NTNU – Trondheim
Norwegian University of
Science and Technology

The Effects of Initial Network for University Spin-Off Companies

An Empirical Study of Board Composition and Performance

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Industrial Economics and Technology Management
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Sammendrag

Forskningsbaserte oppstartsbedrifter (USOs) har bevist sitt potensiale som en verdiskapende strategi for å kommersialisere forskning fra universiteter til marked. De er derimot komplekse enheter, som ofte lider under mangel på ressurser. Denne masteroppgaven er delt inn i to deler, hvorav den første tar for seg en litteraturstudie som kartlegger litteratur om betydningen av nettverk for USOs. Funnene presenteres i perspektiv av ressursbasert teori (Resource Based Theory) og sosial kapital-teori (Social Capital Theory). Generelle linjer i litteraturen avdekkes, og det fremlegges avslutningsvis en modell som beskriver situasjonen for USOs.

Del to går dypere og mer spesifikt til verks, og har til hensikt å undersøke fordelene som tilbys av nettverket til styret for USOs. Studien bygger på funnene fra del én, i tillegg til "Board Capital" teori. Gjennom en kvantitativ analyse av 70 norske USOs ser vi på suksessraten til denne typen bedrifter i forbindelse med den initielle styresammensetning

Våre funn tyder på at styrer med nettverk fra tidligere entreprenører og ledererfaring fra seniornivå øker sannsynligheten for suksess. Videre foreslår vi et sett implikasjoner som kan hjelpe akademiske entreprenører og USOs i å skaffe den rette kombinasjonen av erfaring til sine initielle styrer.

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Oppgavens (foreløpige) tittel **The Effects of Initial Network for University Spin-Off Companies** **An Empirical Study of Board Composition and Performance**	
Oppgavetekst/Problembeskrivelse "The purpose of this master thesis is to study the impact of initial network on resource acquisition and performance of USOs. The thesis will consist of the following parts: 1. A review of the existing literature and theories on central topics; social capital, resource based theory 2. An empirical study of USOs, their resource acquisition and performance of USOs 3. An analysis and evaluation of the empirical study 4. Conclusions and implications"	
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Oppgavens (foreløpige) tittel
The Effects of Initial Network for University Spin-Off Companies
An Empirical Study of Board Composition and Performance

4. Bedømmelse

Kandidatene skal ha *individuell* bedømmelse [ ]
Kandidatene skal ha *felles* bedømmelse [X]

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Hovedveileder

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Originalen oppbevares på instituttet.

Preface

This master thesis was written by Andreas Våge and Eirik Fischer during spring 2014 at the Norwegian University of Science and Technology (NTNU). Both studied Industrial Economics and Technology Management at the time.

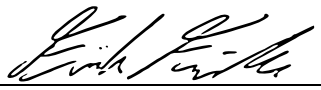
The reader will find two scientific articles which complement each other: The first article presents a theoretical study of University Spin-off Companies in the context of network theory, while the second presents a quantitative study of 70 Norwegian new ventures. Both articles are also designed to communicate independently. The authors chose this format as it is more suited for publishing, which facilitates sharing of information.

Several people have contributed to this thesis. The authors wish to a great extent to thank our academic advisor Ph. D Candidate Marius Tuft Mathisen for invaluable and inspirational guidance. Additionally, we would like to thank Associate Professor Roger Sørheim for his contribution. The authors are also thankful for the suggestions on our thesis from Postdoc Researcher Ekaterina Bjørnåli.

The process of writing this thesis has given the authors a great amount of knowledge on the concept of network effects related to the development of university spin-off companies. Conducting the literature study gave insights and depth within a new, interesting field. Data gathering and analysis gave useful insights in the methods of research, and how to apply and investigate specific areas with the use of pre-existing research and actual data. Also, applying a quantitative method gave the authors the opportunity to use their mathematical and statistical knowledge in practice. Both are happy with the choice of topic and methods used, and are convinced that the newly gained knowledge will serve well in their upcoming careers.

Trondheim, June 3rd 2014

Andreas Våge



Eirik Sola Fischer

The Effect of Initial Network for University Spin-Off Companies: A literature review

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NTNU Industrial Economics and Technology Management
Spring 2014

Abstract
University spin-offs (USOs) are a phenomenon that has proven to be a successful method for commercializing knowledge and technology developed in universities. However, these ventures often lack an initial resource base and legitimacy towards external actors, hence struggling to bring their ideas to market. This study draws the attention towards (1) the benefits present in USOs' initial network, and (2) what type of network that constitutes these benefits. A theoretical framework is presented, consisting of resource-based theory and social capital theory, used to characterize the network benefits that are being exchanged. More specifically, we argue that a non-redundant network provides access to valuable resources, help USOs gain legitimacy, and offer timely information and advice, which is positively correlated with USO performance. This study aims to provide a theoretical model to be used as a basis for further research.

Introduction

The aim of this study is to identify the benefits available for USOs in their networks, and how the characteristics of these networks are. In our changing society the role of universities as a source for creating opportunities is important. Universities have been involved in commercialisation of technology ever since they were first established (Shane, 2004), but have lately increased over time as the institutional environment has become more supportive towards commercial activity (Djokovic & Souitaris, 2008). In the United States the passage of the Bayh-Dole Act is mentioned as one of the contributors to this trend.

University spin-offs (USOs) constitute a way of transferring knowledge from universities to commercial use, and enhance commercialisation by being an effective vehicle for uncertain technologies and encouraging inventor involvement. This formal mode of transfer has resulted in an increasing number of companies spun out over the recent years (O Shea, Allen, O Gorman, & Roche, 2004). USOs benefit society in various ways. They encourage economic development by generating economic value, creating jobs, inducing investment in university technologies and promoting local economic development (Wright, 2007). They also help universities with their mission of scholarly research and teaching by supporting additional research, attract and retain faculty and help train students (Shane, 2004).

Shane (2004) found USOs to be high performing companies with a substantially higher success rate than other start-ups. They are more likely to experience initial public offerings, raise venture capital and survive over time than the average start-up. Nonetheless, there are few success stories, even when investigating long lasting USOs (Chiesa & Piccaluga, 2000). Wright et al. (2012) further state that USOs are rare, atypical entities, which, in the forming, often lack a business plan, and are struggling in raising the

necessary funding. In addition, they often comprise cutting-edge technology, demanding a large resource base to develop and commercialize their product (Shane & Stuart, 2002). Universities tend to possess some of these resources, such as technological expertise and access to skilled personnel. In the aspect of other resources however, such as leveraging competencies and external network towards industry and investors, there seems to be a deficiency (Perez & Sanchez, 2003; Wright, Clarysse, Lockett, & Knockaert, 2008). Although some researchers state that USOs are more effective at generating income for the university than for example licensing (Shane, 2004), they are dependent on establishing linkages to a variety of external actors.

The need to obtain external resources to overcome initial disadvantages and to pursue opportunities is acknowledged as *the entrepreneurial challenge* (Brush, Greene, & Hart, 2001). In the process of gathering knowledge and other resources, the pre-existing network of the founding team is an essential resource (Sullivan & Marvel, 2011). Rothaermel et al. (2007) state that research on network in this initial phase is needed, and Djokovic and Souitaris (2008) further mention research on post-formation development and growth of spin-offs as an important area. Another interesting area for research is the interaction between networks and other potential determinants of spinout structure and performance (Djokovic & Souitaris, 2008). Further, Brush et al. (2001) state that network is used as a tool to gain access to resources, and that these are of crucial importance for USOs. Results from this study can serve as a toolbox, where entrepreneurs can discover what benefits they can harvest from their existing network, and potential benefits by developing their network.

The aim of our study is to highlight the role of social capital for USOs in their early phase. Specifically, we focus on the following research questions: (1) what are the main benefits of being connected to a network for USOs? (2) which network characteristics constitute these benefits? In this paper, we first define the term USO, followed by a brief review of the central theoretical frameworks in resource-based theory (RBT) and social capital theory (SCT). We use SCT to enlighten the dependence USOs have on establishing external linkages, and argue that RBT is convenient to use for describing social capital as a critical resource available to USOs. SCT and RBT need to be simultaneously considered and integrated to better explain entrepreneurial performance (Lee, Lee, & Pennings, 2001). We contend that network is a vital bridge for USOs to acquire external resources, information, advice and legitimacy. The relevant articles from a systematic literature search are reviewed and organized into *content*, *structure* and *governance* as labels. We then review the literature and investigate what benefits a network offers to USOs and the characteristics of these networks. Furthermore, we propose two normative propositions, based on our findings. Finally, we discuss the limitations and implications from the study, and give suggestions for further research.

University Spin-off Companies

"There is a tremendous iceberg phenomenon at work in these organizations" (McMullan & Vesper, 1987: 354).

As our paper revolves around USOs and their attributes, it is important to define what we mean by the phenomenon. The number of definitions on USOs almost equals the number of researchers who have written about it. The implications of using different definitions of USOs severely impact the results of these studies. If a researcher uses a strict definition of USO, and a following scholar misinterprets this in his paper, he might assign or assume characteristics that are not actually present for his subjects. If this continues, the misinterpretations might accumulate beyond the comprehensible, thus harming future research (Carayannis, Rogers, Kurihara, & Allbritton, 1998; Pirnay, Surlemont, & Nlemvo, 2003; Roberts & Malonet, 1996; Steffensen, Rogers, & Speakman, 2000)

The definitions for USOs differ largely. To illustrate this we use the definitions from respectively Wright et al. (2006) and Clarysse et al. (2011).

Table 1. Comparison of USO definitions

Author	Wright et al. (2006)	Clarysse et al. (2011)
Definition	"A start-up company whose formation is dependent on the formal transfer of intellectual property rights from the university and in which the university holds an equity stake."	"A new company that is formed by a faculty, staff member, or doctoral student who left the university to found the company or start the company while still affiliated with the university and/or a core technology (or idea) that is transferred from the parent organization."

The differences often tend to be along a common set of dimensions. As seen above, these dimensions can include origin, technology, team and mode of transfer. Pirnay et al. (2003) address these definitional ambiguities in their in-depth review of previous definitions used. They use the characteristics "who?", "how?" and "what?" to describe their definition.

Table 2. Authors and terms

Characteristics\Authors	Wright et al. (2006)	Clarysse et al. (2011)
The concerned individuals (Who?)	No restrictions	Faculty, staff member or doctoral student
The relationships between individuals and their university (How?)	No restrictions (University ownership)	The founders may either leave the university to start their company; or remain affiliated with the university.
The origin of the USO activities (What?)	Technology-based ideas developed within the university - Implied	A core technology that is transferred from the parent organization to the spin-off firm

The concerned individuals. Spin-offs do not form spontaneously. It is an effect of an individual or a team who have discovered an opportunity they want to pursue through the formation of a new company. If the technology is invented by hired personnel with substantial research experience (Clarysse, Heirman, & Degroof, 2000), the affiliation with the university is as strong as it can be. However, a firm can also stem from other employees or students. Above, we see how Wright et al. (2006) approve of spin-offs regardless of the concerned individuals, while Clarysse et al. (2011) has specified their constraints. Many researchers have definitions that exclude firms most other scholars would include. They often classify the firms close to USOs with other definitions. *"Academic spin-offs"* (ASOs) are created to commercially exploit some promising results obtained by university researchers, whereas "student driven spin-offs" are firms launched to exploit a commercial opportunity, rarely grounded on extensive research activities (Pirnay et al., 2003).

The relationships between individuals and their university are also used in many definitions. Some scholars are quite restrictive by stating that the founders have to leave their earlier positions at the university for the firm to be classified as a USO (Bellini et al., 1999). Others classify the firm as a USO as long as the founders are former employees of the parent organisation (Carayannis et al., 1998; Roberts, 1991; Shane, 2004).

The origin of the USO activities contends the type of technology invention and the place it was invented. From the definitions above, we see how Wright et al. (2006) include ideas, regardless of origin. However, as the definition requires formal transfer of knowledge, including a legal instrument, i.e. a patent, one can contend that knowledge has been produced within the university. Clarysse et al. (2011) however, only include core technology. Others, like Shane (2004), include only firms based on a piece of intellectual property created in the organisation. Shane states with this a clear requirement for the nature of knowledge transfer (Pirnay et al., 2003).

In addition to the characteristics concerning the parties involved and the origin of the idea,

the transfer of knowledge constitutes how information is transferred in between. This transfer can happen through different modes. The choice of mode should primarily depend on what type of knowledge that is being transferred, and the opportunities for exploitation (Grimpe & Hussinger, 2008). Formal transfer mechanisms transfer *codified knowledge*, like licensing and acquisition of patents. This knowledge is generally distinct from the person that generated it (Pirnay et al., 2003). It can therefore easily be transferred and distributed (Callon, 1999), but it can also be copied or imitated (De Bondt, 1997). Informal technology transfer on the other hand, transfers tacit knowledge. It is more concerned with pieces of knowledge accumulated by an individual over time. Codified and tacit knowledge are intertwined. The person that produced the codified knowledge might be more suited to utilize it. This implies that transfer of codified and tacit knowledge goes well together (Siegel, Waldman, Atwater, & Link, 2003).

Our definition of USOs

In defining our view on USOs for this paper, we use the definition from Pirnay et al. (2003) as a starting point. Many universities have close linkages to research organizations. To address these relations in our definition, we include these organizations and define USOs as; *"new firms created, by individuals who are, or were former, employees of the parenting organization, to exploit commercially some knowledge, technology or research results developed within the parent organization - being a university or a university-partnering research organization."*

With this definition, we narrow our reach by requiring that a current or former employee of the university be connected to the firm. This excludes pure student-driven spin-offs. We are not directly addressing the transfer of knowledge. However, the joining of employees from the parent organization implies formal transfer of tacit knowledge. There are no requirements regarding codified knowledge being transferred.

Within this definition, firm heterogeneity is still large. With Pirnay et al.'s (2003) definition, firms from emerging ideas will still be included, although a university might not be the reason for the creation.

Theoretical background

This section will present the different theoretical perspectives used as a basis for underpinning our framework. We first address resource-based theory, both in the context of firms in general and USOs. We then introduce social capital theory.

Resource-based theory

The resource-based view (RBV) can be seen as an excellent starting point for analysis of the relative strengths and weaknesses of firms (Barney, 1995; Wernerfelt, 1984). The perspective focuses on the internal part of the organization and assumes that it consists of bundles of resources, which by the right distribution, combinations and strategy, can lead the firm to achieving sustained competitive advantage (Sørheim, 2003). The possibility of competitive advantage depends on properties of the surroundings and the resources that must be present.

Peteraf (1993) presents a perspective regarding theoretical conditions concerning the environment. These conditions are heterogeneity, imperfect resource mobility, ex post limits to competition and ex ante limits to competition. This is an important foundation for a lot of the resource-based views, incorporating the position and mobility into the value of a resource - justifying the complexity of resources.

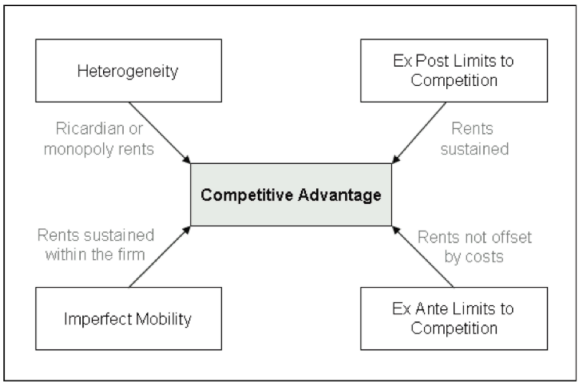

Figure 1. The cornerstones of competitive advantage (Peteraf, 1993)

Heterogeneity concerns the assumption of differences in the availability of resources. This condition of different sets of resources makes the position of firms an interesting landscape of positions with varying opportunities. This also implies that two firms may not be able to

benefit equally from the same strategy, making the process of developing resources a specific and individual task.

Ex ante limits to competition is the assumption of limited competitors competing for the same position initially. It prevents the cost of expenses getting large due to competition, which would eliminate possible rents. Rumelt (2005) points this out by claiming that unless there is a positive difference between ex post value of a venture and the ex ante cost of acquiring a resource, the entrepreneurial rents are zero. It is the ex ante uncertainty that creates profit. We contend that parallels to arbitrage in currency trading can be drawn. If a trader knew that a currency would go up the next day, he would buy today and sell tomorrow.

Ex post limits to competition builds on the condition of heterogeneity. It states that if heterogeneity is not constant, the rent[1] will be fleeting, as new competition will arise. To make the heterogeneity durable, forces that limit competition for the rents must be in place. Imperfect imitability and imperfect substitutability are two critical factors in limiting ex post competition.

Imperfect resource mobility binds the rents in regards to the initial position gained by heterogeneity. It comprises that resources have different value depending on what positions they are used in. Two resources, seemingly equal, may have a different value due to their different positions. The assumption of imperfect resource mobility assumes a cost in moving the resources, making the positions of the two resources essential. Switching and transaction costs imply that every new position will contain marginally less value, thus imperfect mobility. Resources may also be non-tradable.

The resource-based approach (Barney, 1991; Grant, 1991) uses the conditions from Peteraf (1993) and assumes that the resources available are heterogeneously distributed across firms, and that these differences persist over time. Rugman and Verbeke (2002) and Rumelt (1997)) focus on how firms can achieve competitive advantage, by creating isolating mechanisms and resource superiority with firm-level investments in resources and capabilities. The isolating mechanisms of RBV are tools firms use to sustain their position and keep their rivals from re-establishing the balance.

Peteraf's (1993) conditions explain the *surroundings,* and how they facilitate competitive advantage. Barney (1991) further elaborated on the resources the firm must possess to achieve this position. Not all resources have equal value in the context of competitive advantage, and Barney (1991) has theorized that a resource must be *valuable*, *rare*, *inimitable* and *non-substitutable* to be competitive (Barney, 1991). However, even resources with all these properties do not have the potential to create sustained competitive when used on its own. The value increases when these resources are complementary and used together (Grant, 1991). Grant presents how capabilities are the organization's ability to govern the resources more effectively than competitors, being the basis of competitive advantage.

Different categorisations of the resources are used to view the firms in the RBV literature. Grant (1991) uses tangible, intangible and personnel-based resources to describe the firm, while Barney (1991) classifies the resources in physical capital, human capital and organizational capital resources. Physical capital differs from Grant's tangible assets as it also encompasses physical technology used by the firm, as well as the geographical position. Barney defines human capital resources as intelligence, relationships, training, experience, judgment and insights of the individuals in the firm. Organizational capital resources consist of firm's formal reporting structure, formal and informal planning and relationships with other firms and actors in their environment.

Differences in definitions have existed since the establishment of RBV, but scholars tend to build and reference to other authors in choosing and combining their preferred resource classification. The resource-based theory explains which resources that give a competitive advantage. The dynamic capability approach however, a strand that emerged from RBV (Rugman & Verbeke, 2002), takes into account the value the resources possess and how they are structured to develop competitive advantages (Teece, Pisano, & Shuen, 1997). The combination of resources and their

[1] Peteraf (1993) defines rents as *earnings in excess of break even, if their existence does not induce new competition.*

infrastructure are important aspects classic RBV does not take into account. Teece et al. (1997) state that dynamic capabilities reflect a firm's ability to achieve new and innovative forms of competitive advantage. They point out a focus on disequilibria, continuous recombination of resources and firm-level responses to an ever-changing environment (Rugman & Verbeke, 2002). It is important to note that dynamic capabilities alone cannot serve as a source for competitive advantage, but only in combination with a set of resources that are developed in balance (Eisenhardt & Martin, 2000; Rugman & Verbeke, 2002).

The Entrepreneurial Challenge

"That strategy is based on resource strengths is obvious. The more important question that remains to be answered is: What if you don't have any resource strengths?" Wernerfelt (1997).

The strategy for achieving competitive advantage is often a plan for how to develop, combine and configure the strength of existing resources. For entrepreneurs who do not already have these strong resources, the challenge is different. *The Entrepreneurial Challenge* (Brush et al., 2001) comprises the identifying, attracting, attaining, combining and transforming of resources into a strong initial resource base for the organization. Vohora et al. (2004) acknowledge this distinct challenge for USOs and also identifies that there are "critical junctures" in terms of resources and capabilities that a USO needs to acquire to continue developing. These concepts of resources and capabilities are intertwined and entrepreneurs in emerging organizations are dependent on constructing a foundation of resources where capabilities and resources can develop together (Brush et al., 2001).

In this paper, we review USOs in their initial phase. Most of the literature on RBV focuses on mature firms, and most of the resource categories that are used are in context of large, established firms. Brush et al. (2001) acknowledged this lack of resource typology for early stage ventures and reviewed the literature on small business growth. They identified the following resources to be important; capital, organizational systems, management know-how, employees, owner's expertise and reputation, technology, physical, leadership, organizational structure and culture. Further, Brush et al. (2001) categorized the resources of early stage ventures into six types: technological, human, social, financial, physical and organizational resources. Each resource follows a scale of complexity, ranging from simple to complex.

Simple resources are tangible, discrete and property-based. These are simple in the sense of being tangible quantifiable, and are easily imitable. Complex resources are intangible, systemic and knowledge-based, and are difficult to identify, measure and imitate. The resources are also rated on their application, ranging from utilitarian to instrumental. Utilitarian resources, for instance physical resources, are easily utilized and applied directly or combined in the productive process. Instrumental resources are used to provide access to other resources. Figure 2 shows the different scales (Brush et al., 2001).

