	1.027
Abilities									
Academic rank				-0.035	(0.025)	0.965	-0.032	(0.025)	0.968
H-index				-0.008	(0.004)	0.992	-0.010*	(0.005)	0.990
Publications				-0.000	(0.001)	0.999	0.000	(0.001)	1.000
Patent experience				0.737***	(0.097)	2.090	0.623***	(0.099)	1.865
Patent frequency				0.214	(0.119)	1.239	0.178	(0.120)	1.195
Patent impact				-0.032	(0.054)	0.968	-0.037	(0.053)	0.963
1. AE research				0.265	(0.341)	1.304	0.191	(0.347)	1.210
2. AE new firm				0.620***	(0.097)	1.859	0.581***	(0.097)	1.787
3. AE private				0.257**	(0.088)	1.293	0.151	(0.090)	1.163
4. AE gov.				-0.066	(0.085)	0.936	-0.071	(0.085)	0.931
5. AE NGOs				0.023	(0.093)	1.023	0.080	(0.094)	1.083
6. AE consortium				0.205*	(0.090)	1.227	0.182*	(0.090)	1.200
Media				-0.049	(0.033)	0.952	-0.012	(0.034)	0.988
Control									
Gender (Female 0, Male 1)	0.543***	(0.084)	1.721	0.470***	(0.086)	1.600	0.417***	(0.088)	1.517
1.General university	-0.099	(0.089)	0.906	-0.033	(0.091)	0.968	-0.015	(0.091)	0.985
2. University of technology	0.574***	(0.124)	1.776	0.402**	(0.126)	1.495	0.197	(0.133)	1.217
3. (Academic) hospital	0.013	(0.105)	1.013	0.022	(0.107)	1.022	0.019	(0.113)	1.019
4. Uni applied science	0.067	(0.137)	1.069	0.028	(0.139)	1.029	-0.0003	(0.139)	0.999
5. PRO[16]	0.054	(0.090)	1.056	0.034	(0.091)	1.035	0.024	(0.092)	1.024
6. PRI[17]	0.472**	(0.169)	1.603	0.376*	(0.172)	1.456	0.405*	(0.174)	1.499
7. Other institute	-0.239	(0.362)	0.787	-0.129	(0.372)	0.879	-0.050	(0.369)	0.952
Obs.	*2,810*			*2,810*			*2,810*		
Log-likelihood	-3184			-3066			-3037		
McFadden's pseudo R^2	0.095			0.129			0.137		
Cragg-Uhler's pseudo R^2	0.231			0.300			0.316		
$(Chi)^2$ (df)	584 (11)***			767 (24)***			803 (30)***		
Res. deviance	6367			6133			6074		
AIC	6397			6189			6142		
1|2	0.935**	(0.32)		1.40**	(0.49)		1.43**	(0.50)	
2|3	2.449***	(0.32)		3.02***	(0.49)		3.08***	(0.50)	
3|4	4.088***	(0.33)		4.78***	(0.50)		4.86***	(0.51)	
4|5	5.750***	(0.36)		6.51***	(0.52)		6.59***	(0.53)	

*p<0.05, **p<0.01, ***p<0.001.

16 Public research organisation (PRO)

17 Private research institute (PRI)

4.1.1.1 Motivational factors

First, the motivational factors will be explained, for those who show a significant relationship with the dependent variables; willingness to start a firm. Three of these factors can be interpreted and the first is desire for (higher) wealth. The results show that for a one unit increase in 'motivated by wealth', the odds of a scientists having higher level of 'willingness to start a firm' is 2.007 times higher, holding all other variables constant. This result is based on the odds ratio, but it can also be interpreted based on the coefficient value. Here it would be explained that for a one unit increase in 'motivated by wealth' (e.g. going from 1 to 2), there will be an 0.697 increase in value of 'willingness to start a firm' on the log odds scale, holding all other variables in the model constant. However, as the interpretation of the coefficient is a bit more complicated to comprehend under the log odds scale, the odds ratio will be the only one describing the results of the ordinal logit models from here forward. Conclusively, *hypothesis 1a* is supported as wealth have a positive relation to the willingness of starting a firm by a scientist. This result shows, that as theory describes, this motivational factor does indeed 'push' the scientist to pursue a more insecure career, compared to their academic peers who are not motivated particularly by wealth.

Hypothesis 2a theorize that desire to enhance one's academic career will result in a positive relationship to willingness to starting a firm. This is not supported, as no significant relationship is present in the fitted-model, holding all other variables constant. Therefore, no difference or an equal effect is detected between the categories of the Likert scale, pointing towards that even though a scientist might be highly motivated to increase their scientific status, it is equally relevant to the outcome of this factors as if they were strongly disagreeing to be motivated by this factor.

For the following motivational attribute, however, the opposite effect is found. The fitted-model predicts that intellectual curiosity is a significant influence, similar to the first previous motivational factors. However, the suggested theoretically relationship is not supported by the data. The statistics show that for a one unit increase in 'motivated by intellectual curiosity' the odds of a scientist showing higher level of 'willingness to start a firm' decreases by 0.805 times, holding all other variables constant. This result reject *hypothesis 3a*, suggesting an original finding for the field SBE. Curiosity for solving "the intellectual puzzle" is not seen to be a desired characteristic of those likely to pursue an entrepreneurial path in the future. However, it is worth noticing that individual interpretation may cause friction, as curiosity could both be seen from a basic or applied research perspective. Also, not to exclude the reasoning, that this measurement is a universal characteristic for scientists (in this study), as many may relate to this as being a strong incentive for them, regardless of their future objectives, as it is an essential characteristic of related to scientists (Lam 2010).

4.1.1.2 Opportunity factors

Both of the two opportunity factors relationships to the first dependent variable, is supported. For *hypothesis 4a* a high significance is shown in the results of the ordinal logit model. Having a background within the scientific discipline of 'engineering' increases the odds of a scientist having higher level of 'willingness to start a firm' by 1.676 times, holding all other variables constant. But, having a background in the scientific discipline of 'social science' the odds of a scientists having higher level of 'willingness to start a firm' are 0.579 times lower, holding all other variables constant. This suggests that applied science disciplines, at least in the case of engineering, do show to have a positive effect on a scientist's willingness to start a firm. Whereas basic science disciplines, as social science, is negatively influencing the desire of scientists to start a firm. These findings are very much in line with theoretical descriptions, where knowledge transfer through commercialisation do occur more often between academia and industry for scientists with a applied science background, compared to those from basic science (Bekkers & Bodas Freitas 2008; Louis et al. 2001; Lee 1996; Perkmann et al. 2013). The fact that it is more obviously *applicable* research, with the intention to be used in an industrial setting, is reflected in these results.

For the second factor of the opportunity factors, it was *hypothesized (5a)* that inventor privilege will not impact the willingness of a scientists to start a firm. This was proven to be correct, holding all the other variables in the model constant. This means that the effect of this variable is either equal effect or there is no difference between being form a country with or without shared- or full inventor privilege. This evidence that this factor has no influence on the outcome of a scientist's willingness to start a firm.

4.1.1.3 Ability factors

For the factors of ability, three out of five factors shows to have a significant impact on the outcome variable. For the first factor, academic rank, the *hypothesis 6a* is supported, but this means that no significant relationship is found. This proves that academic rank has no influence on the outcome of the fitted-model. Therefore, it can be generalized that being a master student or a professor is subordinate to the scientist's internal motivation to become an entrepreneur. Increase in this rank, and the embeddedness which is expected to follow such increase, is not what motivates a scientists to go down the path of SBE.

Surprisingly, *hypothesis 7a* is rejected, as no positive relationship is found between scientific productivity and the first dependent variable. On the contrary, a slight negative relation to h-index is detected. This means that an increase in a scientist's h-index, will cause a scientist's willing to start a firm to decreases. More specifically, increasing the 'h-index' value causes the odds of a scientist having a higher level of 'willingness to start a firm' to be 0.990 times lower, holding all other variables constant. This contradicts what was expected, which is that reflecting 'good science' though citations and large quantity of publications compared to peers, can help indicate a potential future science-based entrepreneur (SBE) (Gittleman & Kogut 2003; Lowe & Gonzalez-Brambila 2007). However, it is very likely that the prestige, reputation and embeddedness in the community, which was expected gains from this kind of productivity, are more reliant on the productivity of novel science through patenting.

