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MSc. Business Administration - Entrepreneurship, Innovation & Strategy

Master Thesis

The influence of professorial leadership, interfirm collaboration and market research depth on university spin-off funding acquisition and survival

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ABSTRACT

The importance of university spin-offs (USOs) and the economic and societal impact they achieve through the commercialization of university-based research has long been a subject of interest both to academics and policy-makers. However, there is still a lack of literature pertaining to determinants of early-stage university spin-off success. University spin-offs often face difficulties in acquiring early-stage funding and ultimately surviving the initial start-up period as a result of the high uncertainty and risk which high-tech start-ups entail. Consequently, factors which allow USOs to acquire funding and survive are of interest to researchers. Thus, this paper attempts to fill this research gap by analyzing the impact of three such potential determinants: professorial leadership, interfirm collaboration and market research depth. The established hypotheses were tested using a sample of 103 funding proposals submitted by USOs to the Dutch public funding agency. Results show that USOs led by a professor were more likely to survive. Furthermore, the depth of the market research conducted by the founding team was found to positively influence both funding acquisition and survival. This research concludes with implications for future research and suggestions for academics who wish to develop a USO of their own.

Keywords
University spin-off, funding acquisition, new venture survival, research commercialization

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1. Introduction

As centers of learning and technological advancement, universities have long held a central role in the development and diffusion of knowledge and innovation. More recently, universities have expanded their purpose beyond teaching and research to include a third mission: socio-economic engagement (Nelles & Vorley, 2010), which is frequently achieved through the transfer of knowledge from the university to the general market.

One of the means to achieve technology transfer in particular, is through the commercialization of academic research by way of spin-offs, an activity practiced since the 1970s, initially in the United States and subsequently expanding to other countries (Pirnay, Surlemont, Nlemvo, 2003). Universities and policymakers have been devoting increasingly significant resources in the promotion of academic entrepreneurial activities with the goal of generating university spin-off companies (USOs) (Benneworth & Charles, 2005a), defined as "new firms created to exploit commercially some knowledge, technology or research results developed within a university" (Pirnay et al., 2003, p. 356).

Such academic spin-offs tend to help regional economic development, due to the fact that the commercialization of innovations and technologies developed at universities is often locationally restricted by the founders' tendency to remain close to their university (Bercovitz & Feldman, 2006). Academic spin-offs can, therefore, influence the economic trajectory and the types of innovations of a certain region, depending on the spin-offs' level of success and the degree to which they collaborate with other companies (Benneworth & Charles, 2005b). In addition, academic spin-offs promote competition, since the introduction of novel technologies and products into the market pushes incumbents to improve their own offerings in order to compete. Thus, the spin-offs' commercialization of academic research and their contribution to regional economic development and social welfare are all benefits required to justify the large sums of public funding scientific research receives (Helm & Mauroner, 2007).

During the new venture development process, a spin-off's survival presents an evolving challenge as evidenced by survival rates diminishing over time (Wise, 2013). University spin-offs, while achieving a higher survival rate than their traditional counterparts (Zhang, 2008), still fail between 15 and 30% of the time (Clayman & Holbrook, 2003; O'Shea, Chugh & Allen, 2008;). Naturally, increasing the survival percentage of spin-offs as well as determining which influencing factors lead to success are of interest both to policymakers and academics who wish to generate higher economic and societal impact from public research funding as well as expand a university's ability to diffuse academic knowledge (O'Shea, Chugh & Allen, 2008; Bercovitz & Feldman, 2006).

Since early-stage academic spin-offs present both high levels of risk and high cost of investment, universities cannot finance all aspects of commercial and technological development themselves. Furthermore, the majority of universities' public funding is dedicated to fundamental research as opposed to its commercialization. Consequently, universities often lack the financial resources to offer a spin-off and cannot contribute much beyond the legal protection of the spin-off's intellectual property. For this reason, it is often the job of a technology transfer office to seek out capital from external sources such as venture capital firms. (Ndonzuau et al., 2002, Sørheim et al., 2011). Because of this, a key factor in a spin-off's success is its ability to successfully secure funding (Ndonzuau et al., 2002).

However, similar to other new high-tech ventures, the high levels of technological and market uncertainty that academic spin-offs face are factors of concern for external potential investors as well (Fried & Hisrich, 1994). This uncertainty, together with the lowly perceived entrepreneurial abilities of the founding

academics, makes the financing stage particularly challenging (Ndonzuau et al., 2002). Spin-offs founded by academic entrepreneurs face the challenge of investors not perceiving them as credible, due both to the newness of the opportunity and the spin-off's lack of industry track record and experience (Huynh et al., 2017; Wright, Vohora & Lockett, 2004). While academic entrepreneurs may be equipped to deal with the relevant technological uncertainty in their fields, they often lack the competences and experience required to mitigate market uncertainties, traits valued by investors (Perez & Sanchez, 2003; Macmillan et al., 1985). Consequently, early-stage academic spin-offs frequently find themselves struggling with the financing gap that emerges as a result of insufficient public funding available for commercialization on the university end and the reluctance of external parties to invest due to uncertainty present in high-tech markets and the perceived lack of competences on the part of academic entrepreneurs (Ndonzuau et al., 2002, Sørheim et al., 2011).

In view of the importance of funding in the success of academic spin-offs, the focus of this study lies in spin-off characteristics that have the potential to improve the likelihood of a venture successfully receiving funding from public agencies as well as achieving firm survival. While private sources of funding such as venture capital firms and angel investors are, particularly in later stages of development, considered to be highly important for venture success and survival, public funding agencies also offer another funding avenue for USOs (Lockett, Siegel, Wright & Ensley, 2005). Public funding is especially useful in the early stages of firm creation due to the difficulty USOs have in acquiring private investment in this time period as a result of the uncertainty and limited information surrounding their technology. This, in turn, hinders the ability of private investors to evaluate its feasibility and market potential and ultimately dissuades them from investing in the venture at all (Fernández-Alles, Camelo-Ordaz & Franco-Leal, 2014). Public funding through grants, on the other hand, may be less difficult to acquire for USOs as governmental program's primary goals focus more on economic and societal impact by developing and promoting a culture of entrepreneurship at the university level (Ayoub, Gottschalk & Müller, 2016). Depending on the government and approach, this is accomplished through financial and organizational support at the proof-of-concept, pre-seed or seed stage of USO development with the ultimate goal of assisting the USO in achieving venture launch (Rasmussen & Sørheim, 2012).