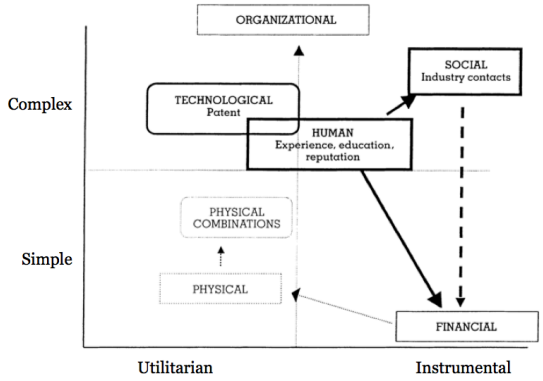

Figure 2. The resource development pathway (Brush et al., 2001).

Following the encouragement from Pirnay et al. (2003) to facilitate the accumulation of knowledge in this field of research, we adopt the work from Brush et al. (2001) and use the categories technological, human, financial and physical resources in our framework for our data sample. The alert reader has probably detected that we do not include the social resources category in Brush et al.'s (2001) framework. The phenomenon of social resources is very intertwined with the concept of social capital, which is the next theoretical topic we will present. We thus choose to cover the social resources in the context of social capital, as this will prevent confusion between these highly connected terms. Organizational resources are excluded from our framework, as we do not see them as relevant for USOs in the initial phase.

In the process of gathering and combining resources, having a network of relationships constitutes as a valuable resource as it provides

its members of collectively owned capital (Bourdieu, 2010). Brush et al. (2001) define 'social resources' as industrial and financial contacts. Others take a more specific approach and refer to these social resources as the network or the social capital of the company (Lee et al., 2001). We will elaborate further on the concept of social capital in the next subsection. As quality relationships are valuable, not easily transformed, and very difficult to imitate, we define social capital as a key resource regarding the potential for competitive advantage (Sørheim, 2003).

Social Capital

Social capital is becoming increasingly popular among many disciplines. The fields of sociology, political science, and economy have used social capital in research (Adler & Kwon, 2002), and it has been used to describe several social phenomena including community life, public health and education (Nahapiet & Ghoshal, 1998). Social capital is seen as the resources gained through networks (Nahapiet & Ghoshal, 1998; Taheri & van Geenhuizen, 2011). The theory is based on the prediction that people who do better are better connected (Burt, 2000). The definition of social capital differs, depending on the scope of the study. Greve (1995) covers only the structure of networks, while Berg et al. (2007) include resources that may be accessed through the network. As opposed to other forms of capital, social capital cannot be traded on an open market (Nahapiet & Ghoshal, 1998). It is shared capital, embedded in the network (Leana & Van Buren, 1999; Lin, 1999).

Social capital and social resources are terms that are frequently used to describe this phenomenon. Some confusion arises because of the various interpretations of the words *capital* and *resources*. Where many argue that it is acceptable to interpret these equally, we decide to differentiate the terms slightly. In Adler and Kwon's (2002) paper, we find them presenting how social capital, like other forms of capital, can either be a substitute for, or a catalysing complement, to other resources. Using this to construct our own analogue; Social capital can be viewed as a phone line between two individuals, and the social resources are the words that are being shared. In this way, we see capital as the tool of communication, whilst resources are the benefits of it. Further, we use a multidimensional approach, adopted from Hoang and Antoncic's (2003) and divide network it into (1) structure, (2) governance, and (3) content.

Network structure: The dynamics of social structures have a great impact on the resource flow, and the amount of resources available to the venture (Hoang & Antoncic, 2003). Network structure is defined by Hoang and Antoncic (2003: 170) as "…the pattern of direct and indirect ties between actors". The amount of resources available is measured by the network size (Aldrich & Reese, 1993) and the ventures centrality in the network (Johannisson, Alexanderson, Nowicki, & Senneseth, 1994; Taheri & van Geenhuizen, 2011). Centrality is the ventures position in the network, and its ability to access and control resources (Hoang & Antoncic, 2003).

Structural position and strength of ties are concepts in the network structure that affect the diversity of resources (Hoang & Antoncic, 2003). The structural position can either be dense or loose (Nahapiet & Ghoshal, 1998). In a dense network, every partner is connected, and mutual trust and credibility make such networks beneficial for reducing cost of knowledge exchange (Coleman, 1990). Coleman (1990) argues that closure of network structure breed trustworthiness and facilitates the emergence of norms. Granovetter (1973) however, suggests that loose networks provide benefits from the diversity of knowledge and brokerage opportunities. Individuals with few weak ties will be deprived of information from distant external actors, and are only confined to information from close friends. Burt (1992) supports this direction and claims that a loose network, with few redundant contacts provides more benefits. He argues that structural holes, being the missing link between two clusters with non-redundant information (Burt, 2002), offers opportunities to access additive information when "bridging" the two clusters. Groups, separated by a structural hole, are aware of one another, but focus on their own activities, each with different flows of information. Burt stated that "these holes offer an opportunity to broker the flow of *information* between people, and *control* the projects that bring together people from opposite sides of the hole" (Burt, 2000: 353).

The concept of strength of ties refers to the intensity of the relationships (Taheri & van Geenhuizen, 2011). Strong relationships develop during long-term interactions, and

help facilitate transfer of new knowledge. There is also a contradicting viewpoint here, where the "strength of weak ties" (Granovetter, 1973) state that resources are obtained through casual meetings, where the information flow is non-redundant (Hite & Hesterly, 2001). Actors, connected through strong ties, are more likely to interact frequently, and this information tends to be the same, restricting diversity (Jack, 2005). However, there are studies showing that networks with little redundancy do not function as well when the transferred information is uncertain (Nahapiet & Ghoshal, 1998). The studies on network structure hence has yielded inconclusive results, but the general consensus is that network structure influences the accessibility of network benefits (Nahapiet & Ghoshal, 1998).

Network governance: Network governance is the element that explains the coordination of the network exchange (Hoang & Antoncic, 2003). The transfer of information can be smooth and effective by governance mechanisms, such as trust, power or influence (Krackhardt, 1990; Larson, 1992). Coleman (1989) emphasizes that a dense network facilitates sanctions that make it less risky for the network participants to trust one another. A relationship governed by mutual trust reduce transaction costs, given that both participants can assume that the other party takes actions that are predictable and mutually acceptable (Uzzi, 1997). Many scholars have stated that developed governance mechanisms can create cost advantages, compared to bureaucratic mechanisms (Thorelli, 1986). Information is costly, and channels that reduce the amount of time and costs are required (Nahapiet & Ghoshal, 1998). With a trusted relationship, both parties can easier predict their counterpart's actions, and hence lower the transaction costs (Uzzi, 1997).

Network content: Network content explains the resources and benefits that are being exchanged between actors in a network. Advice and information are examples on benefits provided by a network (Hoang & Antoncic, 2003). Entrepreneurs use networks as a main source to access opportunities and get new ideas (Singh, Hills, Hybels, & Lumpkin, 1999), and provide access to both tangible and intangible resources (Nahapiet & Ghoshal, 1998). Druilhe and Garnsey (2004) go as far as to state that business opportunities can in general only be realized if the venture manages to participate in collaborations. To have access to information before actors outside the network, gives an advantage when for example speed to market may be a key factor. Higgins and Gulati (2000) state that network content is not only exchange of information, advice, and access to resources. Network includes also a reputational effect. Both Nicolaou and Birley (2003) and Burt (1992) suggest that referral is one of the main benefits of network ties. USOs are operating in an uncertain environment, and for potential investors, referrals are of great value before deciding on whether or not to invest in an entrepreneur's idea. Venture capitalists are more inclined to invest in companies that have been referred to by trusted actors (Shane & Cable, 2002; Sorenson & Stuart, 2001).

In the context of USOs: Social capital has received little attention in the literature surrounding university spin-offs. There is however, a general consensus that social capital often assists entrepreneurs in obtaining access to venture capital, information and potential customers (Liao & Welsch, 2005). We can easily see the advantages of having a founding team with ties to different clusters, bridging the potential structural holes USOs face. As they lack a majority of the resources needed to commercialize their venture, bridging structural holes are crucial to access these resources fast. Brüderl and Preisendörfer (1998) empirically showed that networks gave USOs access to resources, and further enhanced the survival and growth potential. An important issue facing USOs, are the liabilities of newness (Stinchcombe, 1965). They often introduce a new technology, or a new use of existing technologies, and networks can work as a response to insecurity arising (Diez, 2000). Strong ties to external actors offer legitimacy, and enhance the process of passing the critical junctures (Vohora et al., 2004).

Timely information about the technology landscape can permit USOs to adjust the product development more effectively (Elfring & Hulsink, 2003). We can draw parallels with Burt's (2000) research. By bridging clusters, USOs get access to information, which again can be used to find a suitable area of purpose for their product. Gübeli and Doloreux (2005) found that the collaboration between USOs and both the parental institution and external actors is important. During the spin-off process, the parental institution plays a pivotal role for the USOs, helping them to shape a

business idea. They also support USOs with expertise and infrastructure. However, as the spin-off evolves, connections towards local companies, financial organisations and science parks/incubators, become more important (Gübeli & Doloreux, 2005).

Methodology

Research on USOs is a relatively new field, with a small group of authors with highly cited work. We first assessed central literature reviews. Mustar et al. (2006), Djokovic and Souitaris (2008), O'Shea et al. (2004) and Rothaermel et al. (2007) were recommendations from entrepreneurship scholars at NTNU, and thus we started with these. They provided insights into key definitions, concepts and terms used, thus facilitated our empirical search. We compiled a list of keywords for possible search combinations, presented in Table 3.

Scholars often restrict their literature search to recognized journals. As our research area is still in an embryonic stage (Rasmussen, Bulanova, Jensen, & Clausen, 2012), we did not want to restrict our already narrow search further, hence no restrictions regarding journals were applied. The search in the ISI Web of Science was conducted by using the keywords listed below. The ISI database covers leading journals, and it was therefore unlikely that leading articles would be left out of the search. The search was done in two stages. Stage one grasped the main substance of the literature, while stage two adjusted for the desired perspective.

Table 3. Base search

Origin	Nature of the firm
Academic	New venture
Faculty	New ventures
Research-based	Spin-off
Science-based	Spin-offs
Scientist	Spin-out
University	Spin-outs
	Spinoff
	Spinoffs
	Spinout
	Spinouts
	New firm
	New firms
	Entrepreneurial
	Entrepreneurship
	Start up
	Start ups
	Spinning out

Stage 1: We were interested in literature where USOs were the object of study, but given the many different terms used, we decided to make the "funnel" sufficiently big. This was done to make sure no relevant literature would be missed. We also added a column with keywords suited for our research scope. The keywords in this column were a result of a review of the four central articles mentioned earlier. We conducted our first search by using topic (keywords, abstract, title) for the keywords in table 3 and table 4.

Table 4. First stage, network specific search

Third column - Primary search (419)
Network
Networks
Social Capital
Resource-based
Collective goals
Reciprocity
Interorganizational
Interorganisational
Intellectual capital
Sharing

To get the most topical literature, we limited our search from year 2000 until today. The combination of 6 terms for origin, 17 terms for the nature of the firm and 9 terms related to network compiled 419 articles that matched the search criteria. We then manually checked each article by reading the abstracts.

Stage 2: We suspected that our search criteria was to narrow. We therefore conducted a second search with new keywords, to see if it would give us a substantially higher number of articles. The terms used are listed in Table 5 below.

Table 5. Second stage, network specific search

Third column - Secondary search (488)
Network
Social
Ties

Surprisingly the search only resulted in 488 articles. We crosschecked all articles to compile a full list. An additional 175 articles were added. To crosscheck our findings, we combined the two searches for future research, and the search resulted in 594 articles, as predicted.

Table 6. Combined search

Third column - Combined search (594)
Network
Networks
Social Capital
Resource-based
Collective goals
Reciprocity
Interorganizational
Interorganisational
Intellectual capital
Sharing
Social
Ties

To extract the articles that touched upon USOs in combination with network theory, we manually checked each article by reading abstracts. The abstracts gave us enough insight to sort the articles after their relevance for our research. The labels "not relevant", "potential" and "relevant" where used in this process. In the selection process, we mainly focused on four factors to discard articles.

Unit of analysis: Many articles focused on a different level of analysis, mainly technology transfer offices and incubator/science parks. We wanted articles with firm emergence and performance as level of analysis.
Time perspective: Some articles investigated the relationship between a founder's social capital and the probability of starting a USO
Network focus: We focus on the benefits obtained from a network, while some articles looked at the process of gaining social capital
Outside our definition: Articles with a focus on firms that did not fit our definition of USOs were discarded.

Given the subjective method used to discard articles, we read the articles separately and compared our choice to minimize this subjectivity. After reading through the 594 abstracts and discussing our evaluation, we ended up with 45 articles labelled as relevant and 46 as potential. The remaining 503 articles were discarded. The relevant articles were read carefully. Of these, only 13 were assessed as relevant articles for our study. During our initial screening we did not possess sufficient knowledge, and chose to include questionable articles, in fear of discarding potentially relevant articles. However, after revisiting the articles, we choose to discard a total of 22. We then assessed the 46 "potential" articles, and of these we included 4 articles to the relevant-folder.

The Journal of Technology Transfer was not included in the ISI Web of knowledge until the end of 2008. To reassure we did not miss any relevant articles from this journal, we manually checked the journal from volume 25 (march 2000) to volume 33 (december 2008). From this search we conducted an additional three articles, giving us a data sample to 20 articles.

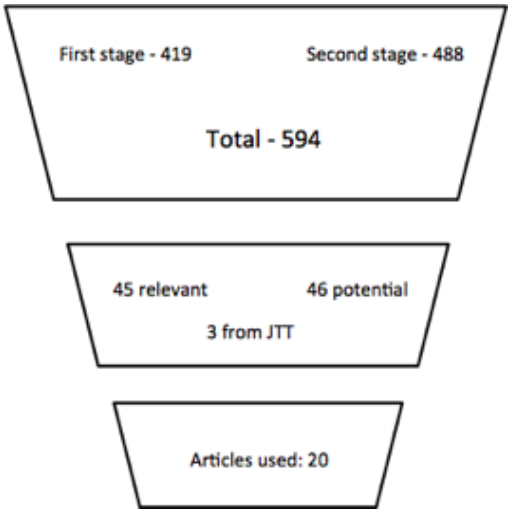

Figure 3. Funnel illustrating the systematic search

We created a database of the relevant articles, as shown in Table 8. It allowed us to reveal patterns that we discuss in the analysis subsequently. We then revisit the articles with an attempt to answer our research questions. This is being discussed in the section *Discussion*.

There are several limitations with our method. Regarding our time span, this clearly discards relevant articles published prior to 2000. Although this is a major limitation, we focused on reading relevant "state-of-the-art" articles. Further, we only used ISI Web of Knowledge, and did not include other databases as sources for our search. A third limitation is the subjectivity, mentioned earlier. We review articles based on our immediate impression of the abstract, and also conducted our keywords based on other scholars subjective keywords. By doing so, we excluded articles that did not contain our qualifying search terms. Because of this, we may have missed relevant literature that uses other terms to describe the phenomenon. Given our low hit rate of only 13 of 503 relevant articles, we may have discarded a few relevant articles. Another grand limitation to our method is the fact that we only included USO/RBSO literature. There are

obviously articles outside this research sphere that touch upon relevant insight from both general entrepreneurship and network-related research. These articles are ignored.

Results

Our extensive search reveals a total of 20 articles, published between year 2000 and 2013. Further examination of the year of publication, shows an increasing trend in publications in this field of research.

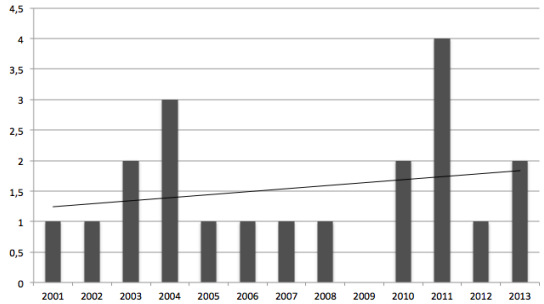

Figure 4. Overview of published articles by year (with trend line)

The increase in numbers of articles regarding university entrepreneurship, has been observed by several scholars (Rothaermel et al., 2007). Rasmussen (2012) explained the increase in articles as a direct result of several special issues, published during the last years. However, looking at our sample, special issues are not the main driver for this increase, and it tells us that the spin-off literature is vibrant (Djokovic & Souitaris, 2008).

Our sample consists of a fairly scattered map of journals. A total of 15 journals for only 20 articles might tell us that we have found a topic that has not yet been embraced by specific areas within the research field. Network literature is well concentrated in highly ranked journals, but in the context of USOs there seems to be less published articles. From Table 7, we see that *Journal of Technology Transfer* contributes with most articles in our sample. The journal is the second most relevant in Rothaermel et al.'s (2007) paper, and thus gives our sample validity. We also acknowledge that our search, by only including USOs, is quite restricted. This makes our sample too small (N=20) to make statistically solid statements.

In assessing the journals, we have taken use of two well-known metrics, namely Impact Factor and SJR. Impact Factor is an un-weighted measure which reflects the average number of citations for the most recent articles in the journals, and are related exclusively to the search engine ISI (Garfield, 2006). It is mostly used as a proxy to assess the relative importance of journals within a field of research. The SJR-indicator is exclusively related to Scopus' search engine, and is a measure of the scientific influence of the journals. SJR is a weighted measure, which accounts for both the number of citations and the prestige of the source journals for the last three years.

Table 7. Journal overview with metrics

Journals: 15	**# of Articles**	**SJR**	**Impact factor**
Journal of Technology Transfer	3	1,36	1,692
Journal of Management Studies	2	2,995	3,799
Technovation	2	1,683	3,177
R & D Management	2	1,45	1,58
Small business Economics	2	1,32	1,13
Research Policy	1	2,458	2,85
Strategic Management Journal	1	5,613	3,367
Journal of Business Venturing	1	2,774	2,976
Entrepreneurship Theory and Practice	1	2,12	2,242
Technological Forecasting and Social Change	1	1,31	2,106
Management Science	1	2,902	1,859

We observe that our sample of journals is very diverse. *Journal of Management Studies*, *Strategic Management Journal*, *Entrepreneurship Theory and Practice*, and *Management Science* are all high quality journals with significant journal metrics. *Tijdschrift Voor Economische En Sociale Geografie* and *Innovation - The European Journal of Social Science Research* stand out as the two journals with the lowest metric scores. It is also noticeable that the articles from these two journals are written by the same authors.

Although no journals stand out as publisher of more than three articles, the presence of these relevant actors gives validity to our sample. *Technovation*, *Journal of Business Venturing*, *Research Policy* and *R & D Management* are top journals within the field of USOs (Rasmussen et al., 2012), and by using the taxonomy of university entrepreneurship by Rothaermel et al. (2007) as a comparison, we see that all of our most contributing journals are represented.

In examining the results, we also observe that top-publishing journals like *Academic of Management* is not present. Network research is also typically published in other high ranked journals in the sociology field, like Administrative Science Quarterly (ASQ) or American Sociological Review (ASR). Neither of these were present in our search. This absence is observed and commented by many scholars as an indicator for the field of university entrepreneurship still being in an atheoretical embryonic development stage (Rothaermel et al., 2007).

Several of the researchers in our sample are known to be frequently associated with the field of USO. From the Table 8 below, we can observe the presence of Mike Wright in four of the 20 articles. Mosey, Stuart, van Geenhuizen and Soetanto are also observed as authors in several articles. These journals are however, ranked differently. Stuart and Mosey appear in the journals with the higher metrics than van Geenhuizen and Soetanto.