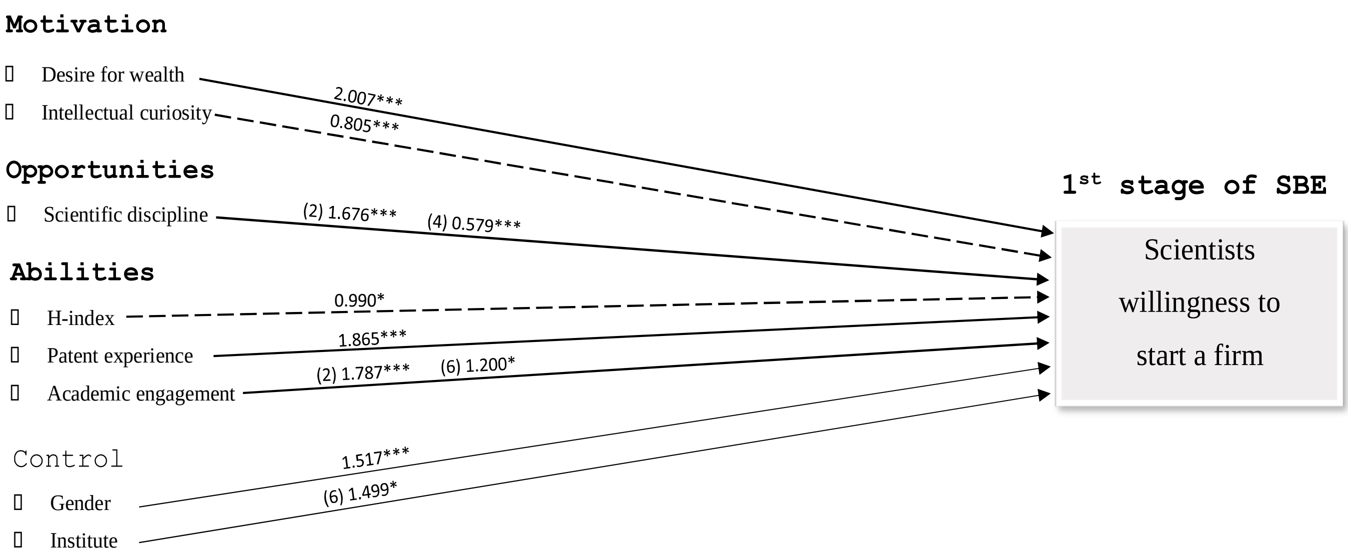
As expected, scientists who have patented and more willingness to start a firm. The scientists who have 'patent experience' increases the odds of the scientist having a higher level of 'willingness to start a firm' by 1.865 times, holding all other variables constant. This result supports *hypothesis 8a*, showing that a scientist who have patented within the last five years, regardless of the amount, have a higher odds of being inclined to start a firm. As it have been described in theory numerous times before, this variable have a strong influence and is also here shown to be highly significant. Having or being part of a patented invention, make it more likely to commercialize the effort. Maybe as it is not only more time consuming, and difficult, to get an idea patented compared to publishing it show to be a significant finding, but the value of the idea may also be clearer to a scientist who chooses to patent the findings of their research.

Hypothesis 9a did not hold, as the expected absence of a significant relationship to academic engagement is not supported. The first measure is highly significant, showing that by having been 'academically engaged with a new firm' during the past two years, means that the odds of a scientist having a higher level of 'willingness to start a firm' are 1.787 times higher, holding all other variables constant. The second measurement is 'academic engaged with consortium of private, public and scientific partners'. By having been engaged with such, during the past two years, increases the odds of a scientist having a higher level of 'willingness to start a firm' with 1.200 times higher, holding all other variables constant. Worth noticing is that the significance of the variable 'academic engagement with private' have no effect on the outcome in model 4, but is seen to be significant under $p<0.05$ in model 3. These results do indicate how important outreach activities are for scientists desire to become an entrepreneur. As it evidence in Perkmann et al. (2013) literature review, it opens up the possibilities for how this research can make real life impacts, also beyond the academic environment. It demonstrates how especially outreach activities to the private segment, both large and small organizations, likely encourage scientists to pursue an entrepreneurial path.

Finally, being visible on media do not show to have any impact on this dependent variable. This supports *hypothesis 10a*, predicting that media will not affect the scientist's willingness to start a firm. Even though nowadays media is having an increasing influence on people's lives, it does not influence the initial stage of SBE. Clearly, overcoming newness and having a large reach is not a determining factor at this stage, possibly because it depends more on attitude, which is based more on internal triggers than external actions.

Figure 2, depicts the described significant relationships and their influence on the dependent variable. The dotted line illustrates that the hypothesised relation have been rejected as the opposite effect of what were expected were detected.

Figure 2. Result model for scientists willingness to start a firm



4.1.2 Results for scientists starting a firm

In this section, the results for the second dependent variable, the 2nd stage of SBE, is presented. First the general statistics results are presented in the four different models, hereafter a more specified outlining of the hypothesised relations are given. In order to determining the model's fit, all the relevant measurements are outlined. The residual deviance (RD) for the null-model of dependent variable *'starting a firm'* by scientists is; *RD* = 2899, and the belonging log-likelihood = -1450, only including one intercept (starting a firm ~ 1). The RD and log-likelihood values of the fitted-model (4) are lower, indicating an improved model. Secondly, the critical $(Chi)^2$ values under a 95% confidence interval are as followed: A df of 9 = 16.92, df of 15 = 25.00, df of 25 = 37.65, and df of 31 = 44.99. None of the values of the models analysed for the dependent variable two, falls below the critical chi-square value, thereby rejecting the null hypothesis.

Table 6. Results of the ordinal regression model predicting 'starting a firm' model 1.

	M-1		
Motivational	*Coef.*	*S.E*	*OR*
Gender (Female 0, Male 1)	0.486***	(0.140)	1.625
1.General university	0.364**	(0.137)	1.440
2. University of technology	-0.037	(0.185)	0.964
3. (Academic) hospital	-0.082	(0.166)	0.922
4. Uni applied science	0.282	(0.197)	1.326
5. PRO	-0.220	(0.141)	0.802
6. PRI	0.419	(0.235)	1.519
7. Other institute	0.411	(0.488)	1.509
Will. firm start	0.777***	(0.053)	2.174
Obs.	*2,810*		
Log-likelihood	-1311		
McFadden's pseudo R^2	0.096		
Cragg and Uhler's pseudo R^2	0.146		
$(Chi)^2$ (df)	258 (9)***		
Residual deviance	2622		
AIC	2646		
0|1	4.04***	(0.22)	
1|2	5.70***	(0.24)	
2|3	6.71***	(0.27)	

*p<0.05, **p<0.01, ***p<0.001.

Table 7. Results of the ordinal regression model predicting 'starting a firm' model 2, 3 & 4.

	M-2			*M-3*			*M-4*		
Motivation	*Coef.*	*S.E*	*OR*	*Coef.*	*S.E*	*OR*	*Coef.*	*S.E*	*OR*
Wealth				-0.176**	(0.061)	0.836	-0.162**	(0.062)	0.851
Enhance career				-0.184**	(0.066)	0.828	-1.971**	(0.067)	0.821
Intellectual curiosity				0.085	(0.098)	1.081	0.084	(0.099)	1.088
Opportunity									
1. Physical sciences	0.144	(0.155)	1.154				0.135	(0.164)	1.145
2. Engineering	0.416*	(0.163)	1.515				0.257	(0.174)	1.293
3. Life science	0.217	(0.156)	1.242				-0.030	(0.166)	0.970
4. Social sciences	0.559**	(0.180)	1.749				0.702***	(0.196)	2.018
5. Humanity	0.942**	(0.287)	2.566				0.853**	(0.302)	2.346
Inventor privilege	-0.034	(0.116)	0.967				0.024	(0.123)	1.025
Ability									
Academic rank				0.111**	(0.041)	1.114	0.106**	(0.041)	1.112
H-index				-0.005	(0.007)	0.995	0.002	(0.007)	1.002