In addition to external team members, another way to mitigate the perceived lack of experience and commercialization skills of a founding team is if the academic entrepreneur behind the spin-off is a professor. If the academic in the leadership position in the spinoff is a professor, their status is more likely to demonstrate greater proficiency in the aforementioned areas due to the longer period of time the professor has spent in academia during which he or she will have had more time to gain industry exposure through prior research efforts, board appointments, consultancy work and informal interactions (Peterson & Philpot, 2009; Francis, Hasan & Wu, 2015; Meyer-Krahmer & Schmoch, 1998; Bruneel, D'Este & Salter, 2010). Professors will have more opportunities to engage in such industry interactions due to a higher demand for their services than those of lower-ranked academics due to the fact that they are recognized as leading subject matter experts. In addition, since professors are able to build strong social capital and networks on the industry side, thereby increasing the likelihood that they are able to attract additional team members who possess industry competences and experiences to their founding team (Mosey & Wright, 2007).

More broadly, on the firm level, USOs are also faced with high-tech innovations that require highly specialized competences to successfully commercialize in niche markets. Gaps in such knowledge and competences that are critical for

survival are difficult and/or costly to acquire through means other than partnership (Colombo, Grilli & Piva, 2006). Collaboration with external industrial partners has been shown to be beneficial during both the R&D and commercialization stages of start-up development (Van Beers & Zand, 2014). In addition to improving innovation performance itself, collaborating with industry partners may positively influence the commercialization potential and credibility of the innovation as perceived by investors collaboration signals that there is already a third party who views the innovation as sufficiently viable to get involved at the very early stages of development (Wright et al., 2004).

One more way USOs are able to signal legitimacy and credibility to investors aside from co-opting it from their industry partners (Wright et al., 2014), is through the depth of the market analysis and financial forecasting they include in their funding proposals. More detailed information about market potential, sales and expected cash-flow of the new firm can lower uncertainty in the eyes of investors and provide legitimacy to the competence of the founding team (Fleming, 2009).

Thus, this research focuses on the impact of the diversity of resources and competences spin-off firms have access to through interfirm collaboration and the composition of their founding team as well as the depth of the market research spin-offs conduct and seeks to answer the following questions:

Research question 1: What is the effect of the inclusion of a professor in the founding team in a leadership role on the chance to secure funding and achieve survival for an academic spin-off?

Research question 2: What is the effect of spin-off's developing their innovation in collaboration with industry partners on their ability to secure funding and achieve survival?

Research question 3: What is the effect of in-depth market research on the ability for a spin-off to secure funding and achieve survival?

2. Theoretical framework

2.1. Professorial leadership

The demographics and characteristics of founding teams have been a central focus of research on both success drivers and funding decisions for new ventures (Beckman, Burton & O'Reilly, 2007; Hsu, 2007; Eesley, Hsu & Roberts, 2014; Colombo & Grilli, 2010; Delmar & Shane, 2006). This focus is due to the particularly challenging circumstances in which new ventures find themselves. New ventures face high levels of uncertainty and risk due to the "liability of newness" (Singh, House & Tucker, 1986) for which they must compensate by adapting to industry competition dynamics and developing competencies yielding a competitive advantage (Zahra, Neubaum & El-Hagrassey, 2002). The characteristics of members of the founding team are thought to have an effect on a firm's ability to accomplish these goals, particularly in the case of small firms whose founders have a higher impact on the overall business outcome.

Less research has, however, focused on team-composition in the context of academic spin-off companies which significantly differ from both new ventures established by entrepreneurs and existing companies (Pirnay et al., 2003). Academic entrepreneurs differ both in competences and objectives from traditional entrepreneurs, often viewing themselves as part-time entrepreneurs and also giving less importance to financial growth (Huynh et al., 2017). Academics, particularly those in the earlier stages of their career whose focus lies more on reputation-building and acquiring tenure as opposed to commercializing research (Abreu & Grienevich, 2013), may also lack some of the business expertise and skills that are highly valued by venture capitalists when making funding decisions and which are as critically important during a business' transition from the

creation to the growth stage (Druilhe & Garnsey, 2004; De Coster & Butler, 2005; Huynh et al., 2017).

Despite the fact that academic entrepreneurs are generally thought to lack skills and prior experience pertaining to commercialization efforts, professors in later stages of their career might deviate from the norm since they are more likely to possess greater industry exposure compared to their pre-tenure counterparts, as a result of their collaborative research and commercialization efforts with industry partners (Haeussler & Colyvas, 2011). Professors gain insight into industry practices by holding board positions in companies that seek their expertise (Peterson & Philpot, 2009; Francis, Hasan & Wu, 2015), by working as consultants (Meyer-Krahmer & Schmoch, 1998) and through informal interactions in meetings and at conferences with firms and industry actors (Bruneel, D'Este & Salter, 2010). Professors are more likely to engage in the aforementioned interactions with industry since a longer academic career and larger breadth of work results in the required reputation as a leading subject matter expert in their field. The human capital pertaining to industry acquired through these interactions allows academic entrepreneurs to develop their social capital and networks external to academia, thereby likely increasing the professor's ability to attract additional team members who possess industry competences and experiences to their USOs, as opposed to relying on their academic networks to achieve this goal (Mosey & Wright, 2007).

Industry involvement and prior experience are criteria valued by potential investors (Hsu, 2007; Mitteness, Baucus & Sudek, 2012) because they influence the success of further entrepreneurial activities (Abreu & Grinevich, 2013). Based on the notion that potential investors evaluate the entrepreneurial team members' competencies and prior experience during their decision-making process, and that a professor is more likely to possess those characteristics than an early-career-stage academic such as a postgraduate student or associate professor, the following hypothesis is presented:

Hypothesis 1a: University spin-offs lead by a professor are more likely to secure funding

In addition to signaling to potential investors, the quality of the academic founder positively affects the survival of the new-ventures in which they are involved, as demonstrated by the increased ability of the venture to reach the IPO stage (Powers & McDougall, 2005, Deeds et al., 1998). The aforementioned industry experience of founders, which senior academics are more likely to possess, helps spin-offs perform to the degree required to reach this IPO stage because founders' experience shortens the learning curve by transferring to other team members prior knowledge pertaining to "opportunity identification and evaluation, resource acquisition firm organizing, information about industry rules and norms, customer and supplier networks, and employment practices" (Delmar & Shane, 2006, p. 220).