Table 8. Author/Article overview. Citations marked with -- were not indexed by either Elsevier Scopus or ISI

Authors	Year	Title	Citations	Journals
Lubik, S; Garnsey, E; Minshall, T; Platts, K	2013	Value creation from the innovation environment: partnership strategies in university spin-outs	0	R & D MANAGEMENT
Hirai, Y; Watanabe, T; Inuzuka, A	2013	Empirical analysis of the effect of Japanese university spinoffs' social networks on their performance	0	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE
van Geenhuizen, M; Soetanto, DP	2012	Open innovation among university spin-off firms: what is in it for them, and what can cities do?	0	INNOVATION-THE EUROPEAN JOURNAL OF SOCIAL SCIENCE RESEARCH
Rasmussen, E; Mosey, S; Wright, M	2011	The Evolution of Entrepreneurial Competencies: A Longitudinal Study of University Spin-Off Venture Emergence	18	JOURNAL OF MANAGEMENT STUDIES
Sullivan, DM; Marvel, MR	2011	Knowledge Acquisition, Network Reliance, and Early-Stage Technology Venture Outcomes	10	JOURNAL OF MANAGEMENT STUDIES
Walter, A; Parboteeah, KP; Riesenhuber, F; Hoegl, M	2011	Championship Behaviours and Innovations Success: An Empirical Investigation of University Spin-Offs	3	JOURNAL OF PRODUCT INNOVATION MANAGEMENT
Taheri, M; van Geenhuizen, M	2011	How human capital and social networks may influence the patterns of international learning among academic spin-off firms*	3	PAPERS IN REGIONAL SCIENCE
Gurdon, MA; Samsom, KJ	2010	A longitudinal study of success and failure among scientist-started ventures	3	TECHNOVATION

Soetanto, DP; van Geenhuizen, M	2010	Social capital through networks: The case of university spin-off firms in different stages	3	TIJDSCHRIFT VOOR ECONOMISCHE EN SOCIALE GEOGRAFIE
Chen, MH; Wang, MC	2008	Social networks and a new venture's innovative capability: the role of trust within entrepreneurial teams	11	R & D MANAGEMENT
Mosey, S; Wright, M	2007	From human capital to social capital: A longitudinal study of technology-based academic entrepreneurs	60	ENTREPRENEURSHIP THEORY AND PRACTICE
Walter, A; Auer, M; Ritter, T	2006	The impact of network capabilities and entrepreneurial orientation on university spin-off performance	82	JOURNAL OF BUSINESS VENTURING
Johansson, M; Jacob, M; Hellström, T;	2005	How and why do research-based start-ups differ at founding? A resource-based configurational perspective.	--	THE JOURNAL OF TECHNOLOGY MANAGEMENT
Vohora, A; Wright, M; Lockett, A	2004	Critical junctures in the development of university high-tech spinout companies	142	RESEARCH POLICY
Heirman, A; Clarysse, B;	2004	Questionnaire of 99 RBSU's from Flanders.	--	THE JOURNAL OF TECHNOLOGY MANAGEMENT
Druilhe, C; Garnsey, E;	2004	Do academic spin-outs differ and does it matter?	--	THE JOURNAL OF TECHNOLOGY MANAGEMENT
Perez, MP; Sanchez, AM	2003	The development of university spin-offs: early dynamics of technology transfer and networking	42	TECHNOVATION
Grandi, A; Grimaldi, R	2003	Exploring the networking characteristics of new venture founding teams	29	SMALL BUSINESS ECONOMICS
Shane, S; Stuart, T	2002	Organizational endowments and the performance of university start-ups	280	MANAGEMENT SCIENCE
Lee, C; Lee, K; Pennings, JM	2001	Internal capabilities, external networks, and performance: A study on technology-based ventures	322	STRATEGIC MANAGEMENT JOURNAL

Articles

We will in this section briefly present the articles, and further elaborate on the findings in the *Discussion* chapter. The literature from our search comprises several different perspectives towards network theory. Building on our earlier categorisation of the social capital elements, we synthesize our findings into *network structure, network governance* and *network content*, introduced by Hoang and Antoncic (2003). These three elements explain the impact network has on USOs. As access to specific resources are commonly mentioned in the literature, we will put extra emphasis on network content and the underlying constructs this category comprises. Brush et al.'s (2001) resource categories will be used as a framework to present the findings regarding the attaining of the different resources.

The network elements are intertwined and not mutually exclusive. A focus on one network element does not discard the others. We have done a subjective assessment, where the articles have been reviewed by the authors separately, concluding with a discussion about the relevance. The goal of these discussions was to separate the articles into the different perspectives. The most relevant drivers for the separation of the articles were the research question(s) and the finding(s). Many articles did discuss all the elements, but often with a

specific scope towards one of them. Articles with a focus on the differences in the structural position and strength of ties were consequently put under network structure, articles investigating of the mechanisms that facilitate transfer of network content were put under governance, and the articles that looks at the benefits of having a network were placed under content.

In addition to the articles in our data sample, we found four literature reviews in our search, being Djokovic and Souitaris (2008), Mustar et al. (2006), Rothaermel et al. (2007) and Stuart and Sorenson (2007). These were used to crosscheck our sample.

***Network structure*:** The social structures and their impact on USOs are being addressed in six articles, where the main focus lies on the strength of ties and the structural position in the network. The articles find different effects regarding which benefits that are offered with different structures. The main findings are that non-redundant ties offer timely information, in accordance with Burt's (Burt, 2000) theories, and that strong ties are crucial during founding phase to overcome initial disadvantages (Shane & Cable, 2002).

While the articles focus on how different network structures affect USOs, some do also shed light on the governance- and content perspectives. Mosey and Wright (2007) discuss the nature of the resources and the governance mechanisms utilized, and hence could be placed under network governance as well.

Table 9. Article overview - Structure

Authors	Research question(s)	Data	Key finding(s)
Johansson et al. (2005)	What are the antecedent conditions and the reasons for further relations between universities and USOs, and how are they sustained?	Case study of four USOs.	It is often researchers initiative to spin out firms, where personal interest is the main factor. USOs are highly dependent on a sustainable link to university research, and are constituted by a few strong ties towards home department, and weak ties to other universities.
Geenhuizen and Soetanto (2012)	How do USOs use network in gaining needed resources, and how does it affect the performance.	59 spin offs from Delft.	Spin-offs engaged in high-density (or closed) networks and strong ties show a relatively large propensity for weak growth, whereas spin-offs engaged with strongly heterogeneous partners and with networks outside the city-region show a relatively large propensity for strong growth.
Taheri and Geenhuizen (2011)	What influences the building of international networks.	100 USOs from Trondheim and Delft.	Firms in loose social networks were more likely to establish international relations, given a larger and more diverse access to resource opportunities for firms in network brokerage positions.
Mosey and Wright (2007)	What is the nature of the resources gained through the social networks of academic entrepreneurs with different levels of prior ownership experience in the early stages of venture development, and what governance mechanisms are utilized by academic entrepreneurs with different experience to access resources through social networks at the early stages.	Multiple case study, with interviews of 24 academics with variance in terms of business experience.	Habitual entrepreneurs are more likely to gain credibility and hence raise equity easier, gain management resources outside their research environment and gain technical resources from their research colleagues.
Hirai et al. (2013)	Empirically examines the effect of university spinoffs' external advice networks on their performance.	79 Japanese university spin-offs.	Non-redundancy in university spinoffs' networks affects their performance positively, and the impact is enhanced by the tie closeness of business relationships and the tie weakness of private relationships.
Shane and Stuart (2002)	How do resource endowments affect the likelihood of attracting venture capital financing, experience IPO and fail.	134 MIT USOs.	The presence of direct and indirect ties to venture investors prior to firm founding sharply decreases the likelihood of failure, and increases the likelihood of external funding. Social capital, because of the impact on fund-raising, has long-term positive influence on the performance of new ventures.

***Network governance*:** Only two articles focus on network governance, where the mechanisms that are coordinating and facilitating the exchange of resources are being addressed. Weak ties tend to facilitate one-time economic exchange governed by legal mechanisms, whereas strong ties tend to facilitate on-going exchanges governed by mutual trust (Newbert, Tornikoski, & Quigley, 2013). Such mechanisms can reduce transaction costs connected with for example monitoring, and thus creating cost advantages. Perez and Sanchez (2003) investigate how active USOs are in network development and technology transfer to overcome initial disadvantages. These disadvantages comprises more than just credibility and trust, hence this article could also be placed within the structural- or content-oriented view.

Table 10. Article overview - Governance

Authors	Research question(s)	Data	Key finding(s)
Perez and Sanchez (2003)	How active in the network development and technology transfer are university spin-offs during their early years to overcome initial disadvantages, and is there any relationship between early networks, knowledge creation and technology transfer in university spin-offs?	10 Spanish University spin-off companies from 1990-2000.	The technology transfer with the university and the USO is decreasing after their early years, while the relationship with customers increases. Links throughout the regional innovation network helped the firms to overcome trust barriers and increase the flow of technology transfer after their early years.
Rasmussen et al. (2011)	How do new ventures in the university context emerge, and how is credibility reached by acquisition and development of the entrepreneurial competencies?	4 university spin offs from UK and Norway.	Nascent USOs are more likely to gain credibility if they can evolve the venture's leveraging competency through interaction of the entrepreneurial team, containing prior entrepreneurial experience, with external resource providers. It is also critical to have a strong leadership role to sustain the venture start-up process.

Network content: Several articles (12) focus on the benefits obtained from network ties. USOs are continuously building their resource base, and access to external resources is vital. However, it is not only resources that are being obtained by USOs. Strategically good advices during the founding process are invaluable, and may easily be the determinant that separates USOs from success and failure. Legitimacy is also an important benefit, helping USOs to pass the credibility threshold easier.

Table 11. Article overview - Content

Authors	Research question(s)	Data	Key finding(s)
Walter et al. (2006)	Network capabilities are positively associated with spin-off performance.	Questionnaires from 149 founders of spin-offs.	The study shows that the performance variables sales growth, sales per employee, profit attainment, perceived customer relationship quality, realized competitive advantages, and long-term survival, are influenced by a spin-off's network.
Lee et al. (2001)	This study examined the influence of internal capabilities and external networks on firm performance.	137 Korean start-ups.	There are three indicators of internal capabilities that are important predictors of a start-up's performance. Among external networks, only the linkages to venture capital companies predicted the start-up's performance.
Grandi and Grimaldi (2005)	What are the founding teams' intention to set up relations with external agents and their frequency of interaction with external agents.	40 Italian academic spin-offs.	Articulation of roles positively affects the intention to set up relations with external agents. Academic entrepreneurs their own "ties" and their interaction modalities with external agents, so they are likely to keep interacting with the same frequency (or even more, given the different nature of the new business) with external agents after the establishment of the new company.

Lubik et al. (2013)	How relationships with each type of partner can be leveraged to help the firm create value.	7 case studies of Advanced Material USOs.	The most commercially successful USOs in the advanced materials industry were forming alliances with a number of corporate partners, limiting their dependence on a single partner, in addition to a wide range of organizations including nonparent universities and other USOs.
Chen and Wang (2008)	This paper examines the effects of social networks and trust on a new venture's innovative capability.	112 technology-based entrepreneurial teams from Taiwan.	Both internal and external social networks have marginally positive impacts on a new venture's innovative capability, and trust within the entrepreneurial teams is found to be important for the relationship between external social networks and innovative capability.
Soetanto and Geenhuizen (2010)	Explores differences in social networks between two development stages and to estimate the influence of network characteristics on growth in these stages.	150 USOs from Delft and NTNU.	Early stage spin-offs tend to employ networks dominated by tightness, strong relationships, more homogeneous partners and local partners, whereas networks of spin-offs in later stages tend to face clearly contrasting features.
Heirman and Clarysse (2004)	This paper studies the initial resources on which new organizations are based and how these resources interact with the institutional origin and market characteristics.	Questionnaire of 99 RBSU's from Flanders.	The initial resources of the firm affect the firms' further development.
Walter et al. (2011)	Does champion behaviour result in innovation success? A longitudinal measure of sales growth.	123 USOs.	The results indicate that network building has the desired positive relationship with sales performance. Surprisingly, pursuing innovative ideas are not related to sales growth.
Vohora et al. (2004)	This paper investigates the development of university spinout companies (USOs).	7 USOs from UK.	Identified that the growth of high-tech ventures is characterized by a number of distinct stages of development, termed "critical junctures". Networks with strong ties and relations with respected actors may help on passing junctures regarding credibility.
Sullivan and Marvel (2011)	Do entrepreneurs with reliance on networking for acquiring technology- and market knowledge benefit from it?	Surveys from 151 spin-offs.	For spin-offs at high levels of technology knowledge acquisition, entrepreneurs who rely more on networks benefit in terms of producing more innovative offerings. Entrepreneurs who relied more on network ties for acquiring market knowledge were not able to utilize their marked knowledge more effectively to generate higher first-year sales.
Gurdon and Samsom (2010)	What are the drivers of success and failure for USOs?	Interviews of 22 USO founders	The technological resources combined with the financial capabilities were regarded as the drivers of success.
Druilhe and Garnsey (2004)	Do Academic Spin-Outs Differ and Does it Matter?	Case studies of 9 firms originating from Cambridge	RBSU's differ in both firms resources and entrepreneurs knowledge/experience. The continuous improvement on the entrepreneurs perception of opportunities is helping the firm gaining a better understanding of the resource configurations required to pursue the refined or newly perceived opportunities.

We have structured the findings on resource acquisition based on Brush et al.'s (2001) categories:

Financial resources: Many of the findings in the articles are pointing towards the financial effects that are being offered from an external network. Direct and indirect ties towards venture investors, prior to firm founding, are important, as this sharply decreases the likelihood of failure (Shane & Stuart, 2002). This also concurs with Tyebjee and Bruno (1984), who argues that VC-funds use references gathered from their own network in

the process of screening the potential firms. The nature of financial resources, defined by Brush et al (2001) as an instrumental resource, make them suitable for acquiring other resources. Heirman and Clarysse (2004) point to the connection between financial and human resources, and how more of one resource leads to a higher probability of acquiring the other, also concurring with Shane and Stuart's (2002) findings. Having direct ties towards venture investors at founding, strongly help USOs gain financial resources (Shane & Stuart, 2002). This further puts them in a position where they can acquire other valuable resources, to create competitive advantages.

Human resources: Many articles highlight how USOs with a loose network are more likely to gain management resources outside their research environment (Mosey & Wright, 2007). Chen and Wang (2008) highlight the impact network has on innovative capabilities. With ties connected to talent and management resources, the USO will have the ability to create high performing human resources. The credibility of the USO, deriving from the university it was spun out from, also affect the attractiveness towards talented employees and can play a role in retrieving the desired human resources (Grandi & Grimaldi, 2003). Knowledge acquisition is a theme in many of the articles, and a heterogeneous network makes it easier to attract talent and management resources. Hence USOs with a narrow network are often limited to the human resources their research environment offers and are thus in need of access to resources from industry partners and external investors. We also note that attracting and obtaining human resources, and not so much the implications of it, is a typical theme in the literature. This is not surprising, given that we investigate the network effects, and not the human resource effect.

Technological resources: Firm-specific products and technologies are important for USOs, as they constitute a part of the USO's core competency. Strong technological resources can create a competitive advantage vis-á-vis rivals (Brush et al., 2001). Habitual entrepreneurs are more likely to gain access to technology resources matching their knowledge (Mosey & Wright, 2007). By having a structurally position with indirect ties, the possibility of identifying a technology that matches your USO increases (Druilhe & Garnsey, 2004; Mosey & Wright, 2007). A non-redundant network gives them access to a wider range of resources, and makes it easier to identify available technologies appropriate for their use. Lubik et al. (2013) point on how academic institutions and other USOs are valuable sources of complementary resources and innovations. Thus, external innovations can be a compliment for the USO's technological resources. Gathering technological resources mainly consists of searching for the right resource. There might be many "try-and-fails" before right match is found, thus the amount of information is important.

Physical resources: Very little of the literature we have sought out comprises findings regarding physical resources. These resources are tangible and easy to measure. However, we see the immense diversity of how these resources exist for the different firms. The fact that these resources possess value to the holding firm relevant to their utility complicates the matter of measuring. The value of the resources will vary, depending on the actor obtaining them, and we therefore note that this might influence the attractiveness as a research subject. Firms, based on Information Technology and other software, are increasing in amount. The physical resources needed in these firms, are normally not too important, compared to more traditional, industrial firms, and thus we can comprehend the low attendance of this subject. However, we convey that there is still a strong link between the network and the availability of physical resources for USOs. For faculty and students, strong ties to the university can give access to laboratories and other equipment. This is a major benefit for USOs, compared to other start-ups. In the case of external network with other firms, the USO can increase their availability to physical resources by sharing the cost of facilities, tools and machines.

Discussion

Our paper missions to investigate the benefits obtained by USOs as an effect of their network, and the characteristics these networks possess. The articles in our sample address both USOs and single entrepreneurs. Firstly, we look at the differences between these classifications, to see if similarities can be drawn. Future researchers may benefit by generalizations made by possible differences. Secondly, we present our findings concerning research question 1, namely what the main benefits of

being connected to a network for USOs are. Thirdly, we sought to answer research question 2, being what network characteristics constitute these benefits. We build on social capital theory to investigate our findings, by looking at the structural position the USO possess. Lastly, we present a model based on our findings, and introduce two propositions.

USOs or academic entrepreneurs?

We discovered that a large part of the literature either used USOs or academic entrepreneurs as the focal object. The differences found in our sample were investigated, to see if similarities could be drawn. If research on entrepreneurs harvests the same results as research on USOs, operationalizations can be made. Earlier research methods on single entrepreneurs may then be used for USOs.

When addressing single entrepreneurs, our findings point to trust mechanisms as the main mechanism that governs exchange of benefits most effectively. In opposition to established firms, entrepreneurs predominantly use informal "open-ended" contracts in their networks. Mosey and Wright (2007) discovered how the difference in experience affect the governance mechanisms of the entrepreneurs' network, and how this affected venture development. Habitual entrepreneurs are strategic regarding the new ties they wish to build. By actively trying to fill the gaps they discover, they build a loose network of ties to people in various positions in different industries. The structural holes (Burt, 2000) are easier bridged, and valuable benefits can be obtained. Rasmussen et al. (2011) further finds that habitual entrepreneurs possess competencies regarding how to access industry partners and investors. But are these findings transferrable to USOs?

Entrepreneurship is a process and not an event (Aldrich Howard & Ruef, 2006). Stuart and Sorenson (2007) shed light to the little theory that exists regarding the distinctions between founders and firms in the entrepreneurial network effects field. USOs are legal entities with self-developed culture, routines and processes that persist independently of individual employees. However, much of the research presented in this paper elaborates on how interpersonal interactions have an effect on the USOs. Firms do not feel sentiments of trust and obligation. This implies that the research must point to how the entrepreneurs themselves should govern their networks with trust. However, USOs *do* have status (Stuart & Sorenson, 2007), and this status can serve as a foundation of legitimacy, which can support the formation of networks and resources (Shane & Stuart, 2002). Hence, the initial social capital possessed by USOs is in fact the social capital of the founders. This capital is being transferred to the firm when it develops internal processes and capabilities. This builds on RVT logic, where the initial resources of the firm over time are becoming embedded within the firm context. The question regarding when the USOs' status becomes independent from its founders is thus of interest. When researchers are able to measure firms' networks, the networks become properties of the firms (Stuart & Sorenson, 2007). In the less frequent instances in which the researcher only has information on founders, the founders' ties become the units of measurement, even though outcomes typically occur at the firm level (Shane & Cable, 2002). Using these contentions one would expect that the findings for newly established USOs and academic entrepreneurs should yield the same results.

The benefits present in USOs' network

The benefits touched upon in our sample constitute access to resources, legitimacy, information, and advice. These construct are not completely different. It can be argued that information and advice are understood as similar types of benefits. Information can also be understood as knowledge, and as Brush et al. (2001) argue, knowledge is a part of human resources. Nevertheless, they may be separated in the following way: Access to resources is a benefit that enables USOs to acquire the resources needed at a specific time, legitimacy is the reputation USOs gain by being connected to prestigious actors, information lets USOs identify available opportunities and potential threats, while advice guides USOs in strategic decisions. We will first review our findings on access to resources, and then elaborate on the other benefits in the respective order.

The most frequently mentioned benefits in regards to resources available through network ties are increased probability of VC-funding and access to investors (Lee et al., 2001; Shane & Stuart, 2002; Tyebjee & Bruno, 1984). USOs often have a resource-demanding technology (Shane & Stuart, 2002), and the availability of

financial resources is especially important. With financial resources, USOs can faster put their products to market. In addition, financial resources are viewed as instrumental - suitable for acquiring other resources (Brush et al., 2001). Management resources available through network ties is another benefit highlighted in our sample (Mosey & Wright, 2007). Surprisingly, little of the literature focused on the physical resources, obtained through network ties. Initially, we thought this would be a well-covered subject, as it is relevant and easy to comprehend. However, this could be explained by the fact that financial resources are instrumental (Brush et al., 2001). Physical resources can be bought with financial resources, and are hence not that interesting to investigate. Also, physical resources are often dependent on the different USOs, making it challenging to generalize. Nevertheless, most of the literature concurs that it is critical with resources from partners to take the innovations to market, given their small size, weak market recognition and lack of legitimacy.

Many of our findings point to the reputational effect of being connected to external actors. In general, USOs gain legitimacy because of their tie to academic institution (Walter, Auer, & Ritter, 2006). They normally consist of researchers, with unproven technology and a high value – high risk potential. USOs are dependent on legitimacy towards external actors to gain network benefits. Corporate spin-offs however, can enjoy resource endowments from their parent companies, and may not be that dependent on credibility to attain critical resources. Further, Heirman and Clarysse (2004) found that academic spin-offs are able to penetrate the venture capital network more easily than independent start-ups and corporate spin-offs, because of their connection with universities and the help from their affiliated TTOs. The credibility benefits were also highlighted by Perez and Sanchez (2003), suggesting that links throughout USOs research networks helped them overcoming trust barriers and flow of technology transfer, given their legitimacy to their parent institution. However, being connected to an academic environment might also give USOs a reputation of being a team of researcher, with no prior commercial experience. The lack of business experience may be a drawback for potential investors or partners. Nevertheless, the literature concurs on how legitimacy is beneficial for acquiring new ties, and that pre-existing ties can offer legitimacy. For newly established entities, the self-promoting process can create cost barriers, due to scarce resources. Legitimacy in the market can make this process easier, and with a greater impact. Hence, the beneficial effect of having legitimacy is very important for new ventures, and especially for USOs, due to their abovementioned characteristics.