Publications				0.0004	(0.001)	1.000	0.00004	(0.001)	1.000
Patent experience				0.112	(0.143)	1.104	0.190	(0.148)	1.209
Patent frequency				0.021	(0.162)	0.922	0.020	(0.162)	1.021
Patent impact				0.131*	(0.061)	1.130	0.128*	(0.061)	1.136
1. AE research				-0.563	(0.448)	0.552	-0.409	(0.451)	0.665
2. AE new firm				1.138***	(0.140)	3.175	1.174***	(0.142)	3.234
3. AE private				-0.005	(0.142)	0.970	0.032	(0.145)	1.032
4. AE gov.				0.181	(0.136)	1.188	0.162	(0.137)	1.175
5. AE NGOs				0.038	(0.143)	1.058	0.044	(0.145)	1.045
6. AE consortia				-0.150	(0.143)	0.865	-0.170	(0.146)	0.844
Media				0.208***	(0.048)	1.234	0.182***	(0.049)	1.199
Control									
Gender (Female 0, Male 1)	0.516***	(0.141)	1.676	0.429**	(0.148)	1.534	0.434**	(0.150)	1.543
1.General university	0.321*	(0.138)	1.379	0.359*	(0.142)	1.411	0.295*	(0.143)	1.343
2. University of technology	-0.128	(0.185)	0.880	-0.096	(0.190)	0.853	-0.155	(0.200)	0.856
3. (Academic) hospital	-0.010	(0.167)	0.990	-0.269	(0.175)	0.762	-0.146	(0.185)	0.864
4. Uni applied science	0.263	(0.198)	1.301	0.356	(0.207)	1.436	0.363	(0.208)	1.437
5. PRO	-0.246	(0.142)	0.782	-0.184	(0.147)	0.820	-0.196	(0.149)	0.822
6. PRI	0.361	(0.238)	1.435	0.243	(0.248)	1.215	0.142	(0.252)	1.153
7. Other institute	0.379	(0.496)	1.461	0.315	(0.521)	1.407	0.249	(0.517)	1.282
Will. firm start	0.792***	(0.061)	2.207	0.770***	(0.065)	2.168	0.790***	(0.066)	2.203
Obs.	*2,810*			*2,810*			*2,810*		
Log-likelihood	-1301			-1220			-1207		
McFadden's pseudo R^2	0.103			0.158			0.168		
Cragg and Uhler's pseudo R^2	0.157			0.234			0.247		
$(Chi)^2$ (df)	275 (15)***			391 (25)***			406 (31)***		
Res. deviance	2601			2441			2414		
AIC	2637			2497			2482		
0|1	4.41***	(0.51)		4.39***	(0.72)		4.83***	(0.74)	
1|2	6.09***	(0.52)		6.18***	(0.73)		6.65***	(0.75)	
2|3	7.11***	(0.53)		7.24***	(0.74)		7.71***	(0.76)	

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

4.1.2.1 Motivational factors

The motivational Likert scale variables are the first to be interpreted upon. For the second dependent variables, it depicts that two out of three relationships are supported. Firstly, evidencing from table 7, it is confirmed for hypothesis 1b. By seeing a one unit increase in 'motivated by wealth' the odds of a scientist having higher level of 'starting a firm' decreases by 0.851 times, holding all other variables constant. Substantiating the theoretical predictions that a change this factors influence will be observed from the first stage to the second of SBE. Changing from being a positive effect, to being a negative effect with more than 1 unit odds value in variance This supports *hypothesis 1b*, predicting that monetary rewards are not a supporting objective for scientist's who strive to successfully starting a firm.

Furthermore, the desire to 'enhance academic career' is as well detected to impact the activity of 'starting a firm' by scientists, negatively. For a one unit increase in 'enhance academic career' the odds of a scientist having higher level of 'starting a firm' decreases by 0.821 times, holding all other variables constant, thereby supporting *hypothesis 2b*. This factor adds no significant effect to the foregoing stage of SBE, but its effect on this stage reflect its undeniable influence on entrepreneurial activities, as it was also expected.

Hypothesis 3b is not supported as the assumption that intellectual curiosity would have a positive impact on starting a firm, do not hold. It is found to not have any significant influence, holding all other variables in the fitted-model constant, on the activity of starting a firm. Surprisingly, this variable is not supporting theoretical implications for either this nor the forgoing stage. Whether it is due to its general presence in most scientists or whether this is, in spite of expectations, not altering for an entrepreneurial outcome is difficult to concluded upon, as to speculations of why a relative impact is detected on the first stage, but not on this, execution stage. But it does suggests that it is relative undesired characteristic for this kind of activity, as it does not show any positive influence. One explanation could lay in the fact that desire for intellectual curiosity is largely related to an academic logic. For a long time, conflicting views between academic and commercial logics has tended to be overstated, which may still shape the general perceptions of scientists (Sauermann & Stephan 2013). Meaning, that when moving to a commercial logic, or away from an academic logic, practices change - hence affecting general (perception of) motivation.

4.1.2.2 Opportunity factors

Surprisingly, none of the two opportunity factors supports the hypothesized relationships for the outcome of this stage. Interestingly the scientific disciplines do not support *hypothesis 4b*, but is on the other hand showing a conflicting result. Because, by being from the scientific field of 'social sciences' the odds of a scientists having higher level of 'starting a firm' are 2.018 times higher, holding all other variables constant. Furthermore, scientists with an academic background in 'humanity' are also increasing the odds of having a higher level of 'starting a firm' with 2.346 times, holding all other variables constant. Therefore, rejecting the hypothesized relations that scientists from applied science discipline would be more likely to start a firm. Opposite, the basic science disciplines have a rather significant influence and high odds ratio. It is observed from the models, that the signs changes from the first to the second stage of SBE, indicating an interesting development. It is also worth noticing that the impact of the variable 'engineering' do show significance under $p<0.05$ in model two, but by introducing the additional variables into the model, this significance fade. But the significance of the two basic science disciplines are undeniable. Being at the frontier of knowledge creation, and not only application, is acknowledge as being of increasingly importance to science-based firms, likely to be reflected on the entrepreneur simultaneously (Pisano 2010).

For the second variable in this category, no relationship is found. *Hypothesis 5b* is therefore not supported, suggesting that inventor privilege and starting a firm are not interdependent.
As this category of factors were expected to particularly hold for the dependent variables of starting a firm, it is somehow disappointing that no relationship is found, even though particular scientific disciplines are seen to be highly significant for this stage. But as this is a relatively unexplored field of research, especially in the context of quantitative analysis, finding something unforeseen, is proving that not all values are generalizable, and some may only hold for this specific strand of entrepreneurship.

4.1.2.3 Ability factors

Several skills and experiences representing ability, have shown to have a highly significant influence on a scientist's likelihood of successfully starting a firm, whereas others did not show the expected relationship. The first ability factor to show a significant relationship is 'academic rank', where for a one unit increase in this factor, the odds of a scientist having a higher level of 'starting a firm' are 1.112 times higher, holding all other variables constant. This finding support *hypothesis 6b*, meaning that any 1 unit increase in a scientist's academic rank, e.g. from master to post-doctoral, or assistant professor to associate professor, increase the likelihood of the scientist establishing and successfully starting a firm.

On the contrary, for following tested relationship, no support is found. *Hypothesis 7b* had the assumption that scientific productivity would make a scientist more likelihood to start their own firm. However, none of the measurements employed in this study exhibited any significant relation to the second stage of SBE. As for the foregoing stage, this is not seen to exert any positive influence on scientists to pursue the entrepreneurial path, only significant evidence obtained points in the opposite direction.