Professors who have already established businesses or have worked in the same industry as the newly-developed spin-offs will also have access to a pre-existing social network within the industry which can aid the firm in entering mutually beneficial relationships with partners, granting it access to otherwise unavailable resources and competences critical for venture performance and survival (Walter, Auer & Ritter, 2006). These arguments are in line with the findings of Criaco et al. (2014) one of the few works focusing on factors influencing venture survival specifically in the context of university spin-offs. Criaco et al. (2014) note that the human capital of founders, particularly entrepreneurial human capital stemming from formal education and personal experience in entrepreneurship as well as university human capital dealing with knowledge acquired from research and teaching activities at universities, positively influence USO survival. Since professors are more likely to have more entrepreneurial capital as well as more university human capital due to the stage of

their career, the following hypothesis is presented:

Hypothesis 1b: University spin-offs lead by a professor are more likely to survive

2.2. Interfirm collaboration

Universities, and products spun-off from research generated therein, are characterized by their ability to contribute towards socio-economic growth through the production and diffusion of innovative outputs (Bercovitz & Feldman, 2006). Commercialization of academic research through innovative products is one way in which universities are fulfilling their mission of transferring knowledge to users (Perkmann et al., 2013). Innovation can be defined as "the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace" (Baregheh, Rowley & Sambrook, 2009, p.1334) and it is becoming increasingly important for organizations in the face of intensifying competition, technological advancement and globalization (Kyrgidou & Spyropoulou, 2013).

A firm's ability to innovate is contingent upon their competences (Danneels, 2002), defined as "a purposive combination of firm-specific assets (or resources) which enables it to accomplish a given task" (McGrath, MacMillan & Venkataraman, 1995, p. 254). The competences a firm possesses, and the way they are utilized determine the type of product innovation achieved (Danneels, 2002). Exploitative innovations are incremental and involve the use of existing competences to meet the needs of existing customers or markets by improving the incumbent solution (Li, Zhou & Si, 2010; Jansen, Van Den Bosch, Volberda, 2006).

Explorative innovations, on the other hand, "exploit technologies that are radical, tacit, early stage and general-purpose, which provide significant value to customers, represent major technical advances and have strong intellectual property protection" (Shane, 2004, p.103) and are in most cases the basis for USOs creation. The reason for this is that exploitative innovations developed by spin-offs, that are incremental in nature and represent single product extensions, often are not seen as a viable basis for the creation of a company due to an inability to offer a sustained advantage in high-competition environments (Li et al., 2010) and are instead frequently licensed to established firms who are in a better position to utilize the exploitation of an existing technology (Shane, 2004).

However, the concern with explorative innovations is the complex range of resources and competences required to develop, refine and successfully commercialize them (van Beers & Zand, 2014). Academic founders are often lacking in these areas by not possessing the market/commercialization knowledge required to determine potential commercial applications for their innovation (Druilhe & Garnsey, 2004), as well as to subsequently refine it in accordance to market requirements once they are determined. In order for the spin-off to develop the competences required to refine the initial opportunity, new members with industry experience are added to the founding team and the market-related competences of the existing academic founders are improved through interactions and collaborations with partner firms (Rasmussen, Mosey & Wright, 2011).

The notion of collaborating with external partners during the various stages of R&D is utilized by both established firms and university spin-offs as it "helps the innovating firm to increase value and to gain competitiveness by pooling, integrating, and combining its resources with those of other firms" (van Beers & Zand, 2014, p. 294). Hayter (2016) notes that the use of non-academic contacts has been found to influence various aspects of university spin-off development, including opportunity refinement and product development, by bridging "academic and non-academic networks while providing knowledge that relates to technology commercialization and

markets and by allowing spin-offs to develop and demonstrate their potential to other critical non-academic contacts" (p. 484).

In addition to improving the opportunity itself, partnering efforts allow for the co-opting of the legitimacy of the established firms and industry actors with whom they partner as part of their endeavor (Karlsson & Wigren, 2012). University spin-offs often suffer from a lack of credibility in the eyes of customers, investors and suppliers due to their lack of track record. This can be overcome by relying on industrial partners to supply critical resources and build an initial stock of credibility (Wright et al., 2004). According to Wright et al. (2014), credibility is necessary to help potential investors overcome the issues of high risk associated with university spin-offs and getting a product from a scientific discovery to market.

In particular, explorative innovations, often radical in nature, carry high levels of uncertainty. In their model of the uncertainty associated with radical innovations, O'Connor and Rice (2013) identify four categories: (1) Technical uncertainties, (2) Market uncertainties, (3) Organizational uncertainty and (4) Resource uncertainty. In addition to the risk and uncertainty associated with new technologies and the challenges in successfully getting them to market, firms suffer from organizational and resource uncertainty as a result of the long-term and often costly nature of radical innovations.

While the work of O'Connor and Rice (2013) deals with radical innovation in established firms, their findings may be even more pronounced in early-stage university spin-offs. The make-up of the project teams dealing with radical innovations in established firms more likely includes from the beginning individuals with industry experience. Furthermore, organizational issues such as employee resistance and lack of persistence will likely be present in addition organizational uncertainties specific to university spin-offs that lack the refined organizational structure present in established firms. In as much as the risk perceived by potential investors in regards to these types of uncertainty can be mitigated through benefits derived from developing and refining the opportunity in collaboration with industry partner firms, the following hypothesis is presented:

Hypothesis 2a: University spin-offs that have developed their innovation in collaboration with a partner firm are more likely to receive funding

In addition to demonstrating to potential investors that other industry actors perceive the spin-off as having value, a spin-off's early-stage collaboration with other firms contributes towards innovation performance by enriching the range of resources and knowledge available to the firm (van Beers & Zand, 2014; Beck & Schenker-Wicki, 2013; Wuyts & Dutta, 2014). This cooperation is critical in the case of explorative innovations, typically used as the basis for spin-off activity (Shane, 2004), which suffer issues of high uncertainty and technological complexity. By partnering with other firms, spin-offs are able to engage in organizational learning by accessing external knowledge and subsequently internalizing it to enhance their own competences (Kim & Inkpen, 2005). This is critical to achieve commercial success for university spin-offs, in particular, since they often have highly specialized technology-related competences that need to be combined with specialized assets, resources and knowledge that they do not possess and cannot acquire otherwise due to financial or time restrictions (Colombo, Grilli & Piva, 2006). The establishment of relationships with industrial partner firms and the benefits these relationships provide are thus considered an important part of the post-founding stage of the USO lifecycle, particularly as the spin-off distances itself from its host university and begins to engage primarily with industry actors in order to overcome issues of resource starvation and legitimacy in order to survive (Prokop, Huggins & Bristow, 2019; Gübeli & Doloreux, 2005). This leads to the following hypothesis:

Hypothesis 2b: University spin-offs that have developed their innovation in collaboration with a partner firm are more likely to survive

2.3. Market research depth

In addition to factors that define the internal competences of the management team and influence product development in USOs, investors also place a significant degree of focus on the characteristics of the intended target market such as its size, growth rate, competition intensity and customer pool (Kollmann & Kuckertz, 2010; De Coster & Butler, 2005). Beyond general information pertaining to market characteristics, investors require more detailed information specific to the firm applying for funding in order to assess the likelihood that it will achieve success and thus be worth investing in. Consequently, the funding decisions investors make are highly contingent on the information the management team presents within their funding proposal (Fleming, 2009).

Since the main goal of investors is generally to achieve positive financial return on their investment, managers, in an effort to persuade them of the value of their venture, often provide investors with financial forecasts that describe their expectations of the future performance of the firm (Hirst, Koonce & Miller, 1999). Despite the context of this research focusing on investment in the form of a funding grant rather than an equity investment, the prospects and forecasts for the financial success of the investee are still of interest since they are an important determinant of overall venture success. Van Geenhuizen and Soetanto (2009), whose research focuses on the key obstacles inhibiting the growth of USOs, found market-related problems, such as a lack of marketing knowledge, sales skills and customer base, to be the most resistant to improvement across the development stages of the business. They further posit that such skills are difficult for USOs to acquire due to the non-commercial environment from which the business originates and the highly specialized target markets for which the product is intended. Consequently, best practices regarding how to market and communicate the value of the product to potential customers in these niche markets are difficult to acquire by means other than direct experience. Thus, proposals that contain detailed information about the new firm's market potential, sales and expected cash-flow, ultimately aid in positively demonstrating that the founding team is already competent in the aforementioned market-related skills.

Additionally, potential investors' perception of the innovation is limited to the information presented in the funding proposal, and consequently investors are unable to fully ascertain the proposal's completeness or accuracy. This inability can have a negative effect on the predictive, and ultimately, the persuasive power of the entire proposal in the eyes of funding decision-makers, particularly if there is a lack of quantified data provided (Fleming, 2009). Proposals that contain more detailed market-related information will likely reduce issues of investor-perceived uncertainty and information asymmetry that make it difficult for them to evaluate the commercial potential of the innovation and dissuade them from participating in financing efforts (Fernández-Alles et al., 2014; Rodríguez-Gulías et al., 2017).

Furthermore, proposals containing greater market analysis and forecasting signal that the innovation is in a later stage of development. This will likely indicate to investors that less time and R&D costs are required between the time of investment and the product launch than if the proposal had been submitted during an earlier stage of the product development cycle. A more thorough market analysis is pertinent too as it provides a head-start to USOs which require more time to translate their innovations into a profitable business than their traditional counterparts (Mathisen & Rasmussen, 2019). This leads to the following hypothesis:

Hypothesis 3a: University spin-offs that have performed a higher degree of market analysis

and forecasting are more likely to receive funding

The benefits of greater in-depth, early-stage market analysis and forecasting efforts extend beyond funding acquisition to the operation side of business development as well. Competent business planning serves to "enhance founders' product development and venture organizing activities and would reduce the hazard of venture disbanding" (Delmar & Shane, 2003, p. 1180). Part of the business planning process in the early stages of new business development entails the use of market segmentation and analysis, as well as financial forecasting as a tool for selecting the most appealing alternative. Due to the inherent uncertainty and risk resulting from the lack of information available at the early stages of the business development process, new ventures rely on what information they are able to derive from market analysis and forecasting efforts in their decision-making process (Cassar, 2014; Quon, 2015). Consequently, the greater the USOs' in-depth and robust market analysis and forecasting efforts are, the likelier the decisions influenced by that information will be the correct ones to achieve firm survival and success. This is in line with market-orientation research, which finds a firm's market-knowledge competence, defined as a "measure of the ability of the firm to analyze its markets in terms of customer needs and the competitive environment in general" (Johnson et al., 2009, p.220), to positively influence opportunity recognition and refinement (Claudy, Peterson & Pagell, 2016) and overall product performance and success (Johnson et al., 2009; Li & Calantone, 1998; Atuahene-Gima and Yinghong 2011),

This leads to the following hypothesis:

Hypothesis 3b: University spin-offs that have performed a higher degree of market analysis and forecasting are more likely to survive

3. Methodology

The setting for this research is the analysis of Dutch academic spin-off research proposals that are submitted in order to obtain funding from the Netherlands Organization for Scientific Research (NWO) valorization grant program. The NWO is a public funding agency which, as part of their activities, provides funding to USO companies in order to foster entrepreneurial activity at universities and help bridge the funding gap these new ventures face. The latter arises due to the frequent inability of spin-off companies to attract private funding as a result of the high uncertainty associated with the radical innovations which usually serve as the basis for spin-off activity (Shane, 2004; Fernández-Alles, Camelo-Ordaz & Franco-Leal, 2014). Similar governmental funding initiatives to the NWO are active in other countries as well, such as the Small Business Innovation Research (SBIR) program in the US and the University Challenge Fund in the UK (Lockett et al., 2005)

Data used for this study is generated on the basis of content analysis of submitted proposals. All data used in this study was aggregated and fully anonymized. Data includes informationpertaining to the make-up of the founding team, characteristics of the product and its patent status as well as a market and competition analysis. Aggregated data enables to construct independent variables on the basis of validated scales.

3.1. Data measures

3.1.1. Dependent variables

Funding decision is defined as the decision of whether or not funding has been granted by the Netherlands Organization for Scientific Research. It utilizes a binary scale, with proposals not receiving fund assigned a value of 0 and those receiving funding assigned a value of 1.

Spin-off survival refers to whether firms submitting the funding proposal survive a period of 5 years after requesting funding. Survival data was collected from LexisNexis, LinkedIn and Crunchbase. It is a binary variable with a value of 0 indicating failure and a value of 1 indicating survival.