A third benefit found to be provided by networks is timely information. An initial barrier for USOs is a lack of opportunity identification knowledge (Vohora et al., 2004). They do normally not possess information channels, and have to rely on their network ties to provide timely information. Information is a benefit that makes it easier to identify available technologies and opportunities appropriate for their use (Mosey & Wright, 2007). This can lower the costs connected to the search for this information. Mosey and Wright (2007) found that habitual entrepreneurs highly valued their ties to the providers of industry knowledge, business development knowledge, and technical knowledge. They were seen to build new ties with researchers to identify new opportunities and match technologies to their knowledge of industry needs. A big pool of potential opportunities equips USOs with a variety of choices, and helps them take strategically better decisions than their rivals. The network reduces the vertical integration and scanning costs (Coleman, 1990) and help USOs to access the strategic information and opportunities. The scanning costs are associated with the costs for obtaining information, and without a beneficial network, USOs have to personally collect this cost. By being provided with this information through networks, these costs are reduced.

The access to advice was touched lightly upon in our sample, and constitutes the fourth benefit. Advice may be seen as guided information regarding a distinct topic. Advice does not have to come upon request, and thus the receiver often evaluates advice differently regarding the person it comes from. Academic entrepreneurs are found to rate their research colleagues consistently high in the ability of providing advice, guidance and access to new technological knowledge (Mosey & Wright, 2007). By contrast, the same entrepreneurs were less positive regarding the advice they received from regional business advisors and consistently negative regarding their interactions with providers of equity finance.

Hence, entrepreneurs view the advices gained from their colleagues higher than advices from external actors. The value of advice can sometimes be assessed by the opportunity costs, relative to buying a similar service. By building effective relationships with TTOs, USOs can gain access to legal- and commercialization advices (Mosey & Wright, 2007). However, it was found that habitual entrepreneurs replaced TTOs with professional legal advisors, to be able to negotiate deals on their own terms. This may contend that the relationship with TTOs is not entirely governed by trust. Westphal (1999) found that firms with boards consisting of ties to strategically related organizations were able to provide the firms with better advice and counsel, and hence supporting Mosey and Wright's (2007) findings. Advices can turn out to be invaluable as they may affect large, strategic decisions for the firm, contributing to better performance.

Network characteristics constituting benefits

A structural position in a network determines to what extent one can obtain and take advantage of the benefits mentioned above. Most of the literature in our sample comprises how non-redundant networks are beneficial in regards to structural holes (Hirai, Watanabe, & Inuzuka, 2013; Mosey & Wright, 2007; Soetanto & van Geenhuizen, 2010). High-density networks show a relatively large propensity for weak organisational growth (Soetanto & van Geenhuizen, 2010), which might indicate that the presence of a loose network is important for USOs. Hence, the ability to bridge structural holes is a key aspect for USOs (Burt, 2000). This aspect is important for other start-ups as well. However, as USOs are small in size, have weak market recognition and lack legitimacy (Walter et al., 2006) it is especially critical. Hirai et al.'s (2013) study also found that non-redundant, strong ties were optimal for USOs' external network. This finding breaks with Granovetter's (1973) theory of strength of weak ties and combine Burt's (2000) structural holes theory with Coleman's (1989) network closure arguments. These findings argue that for USOs, it may be valuable to have non-redundant connections, and that these connections are sufficiently strong to enhance the transfer of valuable information, due to the abovementioned characteristics. They may also be structured in a dense network. This is typical for scientist driven USOs, where their network normally consists of mainly academic ties. This might prevent USOs from becoming known in the market and access potential external actors that could provide resources for future growth. Non-redundancy offers the informational advantage while strong ties promote trust and cooperation and facilitates the exchange of high-quality information and tacit knowledge (Johansson, Jacob, & Hellström, 2005). Johansson et al. (2005) argue that weak, non-redundant ties might provide timely, but superficial information, due to lack of trust and support. Shane and Stuart (2002) also argue on the importance of having pre-established strong ties to external actors. They found a staggering 70% lower chance for failure if USOs had prior strong ties towards venture investors. Trust can also create cost advantages, in comparison to bureaucratic mechanisms. Mutual trust allows both parties to assume that actions taken will be mutually beneficial. A relationship with an external partner that is governed by trust may affect the richness of the relationship, and offer more than just product exchange.

Sullivan and Marvel (2011) states that USOs should search to use their already established connection in a positive cost-advantage setting. This continuing cooperation increases informality, which can build up strong ties that governs efficient exchange of resources. Burt's (2001) theory of structural holes elaborates on how it is possible to borrow networks from other actors you have strong ties towards. Nascent and novice entrepreneurs are borrowing network from their affiliated TTOs, while habitual entrepreneurs with experience and social capital rather want to be independent and use their own networks (Mosey & Wright, 2007). Borrowed networks are either dense or hierarchical. The first of these alternatives describes a situation where the firm is accepted into an "inner circle" of a few actors, under the legitimacy of the sponsor tie. This is comparable to a high-density network which Soetanto and Geenhuizen (2010) linked to weak growth. A hierarchical network on the other hand, results from borrowing a network that spans structural holes (Burt, 2001). In these networks there are no "inner circle" which implicates that one is dependent on the sponsor to continuously vouch for you, hence requiring strong ties.

As USOs often strive to pilot test their technologies in large-scale projects, connecting them to a single, industrial partner, they risk

getting dependent on this actor (Lubik et al., 2013). In addition, the partners can also gain access to the state-of-the-art technology the USO possess, and use it for their own products (Walter et al., 2006). However, being dependant on strong ties is not the only option for USOs. The cost associated with maintaining and building these strong ties must be contrasted with the risk of getting too dependent. USOs are often eager to connect to industrial players, to validate their technology and rapidly commercialise. We argue that there may be substantial risks connected to such single partnerships. By putting trust in one sole player, the power balance has a tendency to become very uneven, and the USO might find it hard to negotiate favourable terms. One way of lowering this risk is to engage in a wider network of weak ties (Johansson et al., 2005), and at a later stage transform these weak ties into nourishing strong ties. This is typically not during founding, but in later stages (Soetanto & van Geenhuizen, 2010). Lubik et al. (2013) also found evidence of vulnerability of relying on a single partner. The USOs working with several partners were found to have greater and more sustained commercial success. However, the main reason USOs relied on a single partner was due to the lack of awareness of their potential partners. The benefits of having access to timely information hence enhance USOs possibilities to engage in fruitful partnerships. By not being structurally positioned, USOs are more vulnerable of being dependent on external actors, because of the lack of timely information. Nevertheless, as Brush et al. (2001) argues, entrepreneurs must carefully consider the cost, timing and reliability of resource providers. Over- and underestimation of resource needs have put companies out of business (e.g. Momenta Corporation (Oviatt, McDougall, & Loper, 1995)), thus indicating that potential partners must be carefully identified. Strong ties in this matter lower the risk of getting locked in with underperforming partners.

Propositions

Our understanding of the literature is that USOs should strive for a non-redundant network, characterized by strong ties and governed by trust. In this way, additive information may be extracted and necessary resources can be gathered early. The key challenges facing USOs are their institutional origin, as mentioned earlier. They need a non-redundant network to span over the structural holes separating them from the commercial actors, but normally do not possess such ties. Figure 5 and 5 show the process USOs could undergo to obtain the abovementioned benefits.

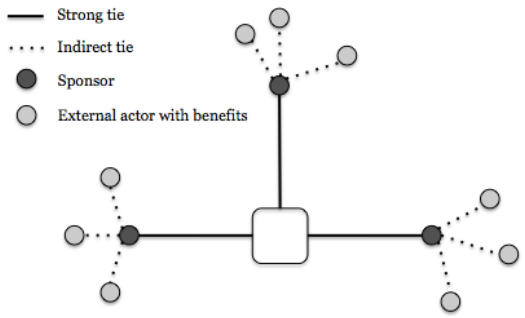

Figure 5. Representation of initial USO network – hierarchical network

USOs often start with strong ties towards their TTOs, universities, and their research colleagues in general. These environments do normally not possess links to external market actors, and can constitute a dense network, although it is TTOs ambition is to possess such links. For nascent entrepreneurs, borrowing sponsors networks to access benefits may be crucial to expand from their environment. It is however, important that the sponsors are not locked in the same dense network, and are able to offer external benefits. If USOs are able to start with strong ties to several external actors with a non-redundant network, they can prevent dependency early on. In this way, the USO obtains benefits from their strong ties, gain legitimacy towards the market, and participate in their strong ties' network, seen in Figure 5. If USOs immediately try to evolve their indirect ties into personal, strong ties, they may be able to convert their borrowed network into their own. This may provide access to valuable information and resources, as illustrated in figure 6.

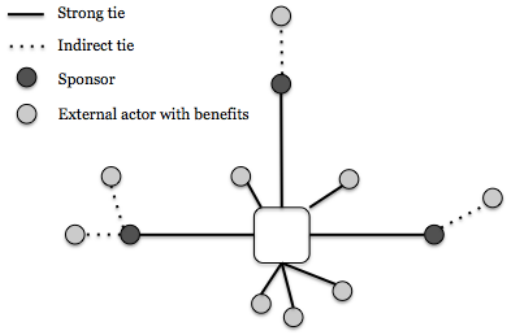

Figure 6. Representation of initial USO network – converted network

A clear problem arises when the sponsors do not offer indirect ties that bridge the USO to the preferred markets. If a USO is located in Norway, and is interested in connecting to actors in the Asian market, their initial sponsors must be able to offer that bridge. This is clearly not the case for all sponsors. A possible method to gain access to bridging sponsors is to identify potential indirect ties that most likely are able to bridge the structural holes. Further, by identifying the relationship chain, connecting you to the bridging sponsors, USOs can go through each link and transfer it to a strong tie, hence get closer to their preferred sponsor. We did not find any support for this in our sample. However, through conversations with experienced entrepreneurs, we found that this method is frequently used to gain access to indirect ties that possess benefits. Another possibility is to build relationships through proactive contact, meetings and marketing. However, the literature shows that the use of network ties is a more cost- and time-effective method. Hence, to not be locked in a dense network, it is important to connect to sponsors with non-redundant networks. However, for USOs with a dense network it might be hard to find these sponsors. This leads us to our first proposition.

Proposition 1: To effectively connect to a non-redundant network, USOs should establish relationships to persons with pre-existing ties to potential sponsors.

As mentioned above, it is important to connect to the indirect ties, to avoid dependence on their original sponsors. A set of pre-existing ties does not necessarily bridge more beneficial ties to the USO. This leads us to proposition 2.

Proposition 2: To effectively localize and evolve beneficial ties into strong ties, USOs should connect with persons with networking capabilities and social capital.

Conclusion

This paper has highlighted the effects that university spin-offs experience with a well-functioned network. A network offers essential resources, advice, information and legitimacy, which translate to better performance. Building network ties is a vital task for USOs, to be able to extract the benefits connected with the network. Further, the paper investigates the characteristics of a suiting network for USOs at founding. A non-redundant network can offer benefits, and help USOs bridge the structural holes they are faced with. However, to prevent superficial information, strong ties need to be established. Strong ties to certain external actors offer legitimacy toward the market and enhance the transfer of valuable information.

Our findings imply that USOs need to attract persons with a non-redundant network, related to the industry, early in the founding phase to exploit his/her connections. It also implies that USOs with strong initial ties will attract resourceful employees to help them grow. Furthermore, a firm that is able to create, and not only use, their network can experience better performance than others.

Limitations and further research

As depicted earlier, the concept of USOs is a complex and complicated matter, with several definitions and research streams. As the formation of USOs is a relatively new phenomenon, the research on the topic is also somewhat embryonic (Rasmussen et al., 2012). The fairly scattered typology of the USO-research landscape might indicate that not all the information is known yet. To illustrate, there might be different “valleys”, where researchers use different terminology to address similar concepts, or even entire districts with similarities not known yet. In our empiric search we have only included USO/RBSO to describe our focal objects. As we touch upon the limitations for our method, there might be relevant literature and knowledge, directly related to USOs, which is not included in our methodical search. The implications for this potential lack of overview might be a slow progress in the research field, as researchers fail to accumulate knowledge.

Our sample contains literature without geographical restrictions, extending from Japan, Europe and United States. The cultural context might play a central role in regards to the network impact. A study with a narrow scope would give a more precise image for our propositions to be tested. Further, we chose to look at performance as an outcome. Performance is a temporary term, and follows a pathway of causes, caused by antecedent events (McMullen & Dimov, 2013). A firm, in a

snapshot of the present, can be successful and showing high performance, but over a longer time span it actually goes bankrupt. By chopping up time and partitioning the observation space along variables, it can be hard to grasp what affects the different outcomes. Whether an action is "good" or "bad" is only determined by the ultimate outcome. The data sample we have conducted contains articles that do not consequently use a process-oriented study. Thus, findings stating that USOs gain a "strong performance" are viewing the performance from the moment the study was conducted. This is a limitation with our study. It would be interesting to do a study with a consistent time span or an event history analysis for the USOs investigated.

In addition to the external limitations, there are internal limitations, entitled to the researchers and their method. In the screening of titles, abstracts and articles, the researchers have individually assessed and interpreted the content. The screening of this sample was done early in the researchers learning curve for the field. As conclusions are built on subjective assumptions, based on theoretical perspectives and earlier research, the researchers may not have known the entirety of the field. Hence, there are some risks of literature being misinterpreted and thus discarded on wrong basis.

Our study does not differ between the different networks USOs use to extract the network content. We look at the content, and not explicitly from where the content is being extracted. Further research in this area might give indications to researchers and even specific advice to academic entrepreneurs and policymakers in USOs and TTOs. To further investigate if there exists a correlation between specific networks and the probability for success would be an example of such a task. This would make it easier for future USOs to narrow their focus area towards persons with the right network ties, instead of using resources on gathering less important ties.

A further extension could be to depict where these networks exist and how to acquire them. One dimension could be to assess what stakeholders in USOs that would be able to affect the outcome, due to their network. Using agency theory (Kathleen M. Eisenhardt, 1989), one can see that there are different motives for a regular employee, CEO or board member when using their personal network for the benefit of the USO. Clearly, these positions differ in their impact potential for acquiring network benefits. Findings within this topic would provide USOs with a useful toolbox, to increase their chances of success.

Initial strong ties for USOs often lead to technology transfer offices. As we have found, much of the literature elaborates on how USOs and academic entrepreneurs are borrowing network from these actors, to try to connect to commercial actors. However, not all USOs have access to, or use TTOs. As Mosey and Wright (2007) stated, habitual entrepreneurs often go past these actors, establishing networks themselves. The chances of success for an experienced entrepreneur are arguably favourable, but what if inexperienced entrepreneurs do this exercise? Would it implicate the establishment of strong ties to other actors, or would it simply just affect the chances for success? The answer to these questions could to a large extent provide support to the models proposed in this paper.

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The Effect of Network for University Spin-Off Companies: An Empirical Study of Board Composition and Performance

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Abstract
University spin-off companies have verified their potential as a wealth creating strategy in commercializing intellectual property from universities. However, they are complex entities, suffering under shortage of essential resources. This study seeks out to investigate the benefits provided by the network of the board for university spin-off companies. Drawing on Board Capital theory, we explore the success rate in connection to the initial board composition, through a quantitative analysis of 70 Norwegian university spin-off companies. Our findings suggest that boards with network from prior entrepreneurial or senior level management experience enhance the probability of success. Moreover, we propose a set of implications, which may help academic entrepreneurs and university spin-off companies in acquiring the right combination of experience to their initial boards. The implications use a three-way perspective, with a focus on entrepreneurs and USOs, technology transfer offices and researchers.

Introduction

This study aims to investigate the impact different types of initial networks have on the performance of university spin-off companies, so-called USOs. USOs are technology-based firms spun out from a university or a research institution with the aim to commercialize a technology developed at the academic institution (Birley, 2002). Encouraged by changed external expectations and internal pressure to generate new sources of income, universities' involvement in technology transfer activities have escalated (Powers & McDougall, 2005). The use of technology licensing has traditionally been the mechanism by which a university has developed and transferred research to marketable products (Siegel, Waldman, Atwater, & Link, 2003). In recent years however, universities have shifted more towards spinning out start-up companies or licensing out the developed technology to smaller firms, rather than to large public companies (Powers & McDougall, 2005). The risks connected to such activities are higher, however, if a firm goes public, the returns could be enormous (Powers & McDougall, 2005). Moreover, some technologies are unsuitable for licensing, making spinning out new ventures the preferable option. USOs can be an alternative effective way of transferring knowledge from universities to commercial use, in relation to licensing. USOs encourage economic development through generation of economic value, jobs and inducing investments in university technologies (Wright, 2007). They represent university efforts at enhancing revenue streams, effectively aligning university and firm interests, and increasing legitimacy towards external actors (Powers & McDougall, 2005). Shane (2004) states that USOs are more profitable, survive longer, and reach the initial public offering threshold more often than licensing to established companies. However, Chiesa and Piccaluga (2000) found few USO successes, when they investigated the field. In opposition to other start-ups, USOs are rare, atypical entities that often suffer in terms of shortage of essential resources (Shane & Cable, 2002). They face technological

uncertainty, with a non-verified technology, and market uncertainty, without knowing if their invention will be positively embraced. They also face organisational uncertainty, if there has to be a new entity spun out (Rasmussen, Borlaug, & Bulanova, 2013). The technologies are found to be radical and general-purpose, and they often struggle in raising financial support (Wright, Lockett, Clarysse, & Binks, 2006). This area of study is growing increasingly, which reflects the increase of USO formation (Lockett, Siegel, Wright, & Ensley, 2005; Shane, 2004; Wright, 2007).

The board of directors and its relationship to firm performance have long been an interesting area of research. Widding (2005) introduces knowledge reservoirs, a concept based on how managers build and acquire knowledge essential to achieve competitive advantage, and discuss the boards' contribution to USOs through what he defines as semi-internal knowledge reservoirs. Research theorize that board composition represents the potential for acquiring resources a firm lacks through their pre-existing ties to external actors (Hillman, Cannella, & Paetzold, 2000). USOs are often knowledge driven and have access to other academic resources (Clarysse, Wright, Lockett, Mustar, & Knockaert, 2007). However, the role of boards in USOs have not yet been fully investigated (Clarysse et al., 2007). USOs are at founding often small, and the board constitutes a major part of their potential to access resources that are unavailable internally (Widding, 2005). Few new ventures enjoy the full range of knowledge and experience needed to function cost-effectively, and board members with external network can be a source for obtaining that. The board of directors may also help to increase the credibility for USOs and thus reducing the liabilities of newness (Stinchcombe, 1965), hence contributing to the development of the firm (Lynall, Golden, & Hillman, 2003; Pfeffer & Salancik, 1978). Boards in the context of USOs are particularly interesting to study, given that they are new ventures in transition and, given their particular characteristics mentioned above, are very dependent on external inputs. To enable the transition from a non-commercial environment to the market, they need to develop their resources and capabilities.

Earlier studies have focused primarily on easily measured attributes, such as board independence or board size. However, a growing body of research on directors' experiences, skills, and other characteristics has emerged (Johnson, Schnatterly, & Hill, 2013). A number of theories - most notably agency, resource dependence, institutional and social network theories - have been attempted to act as a theoretical lens to explain these attributes and their effect on firms, with inconclusive findings (Bhagat & Black, 1999; Dalton, Daily, Ellstrand, & Johnson, 1998). Much of the research assumes composition-conduct-performance relationships, which constitutes that board independence, experience and social ties will affect firm-level outcomes (Adams, Hermalin, & Weisbach, 2008). Johnson et al. (2013) recommend that more studies focus on board composition to enhance this stream of research.

This study sets out to empirically explore the effects of the boards' initial network. it builds on the literature review, presented by Fischer and Våge (2013), and board capital; a capital consisting of social capital and expertise, experience, knowledge and reputation (Hillman & Dalziel, 2003). The theoretical framework presents three research hypotheses, which were tested on a sample of 70 Norwegian USOs. The unit of analysis is the board as a connector to external resources. Studies of network in the context of entrepreneurship seldom take a quantitative approach (Brüderl & Preisendörfer, 1998). To expand this field of research, our study hence adopts a quantitative method to employ statistical tools to investigate our research questions.

This introduction is followed by a theoretical framework, presenting our hypothesis. We discuss the research design and the data collection methods, followed by a presentation of our findings. We then discuss our findings and view them in the context of board capital. Finally, we present implications and areas for further research.

Theoretical framework

This section draws on Fischer and Våge's (2013) study of the networks influence on USOs, which provides the basis of our theoretical framework. Fischer and Våge's study uses resource-based view (RBT) and social capital (SCT) as their main theoretical foundation. A state-of-the-art literature review was conducted, where network benefits for

USOs were investigated. Further, the study draws special attention to the characteristics of the networks enabling the benefits to be obtained. The findings are seen in the context of board capital theory, as the board constitutes a tool to access network actors. We use SCT to enlighten the dependence USOs have on establishing external linkages, and argue that RBT is convenient to use for describing social capital as a critical resource available to USOs.

The benefits present in USOs' network - and its characteristics

The literature on entrepreneurship today assumes that there are benefits to harvest from networks especially in the start-up period of businesses (Brüderl & Preisendörfer, 1998). A network with non-redundant ties offers a higher probability of venture capital funding (Lee, Lee, & Pennings, 2001; Shane & Stuart, 2002; Tyebjee & Bruno, 1984). Because of their connection with universities and the help from their affiliated TTOs, USOs are able to penetrate the venture capital network more easily than independent start-ups and corporate spin-offs (Heirman & Clarysse, 2004; Walter, Auer, & Ritter, 2006). One reason for this is argued to be the "inherited" legitimacy USOs receive through strong ties to their parent academic organization. Also, corporate spin-offs can enjoy resource endowments from their parent companies, and might not be that dependent on venture capital, as USOs are.