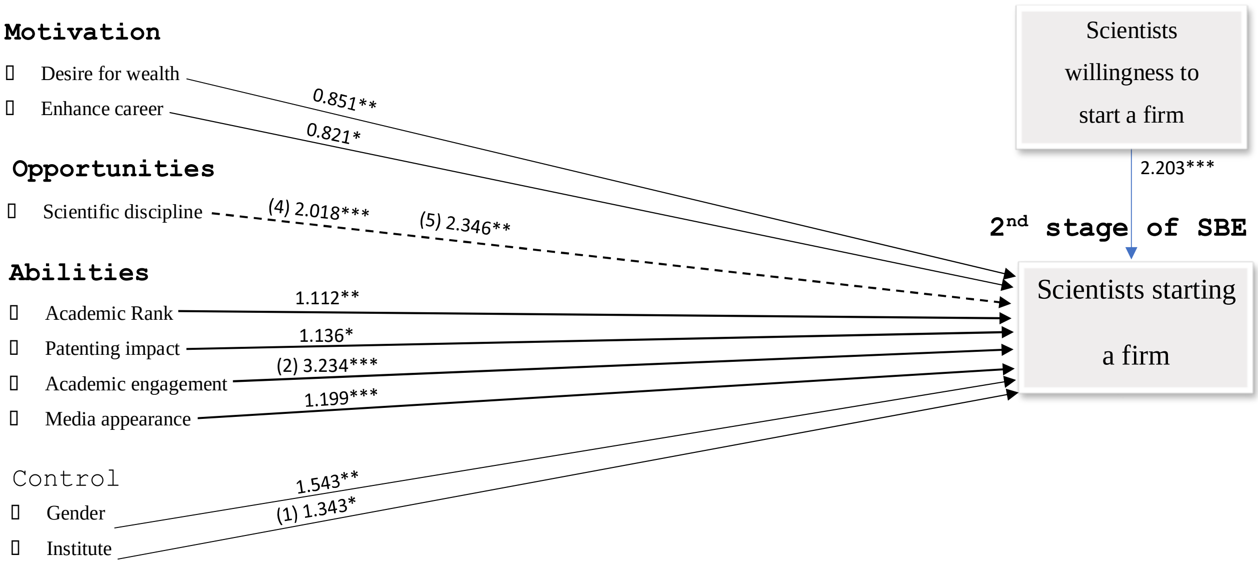
Similar to the previous stage of SBE, having patented has a positive effect on starting a firm. However, whereas for the previous stage it was about the experience, here it hold for the more qualitative measurement, As it depicts in table 7, for a one unit increase in 'patent impact' the odds of a scientist having a higher level of 'starting a firm' are 1.136 times higher, holding all other variables constant. This partly supports *hypothesis 8b,* proving that a scientist who has acquired (an increase in) patent citations on any (amount of) patent(s) filled within the last five years have a higher odds of successfully starting a firm. As this factors, have up until now, been relatively unexplored in the broader entrepreneurial literature, here is presented evidence for its validity. Previously, patent experience has been the main factor for measuring IP ownership, focusing on individuals habits by measuring past behavior. This measurement provides the possibility to strengthen and broaden the understanding of individual-level SBE, by combining a habitual and quality factor into one, namely patent impact. As it has become a rather common practice to patent and patents is only one out of several way to transfer knowledge (Grimaldi et al. 2011), firms and collaborators may find it more attractive if this experience is as well valued and proves to be relevant in the community and for further development.

The fourth ability factor, support *hypothesis 9b*. It shows in model four that by having been 'academically engaged with a new firm' during the past two years, the odds of a scientists having higher level of 'starting a firm' are 3.234 times higher, holding all other variables constant. Proving an outstanding effect on the odds of both dependent variable one and two. The fact that one particular academic engagement activity shows such significant increase in likelihood of scientists engaging in SBE, is an important insight for future studies. At least for SBE, a more context specific experience than academic engagement in general, is needed. By covering over a broad range of activities under AE will not reveal the real impact which make it difficult for policy-makers to target specific groups of individuals. However, this study breaks down the multiple activities included under the activity of AE, specifically showing to be very valuable for this strand of literature. As noticed, outreach activates as commercialisation of research, have become an increasingly used channel for transferring knowledge between the public and private segment (Miranda et al. 2017). For this reason especially, activities like this should be given specific attention, as they are clearly indicating already established links to the private segment. This can likely be crucial for a successful execution of transferring knowledge through firm creation.

The influence of media activities, which as patent impact, is relatively unexplored in entrepreneurship literature, is proven to be highly significant for the likelihood of starting a firm. With a one unit increase in 'appearing in media that is reaching more than 50.000 people' (during the past five years) the odds of a scientist having a higher level of 'starting a firm' are 1.199 times higher, holding all other variables constant. This can be through various channels, but it evidence that media are becoming (increasingly) influential, even in the academic and entrepreneurial sphere. Thus, supporting *hypothesis 10b* for the dependent variables 'starting a firm' by scientists.

In figure 3, it is depicted which of the relationships from the conceptual model is found to be statistically significant. The dotted line illustrates a rejected hypothesised relationship.

Figure 3. Result model for scientists starting a firm



4.2 Binary logit model

For the binary logit model the measure Nagelkerke R^2, similar to Cragg & Uhler R^2, is used for evaluating the goodness of fit. Nagelkerke R^2 can be calculated from the result of the statistical analysis. By calculating this values for the models, the power of explanation can be displayed (Nagelkerke 1991). A goodness of fit is generally accepted to be when the Nagelkerke R^2 value is within the scale of 0 to 1, an preferably an increase in value is desired, as for Cragg & Uhler's pseudo R^2. However, McFadden's pseudo R^2 is used here as well to determining the coefficient, R^2, based on the log-likelihood. This means, that it compare the variance between the null-model and the fitted-model, as described in section 4.1. Generally, the more of the variation explained by the model, the higher the R^2 value will be, with a maximum of 1. However, standing alone values can be difficult to interpret, as the "desirable" value may not be the same for all statistical applications. Therefore, it is best to compare the different R^2's for all models, as the model with the largest R^2 statistic will be the best model fit for this data set. For this data-set the fitted-model (4) have the largest R^2 values, indicating the best model fit, when comparing the four models.

Furthermore, as for the two previous models, the residual deviance (RD) of the null-model for dependent variable '*staying active in firm'* is higher than for the fitted-model. The RD of the null-model = 1606, only including one intercept (staying active in firm ~ 1). The RD of all the models below are all lower, reflecting a good model fit. Most importantly, the fitted-model (4) has the lowest RD, showing the most improvement. The same is showing for the log-likelihood of the null-model as for RD. The log-likelihood values = -803, evidencing that the fitted-model exhibit the most improvement. By employing the log-likelihood of the fitted- and null-model, the likelihood-ratio chi-square, $LR(chi)^2$, can be calculated. Such test shows which distribution the LR follow. The critical $(Chi)^2$ values for the BLM models are as followed; df of 8 = 15.51, df of 21 = 32.67, df of 24 = 36.42, and df of 30 = 43.77. None of the values for the four models, falls below this critical limit. Table 8 and 9 presents an overview of the statistical results.

4.2.1 Results for scientists staying active in firm

Table 8. Results of the binary regression model predicting 'staying active in firm' model 1.

Staying active in firm	*M-1*		
Control	*Coef.*	*S.E*	*OR*
(Intercept)	-3.311***	*(0.229)*	*0.036*
Gender (Female 0, Male 1)	0.832***	(0.182)	2.297
1.General university	0.286	(0.167)	1.330
2. University of technology	0.432*	(0.213)	1.541
3. (Academic) hospital	0.035	(0.197)	1.036
4. Uni applied science	0.538*	(0.226)	1.712
5. PRO	-0.352	(0.180)	0.703
6. PRI	0.802**	(0.258)	2.232
7. Other institute	0.237	(0.626)	1.268
Obs.	2,810		
Log-likelihood	-778		
McFadden's pseudo R^2	0.032		
Nagelkerke R^2	0.041		

LR $(Chi)^2$ (df)	50.9 (8)***
Residual deviance	1555
AIC	1573

**p*<0.05, ***p*<0.01, ****p*<0.001.

Table 9. Results of the binary regression model predicting 'staying active in firm' model 2, 3 & 4.