3.1.2. Independent variables

Interfirm collaboration refers to whether or not the innovation was developed in conjuncture with industry partners with a value of 0 indicating that it has not and a value of 1 indicating that it has. For this research, industry partners are defined as firms or organizations participating in business activities within the commercial market.

Professorial leadership is based on research of the characteristics of academic entrepreneurs and how they influence funding acquisition and overall performance of USO ventures (Beckman et al., 2007; Ensley & Hmieleski, 2005). *Professorial leadership* uses a binary scale, with a value of 0 indicating that the leader of the founding team is not at the level of full professor and a value of 1 indicating that he or she is.

Market research depth refers to the level of research the spin-off has already conducted in regards to market and customer identification and financial forecasting. It uses the following scale: (0) USO has not identified any specific market segment and no potential customers are described, (1) Preliminary market research has been conducted leading to an identification of broad market segments and potential customers, (2) Clearly identified market segment and potential customer, as well as broadly estimated market potential and sales, (3) Clearly identified market segment and potential customers, as well as comprehensively forecasted market potential, sales and expected cash flow.

3.1.3. Control variables

Technology development degree refers to the point of development in which the USO technology is currently in. This variable is measured by way of the stage of the patenting process the USO is in as the ability of a firm to acquire a patent has been found to increase the likelihood of obtaining funding as it is seen as an indicator of the innovativeness of their intellectual property and overall startup potential (Baum & Silverman, 2004). Technology in later stages of development is expected to correspond to later stages of the patenting process as well. Thus, the following scale is used: (0) No patent, no intention to file for patent or missing information. (1) Intention to file for patent is present. (2) Patent application has been filed and/or granted.

Sector refers to market sector in which the USO intends to operate. This variable was originally categorical and has been recoded into four separate dummy variables: *Life sciences, Information and Communication technology (ICT), High Tech Systems and Materials (HTSM) and Chemical.* The sector in which a business operates impacts various aspects of the venturing process including costs, the size of the potential customer base, competition intensity etc. Consequently, the sector a USO operates in may impact survival based on these characteristics and funding decision-makers may consider it as a part of their investment criteria.

Existing external financing refers to whether the spin-off company applying for the valorization grant has already received external funding of some sort (grants, investments, etc.) with a value of 0 indicating no external financing and a value of 1 indicating that the firm has already received external financing. Firms which have already received some sort of outside investment (excluding the Phase 1 NWO valorization grant that each USO in this data sample successfully acquired) may signal to potential investors the innovativeness and potential commercial viability of the venture.

3.2. Data analysis

As the dependent variable is dichotomous, the chosen data analysis method is binary logistic regression, commonly used to analyze "how a set of predictor variables X is related to a dichotomous response variable Y" (Harrell, 2015, p. 219). Binary logistic regression is applicable in this case as linear regression is not a good fit for the data since the use of linear regression with a dichotomous dependent

variable "violates the assumptions of normality and homoscedasticity because a normal distribution is impossible with only two values" (Garson, 2016, p.200).

4. Results

The descriptives and correlations for all variables is reported in Table 1 (see appendix). No issues of multicollinearity were found between independent variables as the correlations fall under the required threshold of 0.5 and the analysis was proceeded with. As this analysis focuses on two dependent variables, the same regression testing procedure was applied to both independently. Firstly. the results of the binary logistic regression analysis for *funding decision* are presented in Table 2 followed by the results for *spin-off survival* in Table 3. Within the two regression tables, the first model demonstrates the effect of the control variables. Models 2-4 in each table show the effect of each independent variable individually. Model 5 shows the effect of all independent and control variables concurrently while Model 6 contains only the independent variables. As the strength of the model containing all independent and control variables is the highest, it is the one that was used in the rest of this research.

Hypothesis 1a investigated the impact of *professorial leadership on* the spin-off *funding decision* and predicted a positive effect. The analysis does not show any significant results and the hypothesis is, therefore, rejected. This goes against the theoretical arguments presented in this research that posited that professors have more industry exposure and experience which would appeal to investors. Hypothesis 1b investigated the impact of *professorial leadership* on *spin-off survival* and predicted a positive effect. The results indicate a positive and significant relationship at the 0.01 level (B=1.546) with a p value of 0.001, meaning that the inclusion of a professor in the leadership position increases the likelihood of the spin-off surviving. Based on the positive relationship with USO survival, and a lack of such a relationship with funding acquisition, it seems that the aforementioned industry experience is valuable during the actual business development process despite investors not perceiving it as such.

Hypothesis 2a investigated the impact of *interfirm collaboration* on the spin-off *funding decision* and predicted a positive effect. The analysis does not show any significant results and the hypothesis is, therefore, rejected. Hypothesis 2b investigated the impact of *interfirm collaboration* on *spin-off survival* and predicted a positive effect. The analysis does not show any significant results and the hypothesis is, therefore, rejected. This result is unexpected, considering the depth of literature emphasizing the benefits of interfirm collaborations with industry partner firms, particularly for new ventures operating in environments of high risk and uncertainty.

Hypothesis 3a investigated the impact of *market research depth* on the spin-off *funding decision* and predicted a positive effect. The results indicate a positive and significant relationship at the 0.05 level (B=0.780) with a p value of 0.017. Hypothesis 3b investigated the impact of *market research depth* and predicted a positive effect. The results indicate a positive and significant relationship at the 0.01 level (B=0.809) with a p value of 0.008, meaning that proposals which contained more a more in-depth analysis of the market segment and more detailed financial forecasting had a higher chance of survival. These results are in line with theoretical arguments that the depth of market research included in the proposal signals both the viability of the venture and the market-knowledge competence of the founding team to investors, and that those factors later proved significant in practice when USOs started operations.

In terms of the control variables, no significant relationships were found for either USO funding acquisition or survival. Firstly, for the *existing financing* control, it likely was not an important factor during the funding process because all of the proposals in this data sample had already

successfully obtained phase 1 grant funding from the NWO itself. In light of this, existing financing may have not been seen as important for the phase 2 grant process. In regards to spin-off survival, existing financing likely had no impact as it was, in most, cases, acquired through grants or innovation competitions which provide relatively small amounts of monetary support. Secondly, *technology development degree* not being a significant predictor of funding may indicate that the funding decision-makers either do not consider the stage of development to be a significant criteria or do not perceive the stage of the patenting process in which the innovation is in to be an accurate indicator of such. In terms of the link between degree of development of the innovation and survival, due to the USOs in this sample being in the early stages of development, whether they have acquired a patent or not may simply be an issue of timing as opposed to an indicator of the innovativeness of the product. Lastly, the intended *sector* of operation also had no impact on USO funding acquisition or survival. The implication of this result is that the individuals evaluating USO funding proposals do not have a preference of a specific sector. Given that funding decision-makers likely possess significant industry experience themselves, it stands to reason that they are aware of or have personally dealt with the potential and benefits of each sector. Similarly, a lack of a significant relationship with spin-off survival may indicate that the sector a USO intends to enter is less important than how and with what innovation they do so.