The concept of hierarchical networks, and how these are borrowed from so-called sponsors, are introduced by Burt (2000). The risks of getting too dependent on these actors are mentioned (Lubik, Garnsey, Minshall, & Platts, 2013). Brush et al. (2001) further argue for how one must carefully consider the cost, timing and reliability of resource providers, as there are risks of getting locked with underperforming partners.

Burt (2000) elaborates on how the ability to bridge structural holes is a key aspect for firms. Hirai et al.'s (2013) study found that non-redundant ties enabled USOs to bridge these holes. However, for USOs to acquire the benefits from their non-redundant network, strong ties governed by trust had to be present. Fischer and Våge (2013) elaborate on how USOs need a non-redundant network to span over the structural holes, separating them from the commercial actors. They contend that USOs should strive for such a non-redundant network with strong ties. The key problem facing USOs are their institutional origin. A model illustrating the process USOs could undergo to obtain the abovementioned benefits is presented below.

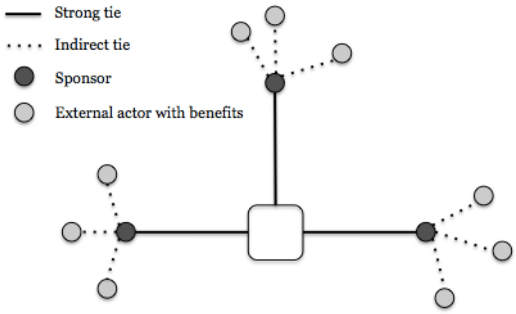

Figure 1: Representation of initial USO network – hierarchical network

USOs start with strong ties to external actors to access timely and valuable information, and to overcome the typical initial disadvantages, shown in figure 1. They also borrow the sponsors' ties, and become a part of the sponsors' non-redundant network. Immediately, the USO should try to evolve the indirect ties into personal, strong ties, to prevent dependencies on their primary strong ties (Fischer & Våge, 2013). This is shown in figure 2.

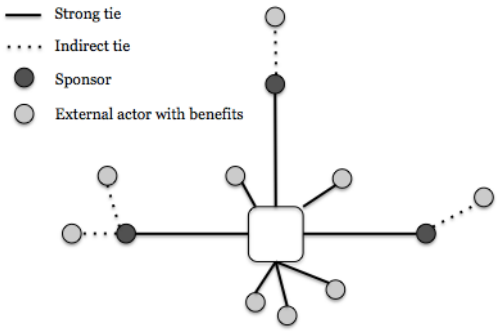

Figure 2. Representation of initial USO network – converted network

A clear problem arises when the sponsors do not offer indirect ties that bridge the USO to the preferred markets. A possible method to gain access to bridging sponsors is to identify potential indirect ties that most likely are able to bridge the structural holes. By strategically inducing network ties towards the preferred sponsors, the structural holes may still be

bridged (Fischer & Våge, 2013). This method was found to be used frequently by experienced entrepreneurs.

Establishing relationships to persons with prior network ties is often a cost-effective way to connect with non-redundant networks (Fischer & Våge, 2013). USOs are normally small at founding, and the employees, together with the board, constitute the available social capital. We argue that the external ties offered by board members are important to investigate in the context of USOs, as a tool for accessing non-redundant networks. Boards are a way for USOs to bridge the structural holes in their environment. If they add persons with connections to beneficial actors, the USO can apply them to gain the benefits mentioned by Fischer and Våge (2013). From figure 1 and 2, board members can take the sponsor role, with timely access to information and advice. The costs connected with the gathering of network ties are hence minimized. Moreover, to add persons with prior experience of building network ties, the board can be a method for USOs to convert indirect ties into strong ties.

Board composition

Board of directors plays an important role in the development of USOs. The role of board members contributes to strategic flexibility and enhance firm growth and survival (Filatotchev, Toms, & Wright, 2006). Rasmussen et al. (2013) found that for Norwegian USOs, the board, together with the academic institution from which they were spun out, contributed more significantly to firm growth, compared to venture capitalists, TTOs and industry partners separately. However, TTO representatives and venture capitalists are normally a part of USO boards, and are hence contributing through their directorships. Board members that are broadly connected to external players normally offer non-redundant ties, and give USOs quick access to information and resources (Oh, Labianca, & Chung, 2006). A well-established resource base help reduce dependency between the organization and the external actors (Pfeffer & Salancik, 1978), lower uncertainty and the transaction costs (Pfeffer, 1972; Williamson, 1999), which enhance the survival rate of firms (Singh, Tucker, & House, 1986).

Many scholars take an internal governance approach rather than an external network approach, when investigating board composition (Lorsch & MacIver, 1989). They state that boards comprised with outside directors will be more effective. Outside directors do not hold stakeholder position in the firm, and will prevent managers from behaving in self-interest (Platt & Platt, 2012). Finkelstein and Mooney (2003) however, criticize this focus and argue that it is the quality of the board members that affects a board's effectiveness. Attention should be given towards the understanding of how to compose an effective board, and this article seeks to do so.

Board capital

Fischer and Våge (2013) uses SCT and RBT as theoretical framework. Board members with prior industry experience will normally establish industry ties to their prior colleagues and suppliers/customers. In this section we introduce board capital theory, and present three hypotheses. We argue that prior professional experience can be operationalized as an indicator for social capital.

Johnson et al. (2013) address social capital in combination with board composition. They state, together with Carpenter and Westphal (2001), that the board's social capital is a channel for the flow of resources, information and advice for a firm. It can be argued that antecedent experience contributes to social capital. A prior job provides network ties to industry players you interact with. Board capital is defined as both social capital and experience, knowledge and reputation (Hillman & Dalziel, 2003). Empirical studies have shown a relationship between board capital and performance (Boyd, 1990; Pfeffer, 1972).

According to Pfeffer and Salancik (1978), a board member that is brought to the board constitutes four benefits: (1) advice and counsel, (2) communication channels towards external actors, (3) legitimacy, and (4) preferential access to support. These benefits are similar to the network benefits addressed in Fischer and Våge's (2013) study. Pfeffer and Salancik (1978) further conclude that these benefits contribute to resource accessibility from the external environment. Each board member brings a different and unique set of skills to a firm, together with their network (Kosnik, 1990).

Firstly, boards consisting of members that bring with them important expertise,

experience and skills to facilitate advice and counsel, will help the firm take better decisions (Baysinger & Butler, 1985). A board with lawyers will be better suited to guide the firm to take better legal decisions, in comparison to a board with only members connected to an academic institution. Westphal (1999) links advice and counsel to subsequent firm performance. Carpenter and Westphal (2001) also found that a board's social capital, consisting of directors having ties to external actors, were able to provide better advice and counsel.

Secondly, board capital has been positively associated with a firm's legitimacy and reputation (Daily & Schwenk, 1996). Pfeffer and Salancik state that "prestigious or legitimate persons or organizations represented on the focal organization's board provide confirmation to the rest of the world of the value and worth of the organization" (Pfeffer & Salancik, 1978: 145). Galaskiewicz (1985) also points on how external ties possessed by the board of directors confer legitimacy towards the external environment.

Thirdly, board capital enhance the information channel the firm has towards the environment (Hillman & Dalziel, 2003). Similarities can be drawn to Burt's (2002) theories on structural holes. Board capital can link USOs to clusters of additive information by bridging the structural holes present in their environment. A board with heterogeneous ties connected to external actors will be provided with timely and valuable information, and board members' external ties also facilitates access to strategic opportunities (Pfeffer, 1991). Boeker (1997), Kor (2003) and Spender (1989) point on board members' industry experience and how it provides them with tacit knowledge of the opportunities, threats, competitive conditions, technology and regulations specific to an industry. Having a board composition of industry-experienced members provides the board with resources to better take good decisions.

Lastly, board capital can be used as an instrumental resource to gain access to resources outside the firm, often on more favourable terms (Boeker & Goodstein, 1991). Pfeffer (1972) found a positive correlation between performance and firms with directors' ties to sectors with constrained resources. Hence, the directors' ties can connect USOs with resource providers, and enhance the development of the firm. This is also supported by Mizruchi and Stearns (2006).

Based on board capital theory, we will investigate the impact a board's social capital, combined with expertise, experience, knowledge and reputation, has on USO performance. Research show that pre-existing knowledge and skills derives from prior professional experience (Hambrick & Fukutomi, 1991), and that directors' past professional experience also produce social capital (Certo, 2003; Hillman & Dalziel, 2003). Different industries and positions are sources to differences in social capital, and it is therefore important to take this into account when examining board benefits.

We introduce *executive level network*, defined as network ties gained through prior entrepreneurial -, senior management - and significant board experience. Our assumption is that experience is linked to network and operationalize network ties through such experience, given their former position as respectively founder or senior manager, or having significant board experience. The common notifier for these ties is the access to decision makers in industries and environments. Having ties to executive level networks, as well as having entrepreneurial experience, are found to facilitate the legitimacy process (Fahlenbrach, Low, & Stulz, 2010; Johnson et al., 2013). Rasmussen et al. (2011) pointed on the effect of an entrepreneur's antecedent network as a bridge to resources, and found that habitual entrepreneurs possess competencies regarding how to access industry partners and investors. Directors' participation in multiple boards help build social capital by connecting ties to other directors (Beckman & Haunschild, 2002). When an individual sits on two or more corporate boards it is defined by Scott (1991) as interlocking directorship. These connections can provide timely access to ideas, knowledge, resources and information (Kor & Sundaramurthy, 2009). However, having significant board experience may indicate that the director still possess several board positions. Serving on many boards may limit the necessary time needed to govern effectively (Carpenter & Westphal, 2001), and hence affect their contribution to the board. Nevertheless, Kor and Sundaramurthy (2009) tested the relationship between membership on multiple boards and the rate of growth and

found a positive correlation, hence leading us to our first hypothesis.

Hypothesis 1: Presence of executive network for the initial board of directors increases the likelihood of success for USOs.

Social capital gained through prior experience in the relevant industry, other industries and academic experience affect board decisions and what they pay attention to (Johnson et al., 2013). We define these ties as *profession-related network*. These types of networks are distinguished from executive networks in the fashion that they comprise a more dense and constricted type of ties, specific to the industries. Executive networks offer ties to higher level actors, typically on senior level, inducing loose networks, while profession-related networks are ties to lower level actors. They are not communicating with decision makers, but may know more about specific details. Industry experience have been found to be positively associated with performance (Kor & Sundaramurthy, 2009), and external connections developed through industry experience may help firms to access resources and establish business relationships (Pfeffer, 1972). Having industry familiarity helps boards to process information better, and see opportunities that others don't see (Johnson et al., 2013), mainly due to their tacit knowledge of the opportunities, threats, competitive conditions, technology and regulations specific to the relevant industry (Kor, 2003).

Research on Norwegian USOs found that the academic institution from where they spun out, contributed more significantly in regards to legitimize their product than TTOs, industry partners, customers and financial actors, separately (Rasmussen et al., 2013). However, Mosey and Wright (2007) concluded that neither prior industrial experience or seniority of academic position did relate to venture growth. This inconsistency makes the topic interesting to investigate. Equally important are the prior development of goodwill and connections to industry players (Certo, 2003). Board members can leverage prior goodwill to obtain information, influence and solidarity (Adler & Kwon, 2002). Such connections are highlighted by Cooper et al. (1994) as especially critical for entrepreneurial firms. Our second hypothesis hence follows.

Hypothesis 2: Presence of profession related network for the initial board of directors increases the likelihood of success for USOs.

A number of studies have found that boards' age contribute to firm success. Platt and Platt's (2012) study on director age in connection with firm bankruptcy indicates that a lower average age for the board of directors increase the likelihood of bankruptcy, hence suggesting that experience gained through years of working is valuable. Age can thus be seen as an indicator of more experience and network ties. Age diversity was also found to be associated with higher firm value (Johnson et al., 2013).

The size of the board is an interesting variable. Social capital theory states that available network resources are to some extent given by network size (Aldrich & Reese, 1993), and hence supporting board size as an operationalization of network size. From resource based view it can be stated that a large board is more connected to external actors than small boards, and support USOs better in obtaining benefits from their pre-existing network (Pfeffer & Salancik, 1978). Based on board theory concerning age and size we present our third hypothesis.

Hypothesis 3: Higher average board member age and board size increase the likelihood of success for USOs.

Methodology

We analyse how board members' earlier experience equips them with a network position, bridging structural holes, and hence gain timely access to ideas, knowledge, resources and information. Coleman (1989) and Nahapiet and Ghoshal (1998) recognize that social capital and expertise, experience and knowledge are conceptually and empirically difficult to untangle, hence we operationalize that earlier experiences induce social capital.

Sample and data collection

The data set we analyse comprises 70 firms registered and supported by the FORNY program. The FORNY program, established by The Norwegian Council of Research, deals with pre-start-up academic spin-offs during the research and opportunity framing stages to support and bring forward the firms and their affiliated TTOs. The portfolio consists of 471

firms and 424 licensing agreements, ranging from year 1995 to 2012, with an annual budget of approximately NOK 155 million (Rasmussen & Gulbrandsen, 2012). The program receives funding from several ministries (Rasmussen & Gulbrandsen, 2012), and strives to both support technology transfer from research institutions and the creation of new businesses (Rasmussen et al., 2013). Our paper focuses on the creation of USOs. Norway introduced a legislative change in 2003, which is similar to the 1980 Bayh-Dole Act in the US, implying that researchers no longer hold intellectual property rights to their inventions (Rasmussen, Moen, & Gulbrandsen, 2006). Due to this change, and the subsequent establishment of TTOs connected to the main research institutions, it is fair to say that the portfolio includes the grand part of Norwegian USOs. The FORNY registers abled us to get data on firms that are no longer registered in national registers. This gave us access to data, free from survivor bias, in opposition to official registers, which is typically used in prior academic research.

The sample of 70 was selected randomly from the 471 USOs, in the interval from 1999 to 2004. Hence, there are no biases in regards to the choosing of cases. The connection to the FORNY program enabled us to get access to the entire history of the annual reports for each firm. The annual reports included the Director's report, financial statements and ownership structure. We were also provided with extensive former media coverage, with relevant information from newspaper, magazines and the Internet. In addition to information regarding income statement, balance and board positions, we could also read the Directors' report regarding future development and stock ownership overview. This made it possible to monitor possible mergers and acquisitions. We started an extensive data collection process, which can be described in two phases. The first phase comprised gathering of data to separate the USOs as success or failure. This phase was conducted as part of a larger research group, as part of a research project with NTNU and Bodø Business School, consisting of eight students, including the authors.

Annual reports, national databases and media were scanned and crosschecked to fully understand the history for each of the USOs. The extracted data can be sectioned into two levels: (1) information describing the content and interior of the firms, including business idea, company development, key product, industry and owner structure, and (2) outcome describing venture capital financing, mergers and acquisitions, and discontinuations. The data were registered in separate files for the individual USOs, using a standardized template[1], developed by a senior researcher in the team. Comments elaborating on diverging or interesting occurrences were noted to ensure the possibility of verifying or discovering any biases or misinterpretations in our data. Continuous communication and mutual reviews were performed to assure that the heuristics behind the coding were understood in similar fashion by the researchers. In addition, the majority of the codings were approved by senior researchers[2] to ensure coherence and robustness between the classifications performed and other research.

The second phase of the data gathering constituted a collection of the board members' information for the individual USOs, and was performed by the authors alone. This comprised thorough mapping of each board members' experience. Each board member was individually checked for work experience, both academic and commercial, using web search and the business-oriented social network service LinkedIn. Some board members were not found using this service. A general Google search was then conducted, to gather work-related information. A subjective impression of the board members was then made. Their former board experience was checked using www.purehelp.no, a national database containing all former board experience for people still active in boards. The database also provides information regarding former managing director positions for each person. Age was also gathered from this source. In addition, we performed a web search for résumés and other media postings, to supplement our findings. Thereafter, the data was put in a board matrix with binary variables, indicating each board member's experience. In total, we mapped prior experience for a total of 601 individual board members. Further, we extracted data regarding revenue and operational income for each USO. This was done to distinguish active and successful USOs from firms not liquidated, but

[1] The coding template can be made available on request

[2] Senior Researcher Einar Rasmussen and Ph.D. Candidate Marius Tuft Mathisen.

with a low probability for future success. An excerpt of the coding sheet used is presented in appendix 2. Finally the entirety of the codings was gathered in a sample summary file[3], counting each firm as an individual case with variables reflecting the code sheet. The codebook used for the gathering of data and for further statistical analysis can be found in appendix 1.

With respect to the legislative change in 2003, we chose to restrict our sample to firms incorporated before this legislation was fully instated, choosing 2004 as our cut-off point. Earlier research on the FORNY portfolio also found that USOs in the Bio/Pharma industry had the longest average commercialization period, being 8 years (Rasmussen et al., 2013). Hence, our cut-off point for founding year would to some extent prevent significant right censoring of our data.

Method

We investigate the outcome of USOs in the context of success. In some cases event history analysis would be an applicable method. However, as we only measure independent variables at incorporation and event, we see methodological weaknesses towards trying to assess and predict the probability of success at any given time. We will therefore disregard this and look at a simple true/false event analysis.

We analyse the dichotomous outcome-variable success and examine its dependence on the aggregate of the different network types the board possess. This, and the presence of multiple continuous and categorical predictor variables, indicate the use of logistic regression as an acceptable method. The analysis is conducted two times. The first analysis is performed on the data describing the USO at founding. The second analysis is performed on the data describing the end event. We conduct this to look for changes in the type of experience that is predictive of success. If this concurs with existing literature on how firms' needs evolve, we will be more certain of that our operationalization are appropriate. Thus, the second regression is performed to support the findings in first regression and should not be viewed as a standalone analysis.

[3] The script of this compilation is available in Appendix 3.

Dependent variables

In order to investigate the spin-off performance, it is important to recognize the multidimensional nature of the performance construct (Chakravarthy, 1986). Our dependent outcome variable describes whether or not the firm has achieved success by the end of 2012. We draw on Rasmussen et al.'s (2013) classification of outcomes, summarized in table 1. Given that many of the USOs in our sample are living deads, being firms not liquidated, but with a low probability for future success, we code USOs as success based on market acceptance.

Table 1. Classification of outcomes

Outcome	Category	Definition
Positive outcome	Active, profitable	Operating income exceeds NOK 500.000 in 2012
	Active, with high turnover	Revenue exceeds NOK 10.000.000 in 2012
	Acquired	The USO is acquired by other company
Negative outcome	Discontinued / deleted	The firm is discontinued from the national registers brreg.no
	Living dead	1,The firm is still registered, but does not meet the revenue or result limits

A *positive outcome* implies that the product or the service is accepted by the market, and that the USO is capable of making a profit of it. However, as this is hard to measure, we settle on using revenue and operating income as indicators for reaching such a milestone. We base the categorization of success on the firms' financial performance and the occurrence of acquisition. USOs with revenue higher than NOK 10.000.000 in 2012 are coded as successful. Reaching this threshold indicates high activity in the start-up, and has probably proven investor acceptance. Success is also coded if the USO's operating income in 2012 exceeds NOK 500.000. The USO has then shown profitability for its product/service. Rasmussen et al. (2013) used a similar cap on operating income, at NOK 100.000. However, when reviewing the distribution of revenue and operating income, we found a significant distinction of firms under and above the respective limits. After reviewing these findings

in consultation with academic researches at NTNU, we concluded on that these distinctions were indicative of some kind of performance threshold, and thus decided on using these as limits.

USOs that have been acquired are coded as successful. We define an acquisition as a transaction driven by industrial motivations, based on the perceived qualities in the USO. An acquisition is often a valuable societal and financial solution. The acquiring firm has resources to quickly take the product out to market, after the concept has been proved to work. Although an acquisition is not necessarily tantamount to success, it is fair to say that the concept has been valued interesting. If the USO however, merges under distressed conditions, it is not coded as an acquisition.

A failing USO can be indicated in many different ways. Some firms are discontinued, while others stay alive with low or no activity. Some firms also have substantial activity, but fail to make any profit. Based on this, a *negative outcome* is categorized as a failure based on discontinuation, low activity or low profit, often known as living deads. A discontinued USO is deleted from the Brønnøysund register. Living deads have little activity, and may lack financial resources to start or continue commercializing.

Rasmussen et al. (2013) also include a category of unknown outcomes in their report on USOs included in the FORNY-program. These are often firms that have not yet had the time to commercialize, and thus still have an uncertain future. As we have been fairly restrictive in our time span, only including USOs from 1999 to 2004, this type of outcome is rarely present in our sample. In regards of this, and as we want a dichotomous outcome variable, we have not taken use of this category. This contends that firms that would have been registered as unknown will be registered as failures in our analysis.

Independent variables

Our measurement of the boards is performed with count measures where each firm has a score, reflecting the aggregate of board members possessing the different type of networks. The initial board is defined as the persons added to the board from founding and the continuing 18 months. We found a repeating tendency for USOs to add board members between 12 and 18 months, and wanted to include their networks in our analysis. This scale measure is used in a similar fashion across levels of analysis to assess the amount of certain characteristics in boards (Johnson et al., 2013). We divide networks into different categories - depending on what type of network ties the board members' prior experience have given. The criteria for the allocation of the different network variables are elaborated within each category. A board member can be placed in various categories depending on his/her prior experience.