	M-2			*M-3*			*M-4*		
Motivation	*Coef.*	*S.E*	*OR*	*Coef.*	*S.E*	*OR*	*Coef.*	*S.E*	*OR*
(Intercept)	-4.028***	(0.688)	0.018	-4.611***	(0.901)	0.009	-5.135***	(0.936)	0.006
Wealth				0.107	(0.068)	1.113	0.114	(0.069)	1.120
Enhance career				-0.206*	(0.080)	0.814	-0.219**	(0.081)	0.803
Intellectual curiosity				0.242	(0.124)	1.274	0.247*	(0.125)	1.281
Opportunity									
1. Physical sciences							0.033	(0.205)	1.033
2. Engineering							0.161	(0.214)	1.174
3. Life science							-0.035	(0.207)	0.966
4. Social sciences							0.629*	(0.250)	1.876
5. Humanity							0.451	(0.399)	1.571
Inventor privilege							0.316*	(0.155)	1.371
Ability factors									
Academic Rank	0.033	(0.052)	1.033	0.030	(0.052)	1.031	0.033	(0.052)	1.034
H-index	-0.006	(0.008)	0.994	-0.008	(0.008)	0.992	-0.004	(0.008)	0.996
Publications	0.0004	(0.001)	1.0004	0.0004	(0.001)	1.0004	0.0003	(0.001)	1.0003
Patent experience	0.581***	(0.170)	1.787	0.551**	(0.171)	1.734	0.645***	(0.179)	1.906
Patent frequency	0.061	(0.185)	1.063	0.066	(0.185)	1.069	0.077	(0.187)	1.080
Patent impact	0.119	(0.066)	1.126	0.121	(0.066)	1.128	0.111	(0.066)	1.118
1. AE research	-0.663	(0.560)	0.515	-0.653	(0.563)	0.521	-0.523	(0.571)	0.593
2. AE new firm	1.685***	(0.181)	5.391	1.698***	(0.182)	5.463	1.731***	(0.184)	5.649
3. AE private	0.078	(0.183)	1.081	0.083	(0.184)	1.087	0.144	(0.188)	1.155
4. AE gov.	0.030	(0.173)	1.030	0.007	(0.173)	1.007	-0.005	(0.174)	0.995
5. AE NGOs	0.100	(0.179)	1.105	0.133	(0.179)	1.142	0.101	(0.182)	1.107
6. AE consortia	-0.230	(0.181)	0.794	-0.264	(0.182)	0.768	-0.219	(0.185)	0.803
Media	0.184**	(0.058)	1.202	0.182**	(0.058)	1.200	0.160**	(0.060)	1.173
Control									
Gender (Female 0, Male 1)	0.575**	(0.192)	1.777	0.592**	(0.194)	1.808	0.631**	(0.197)	1.880
1. General university	0.338	(0.176)	1.402	0.343	(0.227)	1.409	0.278	(0.180)	1.321
2. University of technology	0.204	(0226)	1.227	0.200	(0.227)	1.221	0.192	(0.240)	1.212
3. (Academic) hospital	-0.133	(0.212)	0.875	-0.072	(0.213)	0.931	-0.031	(0.224)	0.969
4. Uni applied science	0.551*	(0.242)	1.735	0.532*	(0.244)	1.702	0.538*	(0.246)	1.713
5. PRO	-0.347	(0.190)	0.707	-0.353	(0.191)	0.702	-0.366	(0.192)	0.694
6. PRI	0.675*	(0.280)	1.965	0.680*	(0.280)	1.974	0.534	(0.287)	1.705
7. Other institute	0.313	(0.681)	1.367	0.317	(0.680)	1.373	0.248	(0.677)	1.282
Obs.	2,810			2,810			2,810		
Log-likelihood	-672			-667			-659		
McFadden's pseudo R^2	0.163			0.170			0.180		
Nagelkerke R^2	0.205			0.213			0.224		
LR $(Chi)^2$ (df)	263 (21)***			273 (24)***			289 (30) ***		
Residual deviance	1343			1333			1318		
AIC	1387			1383			1380		

**p*<0.05, ***p*<0.01, ****p*<0.001.

Depict in table 9, seven of the independent variables are significant under a 95% confidence level for staying active in a firm. This is motivational, two opportunity and three ability variables. These factors of significance will be described in the following sections.

4.2.1.1 Motivational factors

Hypothesis 1c is not supported, meaning that no negative relationship is found between desiring wealth and the likelihood of staying active in the firm. This means that the variable is either equal or there is no difference between the levels of desiring wealth. Therefore, whether a scientist very much agree or disagree to this statement, do not have an influence on the scientist's likelihood of staying active in the firm, holding all other variables constant. Reflecting that other motivational factors is likely to be much more important for an individual, for them to keep their internal drivers stimulated.

The variable, desire to 'enhance academic career', show a supported relationship for *hypothesis 2c*. Because, the odds that scientists will stay active in a firm they started are 0.803 times lower, with a one unit increase in the desire to enhance academic career. Meaning, that scoring this motivational factor one "level" higher, e.g., from strongly disagree to disagree, will decrease the scientist's odds of staying active in the firm they started by a factor of 0.803. This is not a surprising outcome, but it shed light on the importance of being mentally prepared as well, before taking the leap from academia to industry, in order to successfully stay active in the firm. Commitment is therefore a key factor for entrepreneurship, especially recognized for scientists.

Hypothesis 3c is also supported, showing a positive relationship between intellectual curiosity and staying active in the firm. This means, that the odds that a scientist will stay active in the firm are 1.281 times higher, with a one unit increase in the intellectual curiosity Likert scale variable, holding all other variables constant. This result reflect that staying curious is a possible trigger for wanting to explore and expand personal horizon, which is here detected to be an important characterise for an entrepreneurs further success. For a science-based entrepreneur (and the firm), being curious is does however, not show heterogeneous influence over the course of SBE. This could mean that curiosity reflect two different aspects of the same situation. First of all, if a scientist is rating this factor highly in the initial stage, it is likely to reflect their engagement in the research (their current regime). Meaning, that being involved in a very interesting research project, is likely to trigger the scientists intellectual curiosity, but this may have the contrary effect on willingness to leave this regime. Whereas, when the scientist find themselves at the third stage of SBE, they may realize that the exact same incentive which motivated them to be in research, is the same which motivate them to stay active in the firm, just with a changed objective.

Besides the two characteristics shown here to be influencers, having the necessary combination of abilities and make good use of the opportunities offered by the institutional environment, are seen to be important as well for a scientist to stay active in the firm. The opportunities and abilities affecting this outcome are presented in the following subsections.

4.2.1.2 Opportunity factors

The factors of opportunity are both significant for the outcome, 'staying active in the firm'. Firstly, the odds for a scientist to stay active in the firm are 1.876 times higher, when they come from a social science background, holding all other variables constant. This reject *hypothesis 4c* that theoretically argue that a positive relationship, on the contrary, would be expected from scientists with an applied science background. Numerous previous researches on entrepreneurship, empirically support hypothesis 4c (Bekkers & Bodas Freitas 2008; Louis et al. 2001; Lee 1996; Perkmann et al. 2013). Therefore, this is quite a surprising outcome, which indicate that basic research findings, have become more acceptable to pursue in a commercial setting, at least within science-based entrepreneurship. As this relationship was also found for the foregoing stage of SBE, it may indicate a trend which is either very context specific or may also hold for the broader entrepreneurial literature as well.

Secondly, *hypothesis 5c* is also showing a significant impact, but in this case it is supporting the expected relationship. Evidencing that working in a country with shared- or full inventor privilege do have an influence on entrepreneurial firm activity. It showed that the odds for staying active in the firm are 1.371 times higher when a scientist come from a country which provide legal rights over patented inventions, developed within PRIs and PROs, holding all other variables constant.

4.2.1.3 Ability factors

Lastly the ability factors; the category of variables especially predicted to hold for the activity of stage three SBEF. Arguing that, acquiring abilities through experience can help build social- and context-specific competencies, legitimacy, and knowledge creation that is likely to be crucial for success. *Hypothesis 6c*, however, shows an absent of a positive relationship which differ from the projected influence. It can neither be supported nor rejected that academic rank has an influence on the scientist's continues activity in the firm started. It can only be assumed that the likelihood is equal for all ranks or does not differ, as a consequence of a scientist's academic status.