5. Discussion

The present research focuses on funding proposals submitted by early-stage USOs and examines the multiple factors that are hypothesized to have an effect on a project's likelihood of a positive funding outcome and subsequent survival. Despite the increasingly diverse literature pertaining to USOs (Mathisen & Rasmussen, 2019; Ndonzuau et al., 2002; Mosey & Wright, 2007; Huynh et al., 2017; Shane, 2004), less attention has been given to the impact of key determinants on the success of USOs in the early-stages of their development. This paper contributes to the increasingly diverse USO literature by examining three such potentially key determinants: the presence of a professor in the founding team in a leading role, the collaboration of a spin-off with industry partner firms and the depth of the market research conducted by the founding team prior to applying for a funding grant.

Professorial leadership, one factor hypothesized to affect a USO's funding and survival, was found to have a positive effect on spin-off survival but no significant effect on spin-off funding acquisition. The theorized notion that professors, as individuals with more abundant industry exposure, have access to more social capital and a larger industry network as a result of their work as board members and consultants (Peterson & Philpot, 2009; Francis, Hasan & Wu, 2015; Meyer-Krahmer & Schmoch, 1998), holds true for firm survival, but does not seem to be an important factor during the funding decision-making process.

In point of fact, the benefits and resources a professor in a leadership position brings to a USO appear to be most useful during the practical activities of business development and operation when founders actually need to utilize these resources to attract hires to the business, establish formal partnerships with other firms, and acquire knowledge and competences. This would seem to correspond to the conclusions reached by Criaco et al. (2014) regarding the positive impact of a higher abundance of human capital pertaining to entrepreneurial and university experience on USO survival, which professors possess due to the later stage of their career. Similarly, Huynh et al. (2017), examined the relation between entrepreneurial capabilities, a construct measured through "technology, organizational viability, human capital, strategy, and the commercial

Table 2
Determinants of USO funding acquisition

	1		2		3		4		5		6	
	B	S.E.	B	S.E	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Interfirm collaboration			0.637	0.478					0.292	0.516	0.343	0.476
Professorial leadership					0.709	0.452			0.819	0.488	0.680	0.462
Market research depth							0.726*	0.300	0.780*	0.327	0.603	0.291
Tech. development degree	-0.043	0.288	-0.048	0.291	-0.065	0.295	0.084	0.303	0.064	0.312		
Existing financing	0.680	0.532	0.516	0.551	0.650	0.543	0.591	0.552	0.464	0.580		
Life sciences	1.073	1.211	0.889	1.234	1.230	1.215	1.026	1.223	1.091	1.237		
ICT	0.936	1.249	0.610	1.288	1.103	1.249	0.575	1.271	0.539	1.296		
HTSM	0.562	1.188	0.246	1.227	0.65	1.186	0.710	1.212	-0.058	1.236		
Chemie												
Constant	-1.605	1.299	-1.686	1.318	-2.104	1.341	-3.005	1.449	-3.687	1.538	-2.662	0.772
Nagelkerke R^2	0.041		0.065		0.074		0.124		0.169		0.111	

*p 0.05
**p < 0.1

Table 3
Determinants of USO Survival

	1		2		3		4		5		6	
	B	S.E.	B	S.E	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Interfirm collaboration			0.236	0.444					-0.286	0.530	-0.174	0.475
Professorial leadership					1.344**	0.441			1.546**	0.482	1.573**	0.467
Market research depth							0.668*	0.274	0.809**	0.305	0.810**	0.286
Tech. development degree	0.082	0.281	0.080	0.282	0.020	0.301	0.196	0.294	0.149	0.319		
Existing financing	0.542	0.563	0.471	0.577	0.508	0.582	0.444	0.583	0.463	0.609		
Life sciences	-0.236	1.012	-0.313	1.024	0.119	1.043	-0.255	1.027	0.233	1.077		
ICT	-0.223	1.043	-0.355	1.074	0.127	1.071	-0.542	1.066	-0.078	1.134		
HTSM	0.652	0.990	0.526	1.019	0.953	1.015	0.291	1.010	0.696	1.066		
Chemie												
Constant	0.031	1.104	0.020	1.105	-0.899	1.173	-1.221	1.235	-2.530	1.372	-1.966	0.690
Nagelkerke R^2	0.076		0.080		0.192		0.152		0.276		0.238	

* $p < 0.05$
** $p < 0.01$

resource of founding teams" (p. 13) and USO performance and found a significant, positive relationship.

In terms of funding decisions, the notion that the academic seniority of professors may be linked to increased human and social capital may not be apparent or relevant to funding decision-makers. Since the individuals evaluating the proposals may be professors themselves, in some cases the leader of the USO simply being a professor may not seem like a substantially differentiating factor as it might, had a non-academic decision-maker evaluated the proposal. The benefits derived from a professor leading the venture in terms of the characteristics of the innovation and the quality of the proposal itself may not have had time to materialize in a way that is apparent to the funding decision-makers performing the evaluation or that would set those proposals apart from the others.

Additionally, recent literature brings into question whether the characteristics of the founding team has an impact on USO funding acquisition generally. Huynh (2019) found that the entrepreneurial capabilities and networks had no significant effect on the ability of the USO to acquire seed funding from external sources. He notes that the investment judgement is, instead, based on "the business viability data and perceptions of entrepreneurial teams obtained by investors through researching business and financial plans, communications, and personal observations" (Huynh, 2019, p.17). This result gives further credence to the notion that investors are dubious of the capabilities of academics as they trust their own limited personal interactions and observations of founders more than academics' demonstrable track record. Professors may not be immune, after all, to the commonly held conception that academic entrepreneurs lack industry and commercialization skills (Huynh et al., 2017).