Similar types of networks are more likely to correlate, and are therefore placed in groups with each other to act as controls. Correlating variables have similar variance, and using them as controls for each other thus provides better results as we eliminate the contribution effect from the other. The situation of a possible correlation between the predictor variables makes the use of a hierarchical method of preference (Lewis, 2007; Pedhazur, 1997). Introducing the variables in blocks, allows us see how variables perform in effect of control from other variables. The order of presentation of the blocks reflects the order of how the hierarchical regression analysis is performed.

Executive level network

Our first hypothesis states that board members with prior entrepreneurial, senior management and/or significant board experience will contribute with network ties to what we define as senior level actors. These board members presumably help to gap the structural holes USOs are faced with. We have assessed each of these types of experiences separately. A board member will be denoted with the value 1 for each experience variable he possesses.

Entrepreneurial experience constitutes board members who have been active and participating in the process of founding a new firm. Board members with entrepreneurial experience are found to have a loose network, and thus provide less redundant information (Burt, 1992). They also have a larger number of indirect contacts, contributing to access a more diverse information flow (Greve, 1995). Habitual entrepreneurs also possess competencies regarding how to access industry partners and investors (Rasmussen et al., 2011), and may guide boards to connect to beneficial sponsors.

Senior management experience are board members with former positions at the senior management level. The former firms were checked subjectively, to separate senior management experience from holding companies and sole proprietorship. It is evident that the network gained from senior positions at Statoil ASA is substantially bigger than a senior management position at a local grocery store. Senior management experience offers boards with connections to decision makers, which might provide benefits for the USO. Boards consisting of members with prior senior management experience may also offer legitimacy to the market. Founders of firms often have senior management titles. These types of positions might not be comparable with the magnitude of management experience at larger firms. A person with a senior management position in a start-up is therefore only given entrepreneurial experience at first. If the firm then is considered to have gone from adolescence to maturity[4], during the period when the board member was active, we will credit the *Senior Management* variable in addition to *Entrepreneurial.*

Board members' participation in multiple boards may increase social capital in terms of connectivity to other board members (Beckman & Haunschild, 2002; Hillman & Dalziel, 2003). The variable *Significant board experience* is credited if the person has more than ten former board positions, or a board position in a firm with more than NOK 30.000.000 in yearly revenue during the given period. This limit was chosen in consultation with two experienced researchers on the field[5].

Profession-related network

Our second hypothesis contends that board members with prior industrial, other industrial and/or academic experience will contribute with network ties to actors with tacit knowledge in the context of opportunity recognition and advice to help USOs understand the industry's current dynamics. If a board member has such prior experience, and hence is believed to have network ties to the abovementioned actors, he/she is denoted with the value 1 in the respective category.

Academic experience constitutes the network obtained by having former experience from research or other academic environments. Grandi and Grimaldi (2003) investigated academic entrepreneurs in the context of network characteristics, and found that ties to industry actors, developed during the entrepreneurs' time at the academic institution, was the first interaction with the market. Also, the academic network can offer information regarding technology and products worldwide, that actors outside this network do not gain access to. These technologies are not publicly known, and such information thus gives USOs a competitive advantage.

Industry experience quip board members with goodwill and connections with industry players, and can hence help USOs acquire critical resources, gain legitimacy and initiate relationships to nourish firm growth (Certo, 2003). Experience within the industry where the USO is located, and where it is likely there has been developed a network from this position, is credited for this variable. If the board member also had a position at senior management level, this is recorded in addition.

Other industrial experience concerns network developed by having a position in a firm outside the relevant industry for the USO. Through work experience board members add new network nodes, hence spanning structural holes. The experience gained from the position had to be at a level where one safely could assume that the person had gained a noteworthy set of ties.

Board structure

Our third hypothesis states that board members' average age and board size will bring in more network ties and generally more experience to USOs, which may lead to better performance. The following variables where registered as scale measures.

Board member age was found mainly from www.purehelp.no[6]. We used their age at founding and calculated the average age of the

[4] In this assessment we use Quinn and Cameron's (1983) integrative model for new firms. The final stage, "Elaboration of structure" is identified by stronger cash flows, resource allocation decisions focused on expansion within the chosen domain, and adaption of strategies emphasizing productivity enhancement (Jawahar & McLaughlin, 2001).

[5] Postdoc Researcher Ekaterina Bjørnåli and Ph.D. Candidate Marius Tuft Mathisen

[6] www.purehelp.no is a Norwegian site that offers information about previous board positions from 2002 until today.

board. Our contention is that a high age is correlated with more experience; hence an older board member brings more value to the USO.

Board size is associated with better performance (Pfeffer, 1972) and USOs' board size was found from www.brreg.no [7]. We contend that more individuals bring more board capital into the board, and providing a better platform for success.

Control variables

In the use of control variables, we are looking for other variables that might cause some variance in our sample. In regression analysis, every variable included in the model acts as a control to the others. Control variables are thus variables included only to improve the reliability of other variables. When dealing with such a small sample as we are in this study, the ratio between number of predictors and sample size must be taken into account. Rules of thumb suggest a minimum of 10-15 cases per predictor, but lately there has been published some findings on how these rules may be relaxed (Vittinghoff & McCulloch, 2007). However, there is still a general understanding that the reliability of the individual variables and the model is lost when stressing these boundaries (Green, 1991). The inclusion of control variables has thus been thoroughly reviewed, as we do not want to include variables with no predictive/controlling power.

As we investigate the firms from the moment of founding, the set of variables should describe the environment and the total outlook of the firm from this date on. As of this, we have been very restrictive in the selection of control variables and have excluded variables like VC funding and number of employees, as they are all controlling for an environment which does not exist at founding. In choosing these control variables, we have taken use of the recent report from Rasmussen et al. (2013),which has used data from a large sample of USOs in Norway. As our study looks at a sample in a restricted time frame we are controlling for the industries with significantly different commercialisation times. Software is known for having a short commercialisation period, while Bio/Pharma normally has a longer period. These are coded as separate dummy variables where respectively IT and Bio/Pharma are allocated the value 1 if the firm operates in one of these industries.

Our sample contains firms founded between 1999 and 2004. As known, the dot-com bubble burst in 2000. Although Norway was not in the epicentre of this burst, some effects has been registered. Customers, investors and venture capitalists were hesitant in their actions. This also affected new firms to some extent. Thus, we control for the year of founding. DfBeta values measure how much an observation has affected the estimate of a regression coefficient. The inclusion of years as a scale variable affected the constant substantially. To avoid these fluctuating DfBeta values for the constant in our model, we coded *founding year* as years since founding. This means that the firms incorporated in 1999 have the value 15, decreasing for younger firms. There are no implications of this on the model or other variables, however, because of the scale change on the *founding year* variable, these correlations and exp(b) values are inversed.

In addition to the abovementioned control variables, we considered using Related TTO and Region as control variables. As these variables are nominal, and thus would be categorical variables, the inclusion of them would implicate a large set of extra dummy variables. As we are already on the boundaries of our variables, this would be unfortunate for our model. Furthermore, though such variables are important in a cross-country sample, Norway is a small and culturally homogeneous country, with no significant differences between the locations. In addition, after running test-regressions with these variables included, we found no or little predictive power and thus decided to not include them in our model.

Sample, control and verification

To detect outliers, descriptive statistics have been reviewed for each variable. In addition, the sample was screened for influential and

[7] www.brreg.no is a site for the Norwegian government agency that is responsible for the management of public registers. Information and announcements for each registered firm is available.

outlying cases by using *leverage*[8], *Cook's distance* and *DfBetas*[9] as indicators.

After collecting all the data, we performed Harman's one-factor test to check for common method bias. If common method bias were a problem, we would expect one variable to stand out in a factor analysis. In the unrotated factor analysis, one factor accounted for about 33% of the variance, which is an acceptable level (Aulakh & Gencturk, 2000).

The sample and the variables were further tested for multicollinearity. First, by assessing the Pearson correlation table and looking if correlation between variables exceeds 0.8. Then, by performing a multiple regression[10] and checking for the *variance inflation factor*[11]. As expected, after seeing the Pearson correlation matrix, *Senior mgmt. experience* stood out as the variable with highest multicollinearity, with the value 3. No values exceeded our critical VIF-limit of 10.

Limitations

A key limitation for our study is the lack of longitudinal approach. We assume that the performance of the USO is due to the impact performed by the initial board. We do not access the board members added at a later stage. As such, we are not able to separate the types of networks that are important at different stages. This aspect is further discussed under the chapter Further research.

We have used operating income and revenue to distinguish USOs from success and failure. As USOs typically need 10 years or more to show a significant growth (Smith & Bagchi-Sen, 2012), there might be successful USOs in our sample that are coded as living dead, due to lack of development to deliver sufficient revenue or operating income. Concerning revenue and operating income, another limitation for our method is its perspective. We measure the variables at founding and at year 2012. This implies that there may have been undiscovered occurrences with influential effects on the USOs. USOs with sufficient revenue or operating income in between the two time events, but ended 2012 insufficiently, have been coded as failures, despite their earlier success. Also, performance by financial metrics is always a temporary position, and might change in the future.

We have used www.linkedin.com, www.purehelp.no and general Google search for attaining the independent variables. LinkedIn lets each user post their online résumé. Optimally these résumés would be thoroughly filled out with all former positions and achievements. However, the majority of these résumés have flaws i.e. missing information to some degree. There is also a risk of fabrication. Nonetheless, flaws will be present in classical surveys as well, and we contend that our data sample is as solid as survey data. The general Google search that is conducted gave very varying results, extending from complete résumés to no information at all. As senior management positions often are posted on company websites and entrepreneurial experience often turns up in news, these are more likely to be revealed than the other variables. Academic and regular industrial positions are harder to spot using a basic Google search. We therefore contend that this limitation is affecting the other variables, excluding senior level management and entrepreneurial experience.

Board experience ended before 2002 is not included in the Purehelp database, and represents another limitation to our study. Board members with extensive dictatorships earlier than 2002 will not be credited with significant board experience. Lastly, it is fair to say that the network gained through having a professional position for several years, compared to a short period of time is probably consists of more valuable ties. This is not taken into account in our independent variables, and hence constitutes a limitation.

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[8] Cases where declared influential and further investigated if h>2(k+1)/n, where k is the number of covariates and n is the number of cases (Belsley, Kuh, & Welsch).

[9] A Cook's distance- or a DfBeta value above 1 were also taken as indicator of an outlier (Cook, 1977; Sarkar, Midi, & Rana, 2011).

[10] This is possible because the dependent variable (in our case, dichotomous) is not involved in the multicollinearity (Eikemo & Clausen, 2012; Field, 2005).

[11] The Variance inflation factor (VIF) is an index which measures how much the variance (square of the estimate's standard deviation) of an estimated regression coefficient is increased because of collinearity; a VIF of 10 indicates that the standard error is inflated by a factor of 10 due to multicollinearity to other variables (O'brien, 2007). *VIF* is the reciprocal of *Tolerance* (1-R^2), but VIF is more apprehendable. We therefore use VIF and instead adopt the most commonly used tolerance level for Tolerance (0,10) and convert it to its VIF-equival value (1/0,1=10) to use this as our VIF-tolerance value.

Results

Descriptive

The sample consists of 70 firms - 21 coded as success and 49 as failures. As seen in figure 3, the distribution of successful firms is about equal with 10 firms having acquisition as the reason for success. The distribution within the failed firms is somewhat skewed. 22 of the firms have been counted as failures because of financial reasons. Only 11 of the 70 firms have been discontinued.

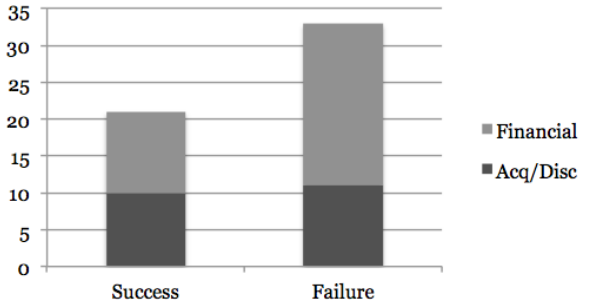

Figure 3. Distribution of outcome

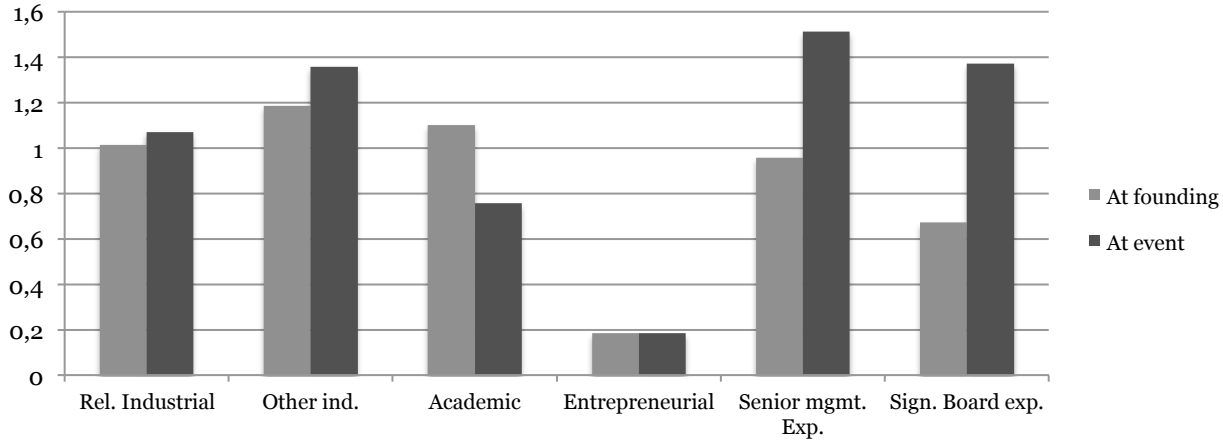

Figure 4. Distribution of experience at founding and event

The data regarding board members were gathered on to time events for the firm. As seen in figure 4 the change in these variables are trending upwards, with the exception of academic and entrepreneurial experience. This increase seems to be largest in senior management experience and significant board experience. It is likely to believe that these variables might be correlated to age of board members. And as we see in figure 5, this increase is also present in the mean age of the board members. This will be further examined in the inferential section.

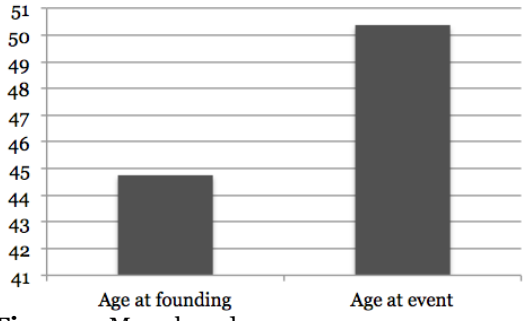

Figure 5. Mean board age

Figure 4 might indicate an increase in board members. However, this representation is also depicting the experience present in the firms, and not the number of board members. The mean board size actually decreased from founding to event. This evident change, represented in figure 6, might indicate that USOs are narrowing their boards to the most essential members during their lifetime. However, another reason for this decrease might be the time of measurement. As seen from the codings, many living dead firms cut their boards to only contain the owner or responsible person.

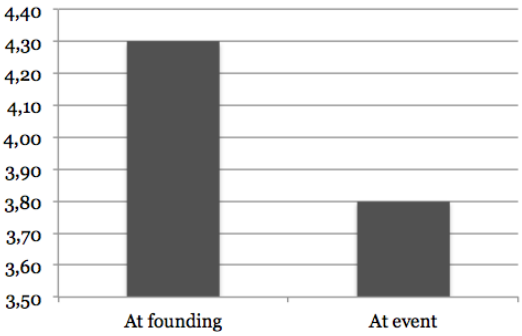

Figure 6. Number of board members

A more detailed overview of the different variables', mean, max, min and standard deviations are found in appendix 4.

Inferential

Table 1 presents a Pearson correlation matrix with the variables ordered in blocks, reflecting the different hypotheses. There are mainly four different clusters of significant correlation.

First, we see the Entrepreneurial (5) and Senior level management (6) variables correlating positively with success at a magnitude of 0,280. This will be further examined and controlled for in the regressions following. There is also an internal correlation between the variables in the Executive level block.

Table 2. Pearson correlation matrix – at founding

		1	2	3	4	5	6	7	8	9	10	11	12
	Success (1)	1											
Control variables	Founding year (2)	.138	1										
	Software (3)	.058	-.073	1									
	Bio/Pharma (4)	-.259*	.077	-.286*	1								
Executive level network	Entrepreneurial (5)	.280*	.051	.192	-.037	1							
	Senior level mgmt. (6)	.280*	-.073	.182	-.006	.459**	1						
	Significant board (7)	-.045	-.141	.071	-.073	.377**	.506**	1					
Profession-related network	Academic (8)	-.140	.093	.111	.229	.185	.156	.005	1				
	Relevant industrial (9)	.112	-.311**	.079	.029	.169	.546**	.235	.034	1			
	Other industrial (10)	.175	-.133	.108	-.016	.219	.604**	.329**	-.003	.332**	1		
Board structure	Board size (11)	.039	-.126	.234	-.158	.186	.284*	.325**	.073	.424**	.434**	1	
	Mean board age (12)	-.201	-.030	-.171	.119	.087	.047	.269*	.129	-.048	-.101	-.011	1

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

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

Table 3. Hierarchical logistic regression – at founding

At founding	Model 1 Exp(B)	Sig	Model 2 Exp(B)	Sig	Model 3 Exp(B)	Sig	Model 4 Exp(B)	Sig
Control variables								
Founding year	**1.254**	.171	**1.223**	.290	**1.252**	.281	**1.255**	.289
Software	**1.020**	.971	**.606**	.465	**.723**	.650	**.665**	.589
Bio/Pharma	**.174***	.036	**.097***	.013	**.100***	.024	**.107***	.033
Executive level network								
Entrepreneurial			**6.668**†	.083	**9.902**†	.060	**11.015**†	.058
Senior level mgmt.			**3.107***	.010	**3.857***	.029	**3.566***	.044
Significant board			**.225***	.027	**.209***	.023	**0.249**†	.056
Profession-related network								
Academic					**.575**†	.092	**.622**	.164
Relevant industry					**1.024**	.954	**1.044**	.922
Other industry					**.898**	.782	**.918**	.836
Board structure								
Board size							**.960**	.436
Mean board age							**.935**	.850
Model Chi-square	7,321		22,081		25,362		25,99	
Model Chi-square significance	0,062		0,001		0,003		0,007	
Delta Model Chi-square			14,761		3,281		0,628	
Delta Model Chi-square significance			0,002		0,35		0,007	
"-2 log likelihood"	78,2		63,44		60,159		59,531	
Hosmer & Lemeshow sig.	0,35		0,607		0,067		0,43	
Overall predictive accuracy	72,90 %		75,70 %		74,30 %		74,30 %	
Cox & Snell R-squared	0,099		0,271		0,304		0,31	
Nagelkerke R-squared	0,141		0,384		0,431		0,44	

†p < 0.1, * p < 0.05, ** p < 0,01 - Model run on 70 firms, 50 failures and 20 successes

Significant board experience (7) is seen to correlate with variable 5 and 6, and it is therefore reasonable to introduce these variables in the same block in the regression analysis. The profession-related network variables relevant (9) and other (10) industry both have a positive correlation with Significant board experience (7) and Senior level management (6). This relationship is somewhat expected, as people with executive level experience often have been found in a specific industry. Board size (11) has a significant positive correlation with 6,7,9 and 10, but not with variable 1. One explanation of this might be that boards have a basis number, consisting of the founders, and that a further extension of the boards are done with the regards to add people with these networks. Also, the lack of correlations between board size and success might indicate that it is the social capital of the board, and not the board size that matters.

Following, the overview of the hierarchical linear regression model is presented in table 2. Model 1 contains the control variables. As we can see, Bio/Pharma has the highest significance value among the control variables. The exp(B)-value of 0,174 indicates that that it has a negative influence on the odds for success. Founding year seems to have the largest positive odds ratio of 1,254, but without significance. Again, note that the founding year variable is coded as years since incorporation, thus the positive coefficient applies to firm age. Model 2 demonstrates support for hypothesis 1 with the strong model significance of 0,001. In this model Senior management and Significant board experience have significant effects. However, where Senior level management demonstrates a positive odds ratio of 3,107, Significant board experience is seen to have a negative influence on the outcome, with an odds ratio of 0,225. Entrepreneurial network stands out with the highest odds ratio of 6,668, but only approaching significance.

Model 3 introduces profession-related network. Surprisingly, Academic related network has a negative effect on success, and approaching significance. As this is the opposite of our expectation, and none of the other variables are approaching any significant values, hypothesis 2 has no support from this model. The Pearson correlation matrix shows substantial correlation between the variables Relevant industrial (9) and Other industrial (10) in model 3 and Senior level management (6). As described earlier this was expected. However, Senior level management (10) is upholding its significance levels even though it is fairly correlated with the new variables. This might indicate that it is the executive part of the network and not the specific industry that is of importance for success. Although this further weakens the hold of hypothesis 2, the stability of significance for the variables 4 and 6 is reassuring for hypothesis 1. Model 4 includes Board size and Mean board age. None of these variables have any significant values. However, variable 6 loses a level of significance at the inclusion of block 4. This is expected, as age can be argued to correlate with board experience.

As a *Goodness-of-fit* assessment we used Hosmer & Lemeshow tests[12] - which were non-significant throughout the model, thus indicating a model with predictive power. The -2 log-likelihood statistic[13] is a good measure to assess the fit of the new step in a model. In our case, the -2LL is continuously decreasing for each step, indicating that we are improving the model.