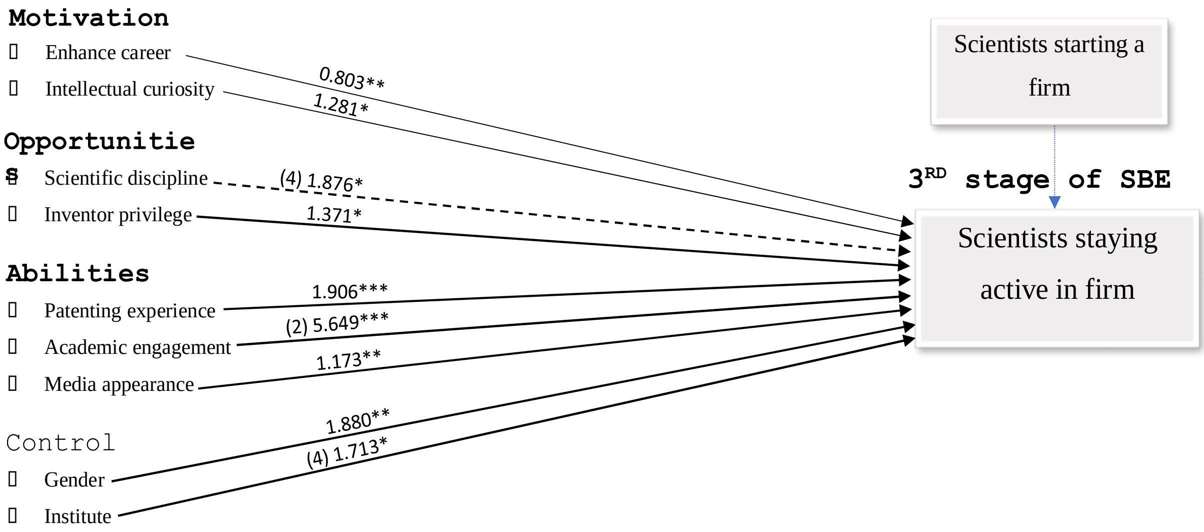
Hypothesis 7c does also not support the expected. For this factor a positive relation was as well hypothesized, but were not proven in the statistical analysis. Scientific productivity have no particular impact on a scientist staying active in the science-based firm. This variable showed not to hold for any of the three stages of SBE, in fact, the only significant relationship found is for the first stage, where h-index have a slightly negative impact on a scientists willingness. The only conclusion which can be made from such lack of relations is that; even if scientists are (either) very productive and receive a great quantity of citations on his/her published work, it will not directly impact them to pursue a career as an entrepreneur.

Fortunately the remaining three factors show significant impacts on the outcome variable. First of all, *hypothesis 8c* is supported, showing that the odds that a scientist stay active in the firm are 1.906 times higher, when the scientist has patented during the last five years, regardless of the amount, holding all other variables constant. This result contribute to the reliability and robustness of this measurement in studies on science-based entrepreneurial firms. Amongst a large data set including multiple variables, this measurement still provides an understanding of what makes scientists likely to stay active in a firm they started. Possible reasons for this can be the awareness and support from their embedded community, which is likely increasing as patent experience is gained (Park et al. 2017; Shane et al. 2003; Goethner et al. 2012). Furthermore, it is pointing towards the importance of having patent experience, subordinate to its extent, indicating that such practical knowledge is the most essential patent factor. However, showing from the second stage of SBE, starting a firm in the first place is influences by the quality of the patent, hence contribution science, showing that these measurements are interrelated.

Additionally, another recurring factor of this study, demonstrating to be positively related to all three stages of SBEF, is the one of academic engagement with a new firm (within the past two years). The odds that a scientist will stay active in the firm are 5.649 times higher for scientists who have been ‘academically engaged with newly established firm(s)’, holding all other variables constant. The result support *hypothesis 9c* with a large increase in odds for the scientists who, while working in academia, have been engaged in e.g. contract research, consultancy or joint research with a new firm (Perkmann et al. 2013). This underlines the importance of giving special attention to such relationship. Its strong influential power is undeniable for all three activities of SBEF, making it an essential contributor to the understanding of this concept.

The last explanatory variables shows a supported relationship for *hypothesis 10c*. Particularly, the odds of staying active in the firm are 1.173 times higher, with a one unit increase in ‘media appearance’, holding all other variables constant. This is almost the same effect seen in the foregoing stage of SBE. Once more demonstrating the interesting development in this field of research. Increased importance of being visible and approachable to a broader audience, also outside the sphere where specific knowledge is often circulated and shared, shows to be a uprising vital part of be(coming) an entrepreneur. Interestingly, this result points towards the need to demonstrate both social and communicating skills, in order to reach a successful development, as outreach activities clearly cannot be based on academic skills only.

Figure 4. Result model for scientists staying active in firm



In figure 4, it is depicted which of the relationships from the conceptual model was found to be statistically significant. The dotted line illustrates that the hypothesised relation is rejected as a significant but opposite effect of what were expected, is detected.

5 Conclusion

The results obtained in this study enable further development of the concept science-based entrepreneurship (firms). In table 10, an overview of the hypothesised results are given, supporting twenty out of thirty relationships between the dependent and independent variables. This gives an apprehend and collective summarization of the relationships that should be given particular attention in further research conducted on individual-level science-based entrepreneurship (firms).

Table 10. Overview of hypotheses results

Hypothesis	***Result***	***Expected Relationship***	***Observation***
1a	Supported	*Positive*	
1b	Supported	*Negative*	
1c	Not supported	*Negative*	
2a	Not supported	*Positive*	
2b	Supported	*Negative*	
2c	Supported	*Negative*	
3a	Rejected	*Positive*	Negative relationship
3b	Not supported	*Positive*	
3c	Supported	*Positive*	
4a	Supported	*Positive*	Positive relationship for ‘applied science’
4b	Rejected	*Positive*	Positive relationship for ‘basic science’
4c	Rejected	*Positive*	Positive relationship for ‘basic science’
5a	Supported	*None*	
5b	Not supported	*Positive*	
5c	Supported	*Positive*	
6a	Supported	*None*	
6b	Supported	*Positive*	
6c	Not supported	*Positive*	
7a	Rejected	*Positive*	Negative relationship to H-index
7b	Not supported	*Positive*	
7c	Not supported	*Positive*	
8.1a	Supported	*Positive*	
8.2a	Supported	*None*	
8.3a	Supported	*None*	
8b	Partly supported	*Positive*	Positive relationship to patent impact
8c	Partly supported	*Positive*	Positive relationship to patent experience
9a	Not supported	*None*	Positive relationship for AE with new firm & consortiums
9b	Supported	*Positive*	Positive relationship for AE with new firm
9c	Supported	*Positive*	Positive relationship for AE with new firm
10a	Supported	*None*	
10b	Supported	*Positive*	
10c	Supported	*Positive*	

This study has tested a large amount of factor's effect on individual-level science-based entrepreneurship in order to answer to the research question. Despite increase interest in these kind of firms, little have been confirmed, about determinants amongst these particular individuals. The study have shed a light upon which incentives are of marginal importance and those that aren't. At the same time, it has determined what are specific factors for each stage of SBE and which are fruitful for the entire entrepreneurial path – from the initial willingness to a scientist being successful with their firm(s). Answering the research question is not straightforward and require interconnected and in-depth explanations. However, influences are found among both motivational, opportunity and ability factors, on the practice and activity of science-based entrepreneurship. Here the most salient results will be discussed and the main outcomes described.

For the first stage of SBE (willingness to start a firm), the motivational factor of 'intellectual curiosity' was found to be of negative influence. This rejected the hypothesis (3a), and left a rather surprising result. This either points towards and original finding or a relationship which require more investigative attention. It was expected that the engagement in challenging activities would be triggered by such desire to satisfy intellectual curiosity. However, as a negative impact was detected, the interpretation of this result could become scattered. The fact that for an entrepreneurial opportunity to at all be recognised as a future possibility, a certain understanding of research's commercialisation potential is needed which may set a natural limitation on this outlook, if lacking (D'Este et al. 2010). If a scientist cannot envision to commercialise his/her research and lack the ability to convey academic knowledge to a broader audience, they may not possess such curiosity, in the sense of expanding such research beyond the academic segment. Naturally, self-interpretation could be a influencer on this factor. If a scientist's is very involved in an interesting research topic facilitated by an academic institute at the time of survey, the perspective attached to this measurement can be more related to grounding knowledge over applying knowledge, depending on the stage of the research. But, the only conclusion which can be drawn from this result is, that for science-based entrepreneurship 'intellectual curiosity' is not a desirable characteristic when associated with motivations for scientists to start a firm. Furthermore, as it was pointed out in the result section, it seems that a potential weakness is turned into a strength over the time of the entrepreneurial journey, as the odds switches sign, though it is insignificant for the "decision" stage (starting a firm).