Consequently, whether or not an applicant is a professor, seemingly has no impact on investors' decision-making process. However, there is conflicting evidence in literature concerning the impact of entrepreneurial capabilities once the scope of the funding context is expanded beyond seed capital to also include start-up and early-growth capital. Huynh (2016) utilized the same construct for USO entrepreneurial capabilities consisting of "measures for entrepreneurial technology, organizational viability, human capital, strategy and the commercial resources of founding teams" (p. 352) as he did in his 2019 work and obtained contradicting results. Unlike Huynh (2019), which focused solely on seed capital, the signaling of the aforementioned entrepreneurial abilities to investors improved fundraising ability overall in the broader early-stage of USO development (Huynh, 2016). Taking into account the aforementioned variance in the importance of entrepreneurial competences depending on the stage of funding, the USOs that this research examines were all participating in the second funding round by a public funding actor, meaning that they have all already successfully obtained first-round funding. As a result, the criteria pertaining to the make-up of the founding team and the characteristics of the individual in the leadership position may have already been taken into account during the first round of the funding process and are thus less important in the stage which this research focuses on. Furthermore, even in cases in which the leadership position is not occupied by a professor, it is common for other members of the USO founding team to be professors themselves regardless. Consequently, even funding decision-makers who consider the professorial human and social capital to be significant funding criteria may not think it is important if such individuals are leading the venture so long as they are able to provide their competences by being a member of the founding team in a different capacity. Additionally, funding decision-makers may, instead of focusing on the background and position of the leader of the USO venture, value the progress made since the USO received first-round financing in regards to the product/innovation itself, as success on this front positively reflects on the competences of the

USO leadership in practice. Whether the USO has been able to make substantial progress and achieve the goals they set for the period between the first and second round of funding are more tangible indicators of the abilities of the individual leading the USO than their position in the hierarchy of academia.

Industry collaboration, a third independent variable and another factor hypothesized to affect a USO's funding and survival, was found to have no significant relationship with either spin-off funding acquisition or spin-off survival. A possible reason for this result is the variance in the benefits gained from both the different partner types and the different collaboration types. Belderbos, Carree & Lokshin (2004) note that there is "major heterogeneity in the rationales and goals of R&D cooperation, with competitor and supplier cooperation focused on incremental innovations improving the productivity performance of firms, while university cooperation and again competitor cooperation are instrumental in creating and bringing to market radical innovations, generating sales of products that are novel to the market, and hence improving the growth performance of firms" (p. 1488). The variance of the benefits derived from collaborations, depending on the function of the partner firm, may explain the lack of a positive finding in terms of firm survival, since the data sample used in this research did not differentiate between partner types. A similar issue is present in terms of the nature of the collaborative relationship itself. For instance, there is likely a notable difference between a basic supplier partnership whereby nothing is provided beyond a guaranteed supply of materials for a certain period, and a more complex cooperation strategy which entails in-depth information sharing and asset complementarity (Belderbos, Carree & Lokshin, 2006). In addition to partner-type and the nature of the collaborative relationship, the size of the partner firm may also have influenced the funding decision-making process as well as firm survival. Most of the USOs in this dataset collaborated with small to medium sized partner firms, while recent research (Hagedoorn, Lokshin & Malo, 2017), conversely, indicates that partnerships with larger firms improve overall innovation performance and allow for more credibility to be coopted, which could be a useful signal to investors. Additionally, the more credibility a USO is able to accumulate, the more leverage it has to attract additional partners which in turn improves innovation performance, particularly if the partners are diverse in terms of their functions and the knowledge they can provide (Beck & Schenker-Wicki, 2013).

This reasoning concerning the importance of the nature of the interfirm collaborative partnership is also in line with the work of Lubik et al. (2013) which examined multiple different partnership strategies of USOs and noted varying benefits for each. For instance, large corporate partners were most desirable due to the breadth of complementary resources that they offer and the greater assistance they provide in getting the innovation to market. Partnering with other USOs, on the other hand, represents less costly and formal relationships that are more flexible to the needs of both parties allowing for the sharing of early complementary and process innovations.

In this research, the lack of depth, in terms of the conceptualization of the interfirm collaboration variable, likely impacted both dependent variables because funding decision-makers may have favored USOs with particular kinds of collaboration and partner types. For instance, a USO that is allied with a large, corporate customer who has already committed to a purchase order, and who has agreed to continued collaboration in refining the product based on feedback, likely results in a greater likelihood of future financial success than other collaboration configurations. This is a factor which is not taken into account in the data or in the analysis.

Lastly, market research depth was found to positively impact both USO funding acquisition and survival. This result indicates that investors do indeed highly value depth and quality of the market, financial and business-plan-related

information that USOs present in their funding proposals. This conclusion follows long-standing results from literature highlighting the importance of the characteristics of the market itself during the investment decision-making process (Hall & Hofer, 1993; Kollmann & Kuckertz, 2010; De Coster & Butler, 2005; Sharma, 2015; Sudek, 2006, Edelman, Manolova & Brush, 2017). Furthermore, spin-offs who, at the early stages, already possess a developed market-knowledge competence (Johnson et al., 2009) signal to investors their proactiveness in achieving familiarity with the niche market in which these companies often find themselves and in which a lack of market-related skills are a significant impediment to venture success (Van Geenhuizen and Soetanto, 2009). Huang & Pearce (2015) also note the contribution of business viability data obtained from investor analysis of a USO's business and financial planning information to investors' decision-making process.

In terms of USO survival, the results attained in this research find support in literature as well. Jara-Figueroa et al. (2018), for instance, found industry-specific knowledge to be significantly important for the survival of new firms in a pioneer role i.e. firms operating in an industry that was not active in a specific region up until that point. Furthermore, the importance of market knowledge has been noted in regard to survival during the process of venture internationalization (Jin & Jung, 2016). Similar to the context of USOs, in both of the aforementioned cases the common thread is new venture survival under conditions of high uncertainty and risk, and the mitigation of those issues through robust knowledge of the market in question. For USOs, the same appears to hold true in as much as firms that engage in more in-depth market research will likely make better informed decisions leading to survival as a result.