Following, the results for our second logistic regression model, measuring the board right before the USOs "end event", are presented below. This model was verified using the same tests as above. Although the model overall seems to demonstrate significance [14] and a goodness-of-fit, there are a number of influential outliers[15] contained in the sample. We have kept these cases in the sample as we want the model to act as a descriptive tool in assistance to the first regression. In addition, there are several methodological weaknesses the reader should be aware of. Board members who have worked within the focal firm have

[12] The Hosmer & Lemeshow statistic tells if the observed data are significantly different from the predicted values from the model. A non significant value is indicative of a model that is predicting the real-world data well (Field, 2005).

[13] The log-likelihood is an indicator of how much unexplained information there is after the model has been fitted. It is based on summing the probabilities associated with the predicted and actual outcomes and is analogous to the residual sum of squares in multiple regression (Field, 2005). The value reported is the log-likelihood multiplied with -2 in order to get a chi-squared distribution of the statistic. Thus -2LL.

[14] The model is significant at p<0,001 level at. block 2. Increasing to 0,007 in block 4.

[15] In total five cases showed values substantially larger than 1 on Cook's Distance, two variables had a normalized residual larger than 3 and four cases had a DfBeta substantially larger than 1.

been accredited for Relevant industrial experience. It is arguable that this gives a wrong impression towards inclusion of external network, as this is somewhat self-reinforced. Moreover, as we measure the board close to end event, it is possible that board changes have happened and that the sitting board is not responsible for the event that has occurred. Thus, this analysis should not be used as a stand-alone model. It is only included with the purpose to support the discussion and contentions from the first regression.

Table 4. Pearson correlation matrix – at event

		1	2	3	4	5	6	7	8	9	10	11	12
	Success (1)	1											
Control variables	Founding year (2)	.138	1										
	Software (3)	.058	-.073	1									
	Bio/Pharma (4)	-.259*	.077	-.286*	1								
Executive level network	Entrepreneurial (5)	.236*	.074	-.055	.028	1							
	Senior level mgmt. (6)	.509**	-.045	.240*	-.089	.568**	1						
	Significant board (7)	.353**	.041	.174	-.025	.474**	.623**	1					
Profession-related network	Academic (8)	-.129	.003	.113	-.010	.092	.104	-.069	1				
	Relevant industrial (9)	.322**	-.298*	.268*	.017	.306**	.524**	.256*	.082	1			
	Other industrial (10)	.400**	.064	.094	-.066	.277*	.656**	.567**	.098	.184	1		
Board structure	Board size (11)	.339**	-.090	.249*	-.146	.310**	.619**	.579**	.331**	.455**	.563**	1	
	Mean board age (12)	-.135	-.005	-.041	.174	.012	-.072	.115	.109	.058	-.089	.254*	1

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

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

Table 5. Hierarchical logistic regression – at event

At founding	Model 1 Exp(B)	Sig	Model 2 Exp(B)	Sig	Model 3 Exp(B)	Sig	Model 4 Exp(B)	Sig
Control variables								
Founding year	**1.254**	.171	**1.499**†	.097	**2.063***	.018	**2.065***	.020
Software	**1.020**	.971	**.364**	.199	**.229**	.112	**.235**	.125
Bio/Pharma	**.174***	.036	**.105***	.024	**.048***	.012	**.049***	.014
Executive level network								
Entrepreneurial			**.600**	.574	**.285**	.292	**.287**	.315
Senior level mgmt.			**3.592****	.003	**3.078***	.037	**3.022**†	.052
Significant board			**1.135**	.687	**1.064**	.874	**1.164**	.738
Profession-related network								
Academic					**.541**	.134	**.567**	.188
Relevant industry					**2.466***	.048	**2.512**†	.058
Other industry					**1.287**	.497	**1.233**	.595
Board structure								
Board size							**.974**	.620
Mean board age							**.987**	.973
Model Chi-square	7,321		55,913		37,623		37,915	
Model Chi-square significance	0,062		0,000		0,000		0,000	
Delta Model Chi-square			22,287		8,015		0,292	
Delta Model Chi-square significance			0,000		0,046		0,864	
"-2 log likelihood"	78,2		62,553		47,898		47,606	
Hosmer & Lemeshow sig.	0,706		0,973		0,599		0,733	
Overall predictive accuracy	72,90 %		78,60 %		87,10 %		87,10 %	
Cox & Snell R-squared	0,099		0,345		0,416		0,418	
Nagelkerke R-squared	0,141		0,489		0,59		0,593	

†p < 0.1, * p < 0.05, ** p < 0,01 - Model run on 70 firms, 50 failures and 20 successes

Table 3 shows the Pearson correlation matrix for our second model. We see how the correlations mentioned in the last matrix persist. However, there are also a large number of new variables with significant correlation directly to the success variable. Relevant industrial (9), Other industrial (10) and Board size are all new and significant at the 0,01 level. We will look at how these variables perform when controlling for each other in the logistic regression, but as a general comment it is reassuring that we see a typical stronger correlation with the outcome variable in this model. As we are close to the end event, we expected fewer, unmeasured occurrences to intervene with our sample, increasing predictive power.

The second logistic regression model shows three major changes in significance and effect for the individual variables. The Senior level management variable is now significant at a $p<0,01$ level, and Relevant industry also shows significant and positive effects towards success. However, Entrepreneurial network has lost both its significant values and effect - an evident change. This may be seen as a result of how the needs of USOs differ in the different stages in a start-up process, and thus indicate the differences within the different networks.

In opposition to the first analysis, it would be relevant to control for events occurring during the lifespan of the USOs. Some typical control variables are the receiving of VC-funds, number of employees, region and change in region. VC-funds was expected to have the largest predictive power of outcome, hence it was included in our initial analysis. However, as it correlates perfectly with the Bio/Pharma variable, we experienced discrimination problems, which collapsed the model. We performed analysis using one variable at a time and discovered that the predictive effect was somewhat larger with Bio/Pharma. Due to this, and that we wanted to keep our model constant, we decided to not include VC-funding as control, and given the correlation with Bio/Pharma this is not considered a significant weakness. The variables that were mentioned but not included were tested in separate regressions. Neither showed any predictive power, and was thus left out.

In summary, our first regression model shows how USOs having board members with network related to entrepreneurial or senior management positions in their initial phase are more likely to achieve success, thus supporting hypothesis 1. Significant board experience however, was shown to have a negative effect on the outcome of the USO. There was no support for hypothesis 2 and 3. The second regression model supports the importance of senior level network also in later stages of the USOs development. The decrease of the odds ratio and significance for the Entrepreneurial variable and increase for Industrial-variables are indicative of a change in needs in the USOs over time. These different needs might be reflected in the differences of these two types of networks. In addition, it proves there are differences in the benefits contained in the different networks.

Discussion

In this paper, we sought to explore the initial board of directors' effect on USO performance. The role of directors as a firm's source to board capital has received considerable research attention, however, the board of directors in the context of USOs has only recently come to the forefront. To advance this stream of work, we provide a deeper understanding of the type of prior network contributing to success during the founding phase. Drawing on board capital theory, we studied the board characteristics at founding in relation to success. Our findings indicate that the accumulated board capital of the board of directors' influences the success rate of USOs, suggesting that a board can use our following findings to determine the type of board members needed to be added. Furthermore, a noteworthy finding of our study is the lack of effect of board size and average board member age, hence indicating that further research should focus more on board members' prior network, network capabilities and experience when investigating boards role in the context of USO performance.

Executive level network

Hypothesis 1: Presence of executive network for the initial board of directors increases the likelihood of success for USOs.

This section outlines the effect entrepreneurial -, senior level management -, and significant board experience have on USO performance. Our findings show that the presence of executive networks at founding increases the likelihood of success.

Entrepreneurial related network

Our findings indicate that presence of entrepreneurial experience in the board increases the odds for success. Entrepreneurial experience is valuable for USOs. Habitual entrepreneurs are strategic regarding the new ties they wish to build. They are active towards filling resource gaps within their ventures by using their existing social capital to build relationships and ties (Mosey & Wright, 2007). Thus, boards with elements of entrepreneurial experience are more strategic in building new ties, or leveraging the results of prior established ties, actively bridging the structural holes USOs are facing (Grandi & Grimaldi, 2003; Mosey & Wright, 2007). Experienced entrepreneurs often work continuously on maintaining established relationships. This equips boards with the ability to, seen in a timely perspective, gain access to the right resources to enhance USO growth. This is also supported by Greve (1995). He found that habitual entrepreneurs have a larger amount of non-redundant ties, thus connecting the entrepreneur with other clusters with non-redundant information.

Our analysis indicates that USOs are in need of different types of network, depending on the maturity of the firm. As an example, entrepreneurial network increased the odds for success if it was present at the initial phase for USOs. However, in later stages for USOs, entrepreneurial network did not have any positive influence towards the outcome. This may indicate how USOs have special needs in the initial phase, and that entrepreneurs have these exact capabilities, which are necessary early on. As they govern their networks based on trust rather than formal contracts, they are able to gain credibility in a quicker fashion and may possess the ability to turn borrowed network ties into their own. This is also supported by Mosey and Wright (2007) who found how habitual entrepreneurs are able to connect with a larger number of external actors due to their social capital.

Senior level management

Senior level management experience is seen to have a positive effect towards USOs outcome. This effect was present in both analyses. We contend that these results indicate that the benefits contained by this type of network exist throughout the lifetime of the firm.

Board members with prior network from senior level management positions provide USOs with a structural position, where timely access to ideas and knowledge needed for problem solving, is present (Kor & Sundaramurthy, 2009). This is in line with Burt's (2002) theories of structural holes, and how social capital links USOs to clusters of additive information. By having these ties, board members are interacting with decision makers, and can more easily obtain the resources needed for USO growth. Senior management positions normally offer legitimacy in the market. As Pfeffer and Salancik (1978) stated, prestigious persons on a board provide value confirmation to the market. Hence, board members with senior management experience may help USOs to pass the credibility threshold (Vohora, Wright, & Lockett, 2004). This separates the roles for entrepreneurial background and senior management background in USO boards. Where entrepreneurial experience help boards find and build strategic ties to potential sponsors, senior management experience can equip boards with legitimacy and offer benefits from their prior ties to decision makers. The ties are not guaranteed to be non-redundant, but may prove fruitful if the connected actors can offer benefits. However, if a board member has performed remarkably well as an entrepreneur it is likely to contend that it has provided him/her with both legitimacy and valuable ties.

Drawing on Vohora et al.'s (2004) critical junctures, USOs are dependent on prior network from senior management experience during the establishment and growth phases. These board members can pass the threshold of credibility by using their pre-existing network, which help USOs to develop fast. However, to pass the threshold of sustainability, prior industrial experience is important (Boeker, 1997; Spender, 1989). The USO has proven itself, gained legitimacy, and is developing into a sustainable firm. In this state, USOs have to continuously reconfigure existing resources and capabilities with new information, knowledge and resources (Vohora et al., 2004). According to our findings, board members with senior management experience tend to also have experience within the relevant industry of the USO. It might indicate that many of these Norwegian USOs might have been fairly selective in the choosing of board members. As we have some indications to that this relevant industrial experience is contributing positively in the later stages, this might be favourable behaviour.

Significant board experience

Our results suggest that having board members with significant board experience in the initial phase is affecting USOs success negatively. Carpenter and Westphal (2001) and Carter and Lorsch (2004) came to the same conclusions. Board members serving on several boards may not be able to devote the same attention to USOs as a board member serving exclusively on a single board. Overly occupied board members tend to learn little about the firm's strategic and governance problems to contribute effectively. It might also be the institutional link serial board members possess. For USOs, board members with significant board experience are often connected to TTOs, and it can be argued that these board members are not contributing to a non-redundant network. They are working closely with the academic institutions, which might indicate that they fail to bridge the USOs with commercial actors.

However, as with entrepreneurial experience, significant board experience is not shown to have any effect on the outcome when measuring at a later stage of the firms' development. This can be explained by the differences in needs for adolescent and mature USOs. Kor and Sundaramurthy's (2009) findings on interlocking directorships, elucidating the positive effects of having ties to other board members, indicate that inclusion of these board members should result in positive outcomes for mature USOs. Although the literature is somewhat contradictory on this topic we may contend that the reason for the negative effect in the initial phase has something to do with how these board members are used to govern their network ties for the benefit of the USO. Board members with significant board experience may not be able to contribute sufficiently for small firms, while for bigger entities they can use their network to further grow the firm. USOs are legal entities with self-developed culture, routines and processes that persist independently of individual employees. They also have an externally perceived status (Stuart & Sorenson, 2007), which all together may attract and facilitate new network ties (Fischer & Våge, 2013). Board members with experience from large established firms may be accustomed to the existence of established processes and routines to contain and maintain new ties. Early-stage USOs however, may lack these routines, and are thus not able to extract the full potential of these ties without follow-up from these board members. It is also possible that the board members underestimate the needs for USOs in early phases to be dynamic and rapid in their network expansion.

Profession-related network

Hypothesis 2: Presence of profession related network for the initial board of directors increases the likelihood of success for USOs.

A noteworthy remark from the findings is the lack of significance for relevant industry network and success, hence not finding support for hypothesis 2. The literature agrees largely on the benefits obtained by having boards containing industry-related network (Johnson et al., 2013; Kor, 2003; Pfeffer, 1972). Greve (1995) emphasized the importance of having a large share of professionals in one's network. He argued that to obtain this, a professional background was important. An industry's development in regards to technology, competition, and regulations is also broadly discussed (Kor & Sundaramurthy, 2009), claiming that knowledge of prior industry conditions can help firms understand the industry's current dynamics. By having ties to such expertise is hence an advantage for USOs. A characteristic found in our sample is that successful USOs have board members with industry experience at the event stage. This finding concurs with Kor (2009). As mentioned, USOs are at this stage in their entrance to maturity, identified by stronger cash flows and resource allocation decisions focused on expansion within the chosen domain (Jawahar & McLaughlin, 2001). This is in accord with the capabilities of persons with industrial related network (Kor & Sundaramurthy, 2009).

Our findings indicate that industry-related network is not crucial for USOs in their initial phase. During founding it is of more value to have a board member with prior senior management and entrepreneurial experience. Industry experience may not be as important for USOs because of their dependency on establishing linkages to a variety of external actors. Many USOs are not in a position to sell the industry yet. They are extremely dependent on acquiring financial support, because of their need to develop their product, and industry experience do not normally bring network ties towards financial actors or other instrumental resources. Mosey and Wright (2007) support this finding, observing the lack of influence of

prior industry experience on the capability to build ties outside the research network.

Board structure

Hypothesis 3: Higher average board member age and board size increase the likelihood of success for USOs.

Researchers have agreed on a connection between board size and linkages to external environment (Pearce & Zahra, 1992; Pfeffer, 1972), giving legitimacy to USOs. We found however, no significance to underpin this hypothesis. Walter et al. (2006) argue through their study that it is rather the network capabilities, and not the existence of a network that affect the performance of USOs. In our USO sample, the majority of board members are related to the academic institution. As discussed earlier, they normally possess a dense network, with strong ties to a research environment, and are thus failing to gap the structural holes separating the USO from potential commercial actors.

We can see similarities to the section regarding significant board experience. Although a board consists of additional members, they fail to convert their personal ties to USO benefits due to their redundant network. If the board lacks the capabilities to obtain and maintain network ties, the presence of redundant ties are of little use.

Hypothesis 3 also states that the average board member age increases the likelihood of success for USOs. This hypothesis was rooted in the assumption that a higher average age will positively vary with the degree of experience. Platt and Platt's (2012) found that a lower average age for the board of directors increased the likelihood of bankruptcy. Older board members will normally have a larger network, due to their prior experience. It was however, not found support for this hypothesis. We argue that high age in general translates to more experience, but that it is not the amount of experience that bridge the structural holes for USOs. For USOs to gain access to commercial benefits, the right prior network is necessary. Hence, we argue that a board without senior management or entrepreneurial experience, will not perform better, although it constitutes additional members, or have a higher average age.

Introducing the model

This section presents our model, based on the abovementioned findings on senior management and entrepreneurial networks. Figure 7 represents the initial network USOs are faced with. They usually have strong ties to their parent university, the affiliated TTO and actors within their research environment. These ties give access to research facilities and other benefits, mentioned earlier, but usually fail to bridge the USO to commercial actors.

By having board members with senior level network, USOs are provided with legitimacy towards external actors. In addition, they can provide the USO with pre-existing ties, bridging structural holes, thus obtaining a structurally beneficial position in a network. This is shown in figure 8.

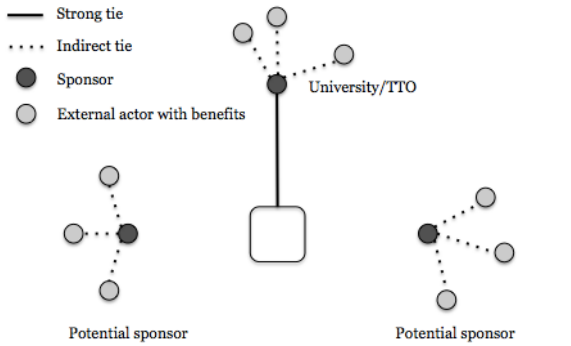

Figure 7. Initial network for USOs

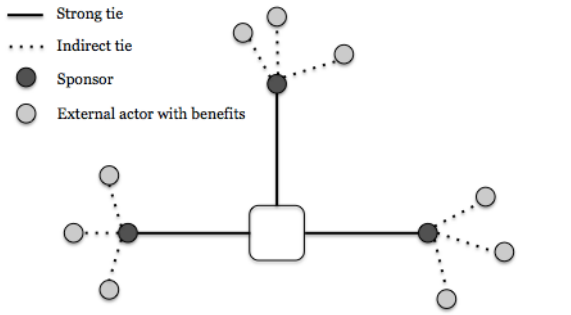

Figure 8. Influence of senior management network

A board with senior level network is easier to perceive as credible, given their professional background, and may provide a connection to financial resources. These members also often possess the industrial capabilities needed in a maturing stage where the USOs focus more on within-domain expansion and productivity enhancement. A board should hence always strive for new members with such professional background.

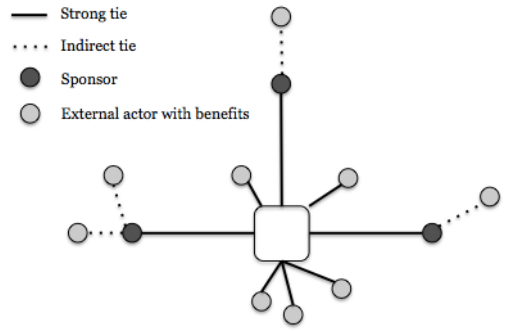

Figure 9. Influence of senior management- and entrepreneurial network

A problem arises when the board's senior management network do not possess ties to a specific market. To be connected to the preferred cluster, the USO has to actively bridge the structural hole. Habitual entrepreneurs are found to be strategic in building new ties, and our model suggest that boards with prior entrepreneurial experience are better to guide USOs in the process of acquiring beneficial ties. This is seen in figure 9, where the entrepreneur is able to convert indirect ties to strong ties. Our paper states that boards with entrepreneurial experience, combined with prior senior management network are beneficial in acquiring the needed benefits for USOs during early stage, and USOs should focus on adding board members constituting such experience.

Implications and further research

This section presents implications of the findings presented in this paper. We contend that this will provide value to academic entrepreneurs, USOs, TTOs, researchers and other policymakers.

Entrepreneurs/USOs

The direct implications for academic entrepreneurs and USOs revolve around the composition of their board of directors. As stated by Fischer and Våge (2013), USOs should strive for a non-redundant network, characterized by strong ties governed by trust. We build on this and contend, in a more specific way, how to achieve this. Academic entrepreneurs and USOs should build their boards proactively to construct a network for bridging structural holes. This should be done early, by building semi internal knowledge reservoirs (Widding, 2005). To avoid getting dependent on specific partners, their focus should be on shifting borrowed indirect ties into strong ties. As persons with senior management experience are likely to bring with them pre-existing ties, they should aim to include these early on. In addition, boards with entrepreneurial experience may have the capabilities needed to turn borrowed hierarchical ties into strong personal ties. People with entrepreneurial background have the largest effect during the founding stages of the firm, and should thus be included as early as possible. USOs should include persons with relevant industrial experience when the opportunity arrives. Further, the network structure and the structural holes it spans should be the focus, not the size of the boards.

TTO

TTOs are often the first strong tie for new established USOs, and normally act as sponsors. In addition, they are a primary source for potential board members at incorporation. One of the main tasks for TTOs is to provide and maintain an advantageous network for USOs. In order to facilitate further creation of strong ties, and prevent dependency for the USO, it is important that the TTO fulfils their role as a facilitator in the right fashion. They should provide and support USOs with new ties, and then let them develop these ties themselves. This will prevent the creation of hierarchical structured networks.

Another issue, discussed earlier, is the institutional link TTOs have. They are working closely with the institutions, and might contribute with a redundant network, ranging mainly the research environment. It is thus important that TTOs offer commercial links for USOs, to connect them to commercial actors. We argue that TTOs, contributing with senior level management and entrepreneurial experience, will have a bigger influence on USO performance.