The motivational factor of 'curiosity' is not the only hypothesis that have contradicted the expected relationship. Scientific discipline have fallen short on supporting two of the predicted relations; hypothesis 4b and 4c. The results suggests that basic science disciplines are having a significant impact on stage two and three SBE, whereas the expected positivise relationship was for applied science disciplines. In spite of the common recognition that entrepreneurs are generally individuals from applied-related fields of work, these results suggests otherwise. A explanation could be in line with evidence found by Hayter (2015) in his follow up research on academic entrepreneurs. He found that even though prior knowledge about commercialisation is important, the main capability for any scientific spinoff is the ability to translate research into something desirable for the industry and consumers. Envisioning such translation can very likely require people with different sets of knowledge (Knockaert et al. 2011), and science-based firms are therefore likely to emerge at the intersection of different disciplines (Pisano 2010). Innovation and “new bodies of knowledge” are a result of cumulative learning, but also such integration of cross-disciplinary knowledge as e.g., chemistry and engineering merging into the discipline of chemical engineering (Pisano 2010). Presumably, basic science in its wider terminology, could be the ‘glue’ which combines knowledge and integrate different background required to execute such risk activity as starting a firm. Therefore, distinguishing between disciplinary backgrounds, may not be as straightforward as theorized. Furthermore, the switch detected between the stages of SBE (here referring to stage one to two), can likely be a reflection of the knowledge required over a science-based entrepreneurial firm’s development, and that this can be regarded to probably change as different skills are required. Having a product/service and ‘translation’ skills can be essential to a spin-off’s initial stage in order to even establish a firm, whereas innovation and creating new knowledge may be of crucial importance for future survival in a competitive environment.

Hypothesis 7a, the influence of H-index, shows to have a contradicting and negative impact to the expected, whereas the related hypothesised relationship for scientific productivity, 7b and 7c reflected no influence neither for h-index nor for the publication measurement. Since theory have described other relationships, these results are rather surprising. This outcome suggests that a measurement widely used in both AE and Entrepreneurship literature, do not seem to impact the shift nor positively influence the willingness for the specific activity of SBE. This reflect exactly how publications are recognized to be a synonymous for the academic segment, whereas secrecy *(e.g., patenting)* is a synonymous for the industry segment (Pisano 2010). Such division is rather clear from the results, as publication work (quality) is evidenced to be more likely to draw the scientist in the opposite direction of initiating entrepreneurship. Reflecting on the h-index measurement, it could also be sensible that the scientists who already proved to have a high quality of their academic work, may not be the one’s envisioning or desiring a different career path. These scientists are likely to be well-embedded in their community and it would be understandable that they, therefore, do not want to pursue their ideas and knowledge in a risky setting, as entrepreneurship. Staying in academia is more likely to provide them with stability and a more reliable future career path.

However, the main implications of this study contribute to the understanding of what generally characterise a science-based entrepreneur (SBE). Here an image will be established, based on the findings, of how an individual scientist who is willing to or are pursing entrepreneurial activities, is to be generally distinguished from their peers. At the first stage, for a scientist who is ***willing to start a firm,*** thereby take the leap into the private landscape of commercially-orientation organizations, certain motivations, opportunities and abilities are found to be essential. For the main influential category of this dependent variable; motivation, it is recognised that desiring higher monetary rewards e.g., envisioning a future with possibilities to generate higher earnings, will trigger the individual to see entrepreneurship as an attractive career path. Ideally motivation should not be found in satisfying intellectual curiosity per se, as a strong incentive towards this will draw a scientist in the opposite direction. A scientist who additionally have prior commercialisation knowledge, by being in possession of one or more patents, supports a favourable view upon stepping into the private segment. Opposite, being in possession of a high or increasing amount of citations on publications (h-index) compared to peers, have a negative effect on willingness. Currency and incentives are well-known to differ from academia to the commercial sphere, and the results somehow support these generally perceived differences between those segment. That profitability and secrecy are more common incentives for the commercial segment (hence wealth and patenting). Where in contrast, for the academic segment knowledge output, peer reviews, reputation and open science are common practices (hence intellectual curiosity and publications) (Pisano 2010). This is also in some way reflected in the academic background of those who are found to be willing to pursue entrepreneurship. Because, the scientists who are found to be more willing to leap into the industry and seize the opportunity of entrepreneurship, are from Engineering backgrounds. Where on the other hand, those individuals are who come from a Social Science background, are more unlikely to demonstrate the same willingness. Lastly, a scientist who is willing to change their career in such drastic manner, is very likely too already having established links to the private sector prior to actual entrepreneurial action. Especially among those who are engaged with newly established firms, starting a firm will not seem as an absurd or distant idea.

Painting a picture of the scientist who has actually taken the leap into the world of entrepreneurship by ***starting a firm***, show some differences in characteristics than the foregoing stage that was more influenced by *expectations* or *ideation*. Generally, the entrepreneurial individual who start a firm, is not to be found amongst engineers, but on the contrary amongst those with an academic background in Social Science or Humanity. These individuals explore the world of creating *"first principles"*, over applying science. Another conflicting effect with the forgoing stage is, those individuals found at this stage are more likely to be rather demotivated by wealth in it broader sense. It reveals that incentives change over the course of entrepreneurship, from the idea is created till it is achieved, motivations change. Meaning that individuals who are *still* motivated by monetary rewards at his stage, are less likely to successfully follow through with implementing such drastic career change in their lives, in line with the argument by Hayter (2015). He saw a trend among academic spinouts, revealing that science-based entrepreneurs found that they could have been achieving higher earnings, by taking part in other opportunities and this incentive was not what kept them involved. Not unexpectedly, a scientist at this stage is motivated to change a career path, and is therefore, not the same who want to enhance (current) academic career. However, having already enhanced academic career, by obtaining a sufficient academic rank, do show to be a relevant attribute among science-based entrepreneurs. The experience and reputation that normally follows an academic career life cycle (*increase in rank*), favour their position (D'Este & Patel 2007). As for the foregoing stage, established networks, especially with academic newly established firms, influence a scientist on this stages of SBE. The similarity in influence, suggest that this (also) lays at the interface between the stages, and is maintained during the transfer from one segment to another. Having access to the networks and knowledge obtained through academic engagement, perhaps make it more manageable for the scientist to undertake such extensive activity as starting a firm, as it creates community support. Beside their knowledge about commercialisation from academic engagement, science-based entrepreneurs are as well the owner of intellectual-property (IP) experience. This is a well-known factor in entrepreneurial literature and secrecy proves to be a valuable asset for a science-based entrepreneur (firm) as well (Pisano 2010). This measurement is nevertheless detected to evolve over the path of entrepreneurship, from being purely based on experience to preferably being concerned with the contribution of the patent to the relevant regime(s). Meaning, that a scientist who has successfully established a firm, have also been able to create a body of knowledge that is essential for the existence of other innovations. This is an indication of what segregate a scientist from an entrepreneurial scientist. Furthermore, having the ability to understand and efficiently use media, help to take the scientist to the next stage. A SBE will by using media, prove that they are at the frontier of e.g., online developments and communication, and thereby demonstrating that they have an understanding of the essentiality of (personal) branding in present-day firms, as it supports both legitimacy and reputation (Fischer & Reuber 2011; Karlsson & Wigren 2012; Rao et al. 2008).

Finally, at the stage of successfully and continuous involvement by the science-based entrepreneur in their own firm, the following characteristics will be found to increase the odds. Only at this stage, intellectual curiosity demonstrates to be a rather useful motivational factor for a scientist who works towards ***staying active in the firm.*** Wanting to pursue the unknown and solve scientific puzzles, keeps the individual motivated in this setting. A reappearing, unfavourable motivational factor is not unexpectedly the desire to enhance one's academic career. Also, at this stage you would expect such desire to no longer be involved in the decision. However, if it is still a factor of influence, evidence suggest the expected - that the scientist will most like return to previous career trajectory. Besides motivational factors, opportunities also contribute to the outcome. A scientist at this stage, are more likely to come from Social Science background and have residence in a country that provides shared- or full inventor privilege over patented ideas. Such characteristics are to favour for those wanting to stay active in the firm. Furthermore, the results show that these scientists will continuously interact with newly established firm prior to, on time of and post- firm creation. One reason for this might be that it help them to overcome the barriers that exist between the academic and commercial sphere. Additionally, scientists will have extensive patenting experience, and this factor will be partly responsible for the likelihood of them more permanently staying in the established firm(s). Lastly, a continuous influence of media shows to be crucial. Conveying knowledge in order to utilize research potential. Being able to convince stakeholders that awareness is established and a large audience can be reached, support the scientist under the entire SBE journey, from idea to reality.