6. Theoretical and managerial implications

This research paper contributes to the literature concerning university-industry relations by analyzing the effect of the leadership role of the venture being occupied by a professor, as well as interfirm collaboration and market research depth on the ability of USOs to secure funding and ultimately achieve survival. It contributes to the expanding stream of literature concerning spin-off funding acquisition and venture survival (Fernández-Alles et al., 2014; Clayman & Holbrook, 2003; Helm & Mauroner, 2007; Mathisen & Rasmussen, 2019, Walter et al., 2006; Zhang, 2008; Ayoub et al., 2016). Specifically, it contributes to the field of USO literature focusing on determinants of early-stage funding acquisition and firm survival (Huynh et al., 2017; Huynh, 2016; Huynh, 2019). Prior research into these key determinates is limited, thus this paper expands the scope of the literature to include the determinates which were part of this analysis,

The positive and significant relationship between *market research depth* and the ability for a USO to acquire funding and ultimately survive is in line with both prior research stressing the importance of such information from the perspective of investors (De Coster & Butler, 2005; Sharma, 2015; Edelman, Manolova & Brush, 2017) and as a predictor for overall product performance and success (Johnson et al., 2009; Li & Calantone, 1998; Atuahene-Gima and Yinghong 2011). This research bridges the gap by analyzing market-research depth in the context of USOs and confirming the applicability of prior research performed on non-USO firms. Secondly, the positive and significant relationship between *professorial leadership* and USO survival corresponds to research highlighting the importance of founders' human capital for firm performance and survival (Criaco et al., 2014; Huynh et al., 2017). Lastly, although no significant relationship was found between *interfirm collaboration* and either of the dependent variables, future research could

expand on the conceptualization of this variable to include partner and partnership type. Additionally, the effects of having multiple partners of diverse functions (van Beers & Zand, 2014) could be taken into account as well.

In addition to the main theoretical contribution of this research in the field of USO-specific literature, it also contributes to other literature streams. Firstly, this research contributes to the literature concerning high-tech startups (Colombo & Grilli, 2007, 2010; Baron & Hannan, 2002, Bertoni, Colombo & Grilli, 2011; Presutti, Boari & Fratocchi, 2011). The majority of USOs in the data sample were high-tech in nature, resulting in overlap with their non-academic equivalents in terms of issues of high uncertainty and risk. However, it is not clear whether these results are directly transferable to non-academic start-ups as there are differences between the two as well, for instance in capabilities (Ortín-Ángel & Vendrell-Herrero, 2014) and innovativeness as measured by patent applications and the number of radical product innovations (Stephan, 2014). Thus, future research could utilize the determinants that this study focuses on as part of a comprehensive comparison between USOs and other high-tech start-up firms. Secondly, this paper adds to the literature pertaining to competences on both the firm and individual level (Danneels, 2002, 2008; Johnson et al., 2009; SubbaNarasimha, 2001; Sturm, Vera & Crossan, 2017; Cheng & Jen, 2005), specifically in the context of how they influence the ability of USOs to acquire funding and survive.

From a practical perspective, this research demonstrates to academics interested in developing their own spin-off the importance of professorial leadership, since the business experience and networks they provide may prove beneficial to the venture's success in addition to the substantial scientific knowledge they also possess. This is particularly important for high-tech start-ups such as USOs whose ability to overcome obstacles during the business development process is, in part, contingent on the resources and competences which they can acquire, a process in which the leader of the venture plays a significant role. Consequently, USOs should strive to utilize the knowledge and experience that professors possess during the business development process. Based on this result, a recommendation could be made to USOs to attempt to fill the leadership position of the firm with a professor. However, due to the scope of this research being limited to USOs originating from Dutch universities that are seeking funding from a single grant program, the transferability of these results to a broader context comes into question when taking into account cultural differences across countries and funding programs. Lastly, this research highlights the importance of conducting thorough market research, starting at the earlier stages of business development. By analyzing potential markets and determining possible applications for their innovations early on, new spin-offs will have ample time to ascertain what options they have moving forward and to select the ones most in line with their vision.

7. Limitations and implications for further research

This research is limited by several factors. Firstly, this analysis was geographically restricted to the Netherlands as all the spin-offs analyzed originated from Dutch universities. For the results of the study to be applicable on an international level, a more representative data set is required. Consequently, further research could examine the variables in the context of a different country or multiple countries. This research is also limited by a relatively small sample size of 103 which could be increased in future research on this topic along with the time-frame of USO operation encompassed in this study. Additionally, future research could make use of the funding and survival determinants outlined in this research on firm performance since a non-binary dependent variable could provide more insight. By developing a more comprehensive dependent variable representing firm

performance instead of survival, future research could specify in exactly what way the determinates outlined in this research beneficial.

Secondly, as spin-offs grow and reach later stages of development, they will likely require additional funding which they may seek through deals with venture capitalists, investment banks or angel investors. However, the funding criteria used by these parties vary (Mason & Stark, 2004), and may not be comparable to the funding criteria used by the NWO when evaluating and deciding on funding proposals. Further research may delve deeper into whether funding criteria for USOs vary across investor types as well as if the criteria used by each differ to those used for non-academic start-ups.

Thirdly, for the interfirm collaboration variable, partner type and collaboration type were not taken into account. Since there is potential for substantial variance in this regard, further research could seek to develop a more complex model and typology based on this variable and analyze its effect on spin-offs' funding acquisition and eventual survival.

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10. Appendix

Table 1

Range, mean, standard deviation and correlations of the variables (N = 103)

	Range	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
1 Funding	0-1	0.320	0.469	1										
2 Survival	0-1	0.600	0.492	0.261**	1									
3 Interfirm collaboration	0-1	0.590	0.494	0.146	0.092	1								
4 Professorial leadership	0-1	0.560	0.498	0.143	0.323**	0.145	1							
5 Market research depth	0-3	2.060	0.850	0.223*	0.267**	0.267**	-0.320	1						
6 Tech. development degree	0-2	0.20	0.405	-0.027	0.055	-0.036	0.081	-0.167	1					
7 Existing financing	0-1	1.510	0.765	0.117	0.116	0.175	0.057	0.051	0.038	1				
8 Life Sciences	0-1	0.243	0.431	0.097	-0.095	-0.129	-0.049	-0.253	0.093	0.107	1			
9 ICT	0-1	0.262	0.442	0.017	-0.147	0.045	-0.098	0.063	-0.258**	-0.247*	-0.337**	1		
10 HTSM	0-1	0.447	0.499	-0.073	0.212*	0.149	0.083	0.215*	0.085	0.079	-0.509**	-0.535**	1	
11 Chemical	0-1	0.485	0.216	-0.058	-0.001	-0.180	0.108	-0.122	0.144	0.110	-0.128	-0.135	-0.203*	1
N of cases 103														

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)