6 Discussion and further research

In general, this study contributes to the literature by empirically exploring which motivational, ability and opportunity factors influence the choice of a scientist to engage in the entrepreneurial activity of starting a firm. It answered the call for researching how commercialization efforts can best be encouraged and supported by government and policies (Audretsch et al. 2006). Furthermore, it has shown which factors from (academic-) entrepreneurship and engagement literature does and does not overlap with the field of science-based entrepreneurship (SBE). As this study is based on a large sample, generalizability is extensive and present findings with the aim to establish which of the factors tested are applying specifically to the field of science-based entrepreneurial (firm) activities.

First of all, it is encouraged that further research explores whether the single factors and established relationships are an exceptional case or whether other, motivation, ability and motivational factors have an impact on the patterns observed in this study. Large proportions of the sample are from Western Europe (51.5%) and North America (31.3%), which may impact the relationships to a degree that does not make it generalisable for the entire world population of scientists. By testing the factors found to be significant for this study in different settings, combined with other factors will reveal its robustness for predicting and explaining science-based entrepreneurial activities. However, by also focusing specifically on the influential relationships found as a whole, the impact of these measures can be confirmed, increasing its reliability beyond this studies research design and application.

Beside confirming and testing these factors in other combinations and relationships, this study can also show to be a fruitful starting point to establish links with other fields of research. A particularly interesting field would be the '*Theory of Planned Behaviour (TPB)* that falls within the field of psychology (Ajzen 1991). Behavioural incentives, to a wider extend than adopted in his study, could complement the insights gained. Even though TPB has not yet been applied specifically to SBEF, this study suggests that past entrepreneurial behaviour (e.g., patenting activities, media appearance and academic engagement) together with skills and knowledge are of great importance to science-based entrepreneurship. How these two fields of research can complement each other is evidenced in Goethner et al. (2012) study on entrepreneurial intentions, indicating a fruitful field of unification. Goethner et al. (2012) find evidence for entrepreneurial experience and linkage with industry to be influencers of academic entrepreneurial intentions, somehow similar to findings of this study. But they also detect a pattern of indirect effects through TPB factors as an individual's attitude and perceived behavioral control. Demonstrating how expanding SBE(F) studies into the psychological field could help further shape how the individual's decision-making process develop, especially over the different stages of SBE(F) and which emotional triggers may impact such behaviour.

In addition to expanding the field of science-based entrepreneurship by combining it with other disciplines, interesting aspect could also be gained from extending the individual-level research to also focus on teams as a whole. In order to realise and execute commercialisation in form of starting a firm, many entrepreneurs operates in teams of two or more. Often different skills sets are required to take an invention from idea to reality. As Knockaert et al. (2011) find in their qualitative study, at least one commercially or marketing minded individual need to be part of the founding SBE team, for it to successfully be commercialised. It could, therefore, be interesting to test the individuals from founding SBE teams to established whether the same or additional parameters holds for all individuals, also over the different stages. Furthermore, if any variation is detected (suggested by previous and current study), to also investigate what characterizes individuals with particular positions within the science-based entrepreneurial teams. Questions as "*Are the characteristic very homogeneous or heterogeneous within the teams, and among different types of SBEFs (e.g., from firms providing goods to those who provide a service)?".* This would be of great value to the development of this field of study; science-based entrepreneurship. This would possibly also add to the understanding of other overlapping disciplines, providing yet a possibly to interconnect and investigate what lays at the interface of different research areas.

From a more methodological perspective, insight to strengthen this field of research could be gained by cross analysing all patents held by SBEs and SBEFs. Here is meant, individual-level patents and patents held by (newly established) scientific firms, respectively. By doing so, it can be identified which research areas are most commonly found within different academic disciplines to be commercialised. Additionally, to investigate how many patents are used for commercialisation, and what distinguish those from the remaining. Furthermore, this would make it possibly to identify which topics provides ground-breaking knowledge that is fruitful for commercial purposes. Because the fields of basic- and applied science showed to have varying impact across the stages of SBE, it gives rise to such in-depth study. By in details breaking down what lays under the difference in scientific disciplines, and possibly answer to the question, *'why such a shift happens over the stages of SBE*', could not only be fruitful for scientific reasons, but also for technological transfer (TT) offices and policy-makers to focus and tailor their efforts.

For policymakers, the established factors of this study, can help identify which individuals from the academic segment are most likely to enter entrepreneurship in the future. By making these factors more transparent, it will become more predictable and, therefore, easier to decide on how to stimulate policy initiative(s). This help to reinforce and create additional support for future success of these scientists who are already active in the field of entrepreneurship, as these measurement help to identify such individuals. Putting these initiatives into action can help focus on stimulating both neglected factors (i.e., qualitative measurements as media and habits), as well as widely acknowledged factors. Furthermore, it is evidencing that specific outreach activities are more commonly used among those scientists who seek to leap into the industry sphere. Specifically, these activities; academic engagement with newly established firms and at early stage with consortia, should be focused upon for fostering more growth in the transfer of academic knowledge from research to industry. It furthermore suggests that community support is an important factor in the establishment of SBEFs. Individuals who have a support network, especially with the industry segment, are more likely to transit and succeed. The context specific characteristics suggested in this study, can help to shape the policies for the entrepreneurial landscape to be favorable for those who transfer from an academic setting, by focusing on additional elements to the general entrepreneurial incentives (e.g., as monetary rewards). From this study's results it is suggested that networking should be given special attention if aiming for a sustainable SBE environment, along with the more behavior aspects of (being given access to) communicating with a broader audience through media and establishing reputation through patenting activities and ownership.

6.1.1 Limitations

Even as this study have shown robustness in both the reliability and generalizability of the measurements applied, limitations are present. First of all, it is worth mentioning the limitation of data collected at one point-in-time. Such limitation is not unknow and have been recognized as a limitation for earlier studies of the same character (Hayter 2011). Research designs of this kind, have the possibility of overlooking dynamic aspect of; the market, the ongoing opportunities that arise, along with shift in motivation and personal circumstances (Hayter 2011). If time allowed, it would be fruitful to conduct a research, which investigate the relationships found in this study from a dynamic perspective, by testing the factors over a longer period of time. Additionally, such or a supplementary research, could also consider accounting for time-lag in certain measurements – here more specifically referring to translating behavioral aspects into results (Carsrud & Brännback 2009). It was also addressed in the methodology; the limitation of internal validity. The lack of time series investigation of the relationships, causes constrains. The nature of the cross-sectional research design, means that a causal relationship cannot be guaranteed (Bryman 2012). Furthermore, especially behavioral duration, but also other time-affected variables, are difficult to measure as they typically don't have a clear start and ending point, e.g., from an opportunity is recognized to it is acted upon. It is commonly acknowledge that this is a limitation - by some its approached by using phrases as "strive", "trying" or "desire", to try and handle such historical 'errors' (Carsrud & Brännback 2009). Two variables that are causally related, means that if the effect of the explanatory variable change, it will have a direct impact on the outcome. It assumes that the causal direction is fixed. For cross-sectional analysis such inference conclusions cannot be drawn, therefore, it is important to keep in mind, that these types of studies are indicating a relationship not causality (Bryman 2012, chap.15). It is encouraged that future research test the relationships found in this study using an analytic procedure that allows to test their causal relationships.

Furthermore, for some of the more static measurements in this study, data is collected dating five years back, and it would be valuable for the dynamic measurements to be represented in such timeframe as well. Moreover, using this type of data to map an entrepreneurial trajectory, can result in some degree of measurement fluctuation among participants or not reflect the whole truth. Some individual's feelings or memories may be altered or modified by the perception of the individual and their truth, judging it (a specific time or activity) in retrospect (Carter et al. 2003). All retrospective data, hence self-reported data, is always subject to some degree of falsification (Baron & Ensley 2006). However, there is only one actual possibility to reject the significance and impact of the results (relationships) detected in this study. It will be by specifically designing an analytical procedure that can test for these relations in question, and if thereby actually falsifying them, or on the contrary proving the relationships validity (Baron & Ensley 2006).

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