Researchers

Our findings support that boards with entrepreneurial experience at founding enhance the performance of USOs. Mosey and Wright's (2007) study showed the same results for entrepreneurs in the management team, pointing on the positive effect of entrepreneurial experience. Similarities were also observed between the studies with relevance to prior industrial experience, enlightening the lack of effect this experience

has towards performance. As the results from these types of studies show equal results, one implication may be that it is possible to operationalize findings regarding entrepreneurial network to also be valid for board's network.

Furthermore, the entrepreneur and the board possess some of the same characteristics, and we imply that the board can be used as a toolbox for entrepreneurs in the management team,
to acquire resources and information not present in the team. This builds on Widding's (2005) theory on knowledge reservoirs. Using the same argument as earlier, findings regarding one of these subjects can be operationalized to also be valid for the other.

Using LinkedIn, and other open databases on the Internet, is a new method of data gathering. If our findings prove to be fruitful, researchers can adopt our method of operationalizing social capital with prior experience in other studies. By choosing a mature sample, ranging from 1999 to 2004, we assume that the available data on LinkedIn and Google will increase by the years, making our data collection method more accurate for future researchers.

Further research

Our study is not without limitations, and there are areas for further research. We analyse solely Norwegian USOs. Further researchers could extend and apply our research to other nations, to control for differences. The role of venture capital firms is bigger in the US than in Norway, and VC funding could hence be an indicator for success. Also, we observed USOs from two time events only, namely at founding and at event. Future research could be extended to take a longitudinal study, focusing on how changes of the board affect the performance, and to separate the types of networks that are important at different stages. To know when to include the different types of networks in the board of directors would be very valuable for the growth USOs. A way to do this could be to code the board composition for each year, over a time span of 8 to 10 years, and see how the characteristics of the boards change for successful firms.

Our findings suggest that board members with senior management experience tend to also have experience within the relevant industry of the USO, and that industry experience is favourable in later stages of the firm. However, we have not controlled for the distribution of these traits within the board itself. If the traits registered for a board were possessed by only a single person, it might yield different results relative to evenly distributed traits. Furthermore, we have not separated between inside and outside directors. Also, as mentioned in our second regression analysis, we have not distinguished between work experience in the focal firm versus other firms. As there are clearly differences between insiders and outsiders, it would be fruitful to separate them to uncover the best board characteristics for USO success. We also note that the dependent variable can be hard to capture empirically. There are several factors that influences USO performance. It would be interesting to test our results on other dependent variables, such as CEO replacement, which is more affected by boards.

Another point concerns control variable. Our findings suggest that Bio/Pharma as a control variable is of relevance, as the commercialization period is found to be slower for USOs operating in that sector. Interestingly however, is the use of software as a control variable. Researchers before have found that the commercialization period for software is shorter than average. This was not found in our sample, and attention should be given to validate this. Additionally, we found that only 1 of the 70 USOs in our sample changed location during our time interval. It would be interesting to investigate through a qualitative analysis why so few USOs stick to their originated location, even though many of them do not achieve success. Moreover, people who have been working at technology transfer offices for a longer period will often be involved in enough boards to be accounted for significant board experience. This board experience was discovered to be disadvantageous in the initial phase of USOs. As it is plausible that a large part of these board members stem from TTOs, an interesting subject for further research is to examine the number of TTO employees in the boards and control for this in a similar analysis as conducted in this paper.

At last, our new method of data gathering, using LinkedIn and other open databases on the Internet, is an area open for further inspection. The information available here, is partly submitted by the person it regards, which can look similar to a general survey.

However, the information is submitted with a personal agenda, rather than to support a scholar's research. This can indicate that the data has some risks towards being biased. A study comparing the information found on the Internet, compared to regular survey data, could assess the likelihood of the online information being correct and unbiased. Also, in regards to our operationalization of network using experience, one could try to directly measure the network by using LinkedIn, and compare the results to see if our operationalization is valid.

Conclusion

This study indicates through empirical findings that the initial characteristics of the board affect university spin-off companies' performance. Our findings highlight that successful USOs consists of board members with senior level management and entrepreneurial experience that help connect them non-redundant networks. Senior level management experience contributes with ties to relevant external actors. They provide legitimacy in the market and provide timely information to induce USO growth. Entrepreneurial experience provides skills to target the right actors when needed. They use their prior experience to guide USOs during the founding stage, where right decisions are crucial for future success.

Furthermore, our study has shown that a board member with prior board experience does not affect the performance of USOs. We argue that board members, occupied by positions in other boards will not be able to devote the preferred attention to the USO. They are also often connected to TTOs, and are not contributing to a non-redundant network. Neither did we find any indications that board members with prior industrial experience affect USO performance.

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Appendix 1 - Codebook

Codebook - Firm Overview

Variable	SPSS Variable Name	Coding instructions	Measure
Firm data			
fornyid	fornyid	uniqe ID from FORNY database	Nominal
Founding year	foundyear	Year of founding	Scale
Software	software		Nominal
Bio/Pharma	biopharma		Nominal
TTO/University	ttouni		Nominal
Events			
Acquisition	acq	Year of acquisition	Scale
Acquisition success	acqsuccess	Dummy variable. 1 = Acquired	Nominal
Venture Capital	vc	Year of VC investment	Scale
Venture Capital BIN	vcbin	Dummy variable. 1 = recieved venture capital	Nominal
Failure	failure	Year of Failure	Scale
Development			
Result	result	Operating income in 2012	Scale
Revenue	revenue	Revenue in 2012	Scale
Money success	moneysuccess	Dummy variable. 1 = success by abovementioned	Nominal
Success	success	Dummy variable. 1 if acqsuccess or moneysuccess	Nominal

Codebook - Person registe: At founding (af), equal for "at event (ae)"

Non important	afpXnonimp	Dummy variable. 1 = non important person	Nominal
Relevant Industrial	afpXindustrial	Dummy variable. 1 = relevant industrial experience	Nominal
Other industrual	afpXother	Dummy variable. 1 = other industrial experience	Nominal
Academic	afpXacademic	Dummy variable. 1 = academic experience	Nominal
Entrepreneurial	afpXentr	Dummy variable. 1 = entrepreneurial experience	Nominal
Senior management	afpXsenior	Dummy variable. 1 = senior management exp.	Nominal
Significant board experience	afpXsignboard	Dummy variable. 1 = significant board exp.	Nominal
Age	afpXage	Age at founding (af) and at event (ae)	Scale

Codebook - Person and Firm aggregates

Non important	afSUMnonimp	Sum of board members with afpXnonimp	Scale
Relevant Industrial	afSUMindustrial	Sum of board members with afpXindustrial	Scale
Other industrual	afSUMother	Sum of board members with afpXother	Scale
Academic	afSUMacademic	Sum of board members with afpXacademic	Scale
Entrepreneurial	afSUMentr	Sum of board members with afpXentr	Scale
Senior management	afSUMsenior	Sum of board members with afpXsenior	Scale
Significant board experience	afSUMsignboard	Sum of board members with afpXsignboard	Scale
Age	afSUMage	Average age of board members	Scale
Region	region	Region where USO is registered: Nord, Sør, Øst, Vest, Midt, Oslo	Nominal
Age of firm	firmage	Years since USO was incorporated	Scale
Board members	afSUMboard	Number of boardmembers at founding and event	Scale

Appendix 2 – Code sheet

Firm specific codesheet		
Firm	******* AS	
Orgn.nr	*********	
FornyID	********	

Comments
Not as I can see in the annual reports
Såkorninvest Midt-Norge AS

Founding status		
Founding year	2001	
TTO/University	LEN	
Software	1	*Yes*
Bio/Pharma	0	*No*

Events	2012	2012
Acquisition	0	
Failure	0	
Venture Capital	0	
Revenue	19 242 835,0	
Result	1 595 431,0	

Name - At founding	Source	Non important	relevant industrial	Other Industrial	Academic	Entreprene urial	Senior mngmt	Significant board exp	Managing director	Actal age	Real age
**** ****** ********				1						36	48
**** ******			1				1			36	48
******* ******			1		1		1			48	60
**** **** ******			1	1		1	1	1		56	68
******* *******			1							38	50
***** *********			1			1	1			38	50
***** **** **********		1								26	38
***** ******		1							2	38	50

Name - At event/2012	Follower	Non important	relevant industrial	Other Industrial	Academic	Entreprene urial	Senior mngmt	Significant board exp	Managing director	Actual age	Real age
***** ********			1				1			52	53
****** *** *********				1				1		66	67
**** *****		1								45	46
*** **** *****								1		42	43
***** ***** ****				1			1		2	64	65
**** ********* *******							1			45	46
********* ******* *********		1								38	39
										0	

Appendix 3 – Summary script

The following script was used to gather data from the 70 different templates into one master-file containing the whole sample.

```
Sub Superfischscript()

    Dim Summary As Worksheet
    Dim FolderPath As String
    Dim NRow As Integer
    Dim WorkBk As Workbook
    Dim SourceRange1 As Range   'Firm
    Dim SourceRange2 As Range   'Orgnr
    Dim SourceRange3 As Range   'FornyID
    Dim SourceRange4 As Range   'Foundingyear
    Dim SourceRange5 As Range   'TTO/University
    Dim SourceRange6 As Range   'Software
    Dim SourceRange7 As Range  'Bio/Pharma
    Dim SourceRange8 As Range   'Acq
    Dim SourceRange9 As Range   'Acq cmt
    Dim SourceRange10 As Range   'Failure
    Dim SourceRange11 As Range  'Failure cmt
    Dim SourceRange12 As Range  'VC
    Dim SourceRange13 As Range  'VC cmt
    Dim SourceRange14 As Range  'Revenue
    Dim SourceRange15 As Range  'Revenue cmt
    Dim SourceRange16 As Range  'Result
    Dim SourceRange17 As Range  'Result cmt



    Dim SourceRange21 As Range  'AFP1
    Dim SourceRange22 As Range  'AFP2
    Dim SourceRange23 As Range  'AFP3
    Dim SourceRange24 As Range  'AFP4
    Dim SourceRange25 As Range  'AFP5
    Dim SourceRange26 As Range  'AFP6
    Dim SourceRange27 As Range  'AFP7
    Dim SourceRange28 As Range  'AFP8
    Dim SourceRange29 As Range  'AFP9
    Dim SourceRange30 As Range  'AFP10

    Dim SourceRange31 As Range  'AEP1
    Dim SourceRange32 As Range  'AEP2
    Dim SourceRange33 As Range  'AEP3
    Dim SourceRange34 As Range  'AEP4
    Dim SourceRange35 As Range  'AEP5
    Dim SourceRange36 As Range  'AEP6
    Dim SourceRange37 As Range  'AEP7
    Dim SourceRange38 As Range  'AEP8
    Dim SourceRange39 As Range  'AEP9
    Dim SourceRange40 As Range  'AEP10

    Dim DestRange1 As Range     'Firm
    Dim DestRange2 As Range     '
    Dim DestRange3 As Range     '
    Dim DestRange4 As Range     '
    Dim DestRange5 As Range     '
    Dim DestRange6 As Range     '
    Dim DestRange7 As Range     '
    Dim DestRange8 As Range     '
    Dim DestRange9 As Range     '
    Dim DestRange10 As Range    '
    Dim DestRange11 As Range    '
    Dim DestRange12 As Range    '
    Dim DestRange13 As Range    '
```

```
Dim DestRange14 As Range    '
Dim DestRange15 As Range    '
Dim DestRange16 As Range    '
Dim DestRange17 As Range    'Result cmt

Dim DestRange21 As Range    'AFP1
Dim DestRange22 As Range    '
Dim DestRange23 As Range    '
Dim DestRange24 As Range    '
Dim DestRange25 As Range    '
Dim DestRange26 As Range    '
Dim DestRange27 As Range    '
Dim DestRange28 As Range    '
Dim DestRange29 As Range    '
Dim DestRange30 As Range    '

Dim DestRange31 As Range    'AEP1
Dim DestRange32 As Range    '
Dim DestRange33 As Range    '
Dim DestRange34 As Range    '
Dim DestRange35 As Range    '
Dim DestRange36 As Range    '
Dim DestRange37 As Range    '
Dim DestRange38 As Range    '
Dim DestRange39 As Range    '
Dim DestRange40 As Range    '

Dim FornyId As String
Dim SpacePos As Integer
Dim SpacePos2 As Integer
Dim FirmName As String
Dim FullFileName As String
Dim NumberOfFiles As Integer

' Create a new workbook and set a variable to the first sheet.
Set Summary = ThisWorkbook.Worksheets(1)
Summary.Name = "Summary Sheet"

'Lets the user select a file in the desired folder
FolderPath = GetFolderPath()

' NRow keeps track of where to insert new rows in the destination workbook.
NRow = 1

'Count number of files in folder
'NB: Make shure there are no other files in the folder than FORNY-coded templates
NumberOfFiles = CountFilesInFolder(FolderPath)

'Loop over all files in folder
Do While NRow <= NumberOfFiles

   'Get filename
   FullFileName = GetFirmName(NRow, FolderPath)

   ' Open a workbook in the folder
   Set WorkBk = Workbooks.Open(FolderPath & FullFileName)

   ' Set the source range
   Set SourceRange1 = WorkBk.Worksheets(1).Range("B2")    'Firm
   Set SourceRange2 = WorkBk.Worksheets(1).Range("B3")
   Set SourceRange3 = WorkBk.Worksheets(1).Range("B4")
   Set SourceRange4 = WorkBk.Worksheets(1).Range("B7")     'Founding year
   Set SourceRange5 = WorkBk.Worksheets(1).Range("B8")
   Set SourceRange6 = WorkBk.Worksheets(1).Range("B9")
   Set SourceRange7 = WorkBk.Worksheets(1).Range("B10")      'Bio/pharma
   Set SourceRange8 = WorkBk.Worksheets(1).Range("B13")      'Acq
   Set SourceRange9 = WorkBk.Worksheets(1).Range("C13")
   Set SourceRange10 = WorkBk.Worksheets(1).Range("B14")   'Failure
```

```
    Set SourceRange11 = WorkBk.Worksheets(1).Range("C14")
    Set SourceRange12 = WorkBk.Worksheets(1).Range("B15")   'VC
    Set SourceRange13 = WorkBk.Worksheets(1).Range("C15")
    Set SourceRange14 = WorkBk.Worksheets(1).Range("B16")   'Revenue
    Set SourceRange15 = WorkBk.Worksheets(1).Range("C16")
    Set SourceRange16 = WorkBk.Worksheets(1).Range("B17")   'Result
    Set SourceRange17 = WorkBk.Worksheets(1).Range("C17")

    Set SourceRange21 = WorkBk.Worksheets(1).Range("A20:M20")   'AFP1
    Set SourceRange22 = WorkBk.Worksheets(1).Range("A21:M21")   'AFP2
    Set SourceRange23 = WorkBk.Worksheets(1).Range("A22:M22")   'AFP3
    Set SourceRange24 = WorkBk.Worksheets(1).Range("A23:M23")   'AFP4
    Set SourceRange25 = WorkBk.Worksheets(1).Range("A24:M24")   'AFP5
    Set SourceRange26 = WorkBk.Worksheets(1).Range("A25:M25")   'AFP6
    Set SourceRange27 = WorkBk.Worksheets(1).Range("A26:M26")   'AFP7
    Set SourceRange28 = WorkBk.Worksheets(1).Range("A27:M27")   'AFP8
    Set SourceRange29 = WorkBk.Worksheets(1).Range("A28:M28")   'AFP9
    Set SourceRange30 = WorkBk.Worksheets(1).Range("A29:M29")   'AFP10

    Set SourceRange31 = WorkBk.Worksheets(1).Range("A32:M32")   'AEP1
    Set SourceRange32 = WorkBk.Worksheets(1).Range("A33:M33")   'AEP2
    Set SourceRange33 = WorkBk.Worksheets(1).Range("A34:M34")   'AEP3
    Set SourceRange34 = WorkBk.Worksheets(1).Range("A35:M35")   'AEP4
    Set SourceRange35 = WorkBk.Worksheets(1).Range("A36:M36")   'AEP5
    Set SourceRange36 = WorkBk.Worksheets(1).Range("A37:M37")   'AEP6
    Set SourceRange37 = WorkBk.Worksheets(1).Range("A38:M38")   'AEP7
    Set SourceRange38 = WorkBk.Worksheets(1).Range("A39:M39")   'AEP8
    Set SourceRange39 = WorkBk.Worksheets(1).Range("A40:M40")   'AEP9
    Set SourceRange40 = WorkBk.Worksheets(1).Range("A41:M41")   'AEP10

    ' Set the destination range
    Set DestRange1 = ThisWorkbook.Worksheets(1).Range("A" & NRow + 1)   'Firm
    Set DestRange2 = ThisWorkbook.Worksheets(1).Range("B" & NRow + 1)
    Set DestRange3 = ThisWorkbook.Worksheets(1).Range("C" & NRow + 1)
    Set DestRange4 = ThisWorkbook.Worksheets(1).Range("D" & NRow + 1)
    Set DestRange5 = ThisWorkbook.Worksheets(1).Range("E" & NRow + 1)
    Set DestRange6 = ThisWorkbook.Worksheets(1).Range("F" & NRow + 1)
    Set DestRange7 = ThisWorkbook.Worksheets(1).Range("G" & NRow + 1)  'Bio/Pharma
    Set DestRange8 = ThisWorkbook.Worksheets(1).Range("H" & NRow + 1)
    Set DestRange9 = ThisWorkbook.Worksheets(1).Range("I" & NRow + 1)
    Set DestRange10 = ThisWorkbook.Worksheets(1).Range("J" & NRow + 1)
    Set DestRange11 = ThisWorkbook.Worksheets(1).Range("K" & NRow + 1)
    Set DestRange12 = ThisWorkbook.Worksheets(1).Range("L" & NRow + 1)
    Set DestRange13 = ThisWorkbook.Worksheets(1).Range("M" & NRow + 1)
    Set DestRange14 = ThisWorkbook.Worksheets(1).Range("N" & NRow + 1)
    Set DestRange15 = ThisWorkbook.Worksheets(1).Range("O" & NRow + 1)
    Set DestRange16 = ThisWorkbook.Worksheets(1).Range("P" & NRow + 1)
    Set DestRange17 = ThisWorkbook.Worksheets(1).Range("Q" & NRow + 1)

    Set DestRange21 = Summary.Range(Summary.Cells(NRow + 1, 18), Summary.Cells(NRow + 1, 30))      'AFP1
    Set DestRange22 = Summary.Range(Summary.Cells(NRow + 1, 31), Summary.Cells(NRow + 1, 43))
'AFP2
    Set DestRange23 = Summary.Range(Summary.Cells(NRow + 1, 44), Summary.Cells(NRow + 1, 56))
'AFP3
    Set DestRange24 = Summary.Range(Summary.Cells(NRow + 1, 57), Summary.Cells(NRow + 1, 69))
'AFP4
    Set DestRange25 = Summary.Range(Summary.Cells(NRow + 1, 70), Summary.Cells(NRow + 1, 82))
'AFP5
    Set DestRange26 = Summary.Range(Summary.Cells(NRow + 1, 83), Summary.Cells(NRow + 1, 95))
'AFP6
    Set DestRange27 = Summary.Range(Summary.Cells(NRow + 1, 96), Summary.Cells(NRow + 1, 108))
'AFP7
    Set DestRange28 = Summary.Range(Summary.Cells(NRow + 1, 109), Summary.Cells(NRow + 1, 121))
'AFP8
    Set DestRange29 = Summary.Range(Summary.Cells(NRow + 1, 122), Summary.Cells(NRow + 1, 134))
'AFP9
    Set DestRange30 = Summary.Range(Summary.Cells(NRow + 1, 135), Summary.Cells(NRow + 1, 147))
'AFP10
```

```
    Set DestRange31 = Summary.Range(Summary.Cells(NRow + 1, 148), Summary.Cells(NRow + 1, 160))
'AEP1
    Set DestRange32 = Summary.Range(Summary.Cells(NRow + 1, 161), Summary.Cells(NRow + 1, 173))
'AEP2
    Set DestRange33 = Summary.Range(Summary.Cells(NRow + 1, 174), Summary.Cells(NRow + 1, 186))
'AEP3
    Set DestRange34 = Summary.Range(Summary.Cells(NRow + 1, 187), Summary.Cells(NRow + 1, 199))
'AEP4
    Set DestRange35 = Summary.Range(Summary.Cells(NRow + 1, 200), Summary.Cells(NRow + 1, 212))
'AEP5
    Set DestRange36 = Summary.Range(Summary.Cells(NRow + 1, 213), Summary.Cells(NRow + 1, 225))
'AEP6
    Set DestRange37 = Summary.Range(Summary.Cells(NRow + 1, 226), Summary.Cells(NRow + 1, 238))
'AEP7
    Set DestRange38 = Summary.Range(Summary.Cells(NRow + 1, 239), Summary.Cells(NRow + 1, 251))
'AEP8
    Set DestRange39 = Summary.Range(Summary.Cells(NRow + 1, 252), Summary.Cells(NRow + 1, 264))
'AEP9
    Set DestRange40 = Summary.Range(Summary.Cells(NRow + 1, 265), Summary.Cells(NRow + 1, 277))
'AEP10

    ' Copy over the values from the source to the destination.
    DestRange1.Value = SourceRange1.Value   'Firm
    DestRange2.Value = SourceRange2.Value
    DestRange3.Value = SourceRange3.Value
    DestRange4.Value = SourceRange4.Value
    DestRange5.Value = SourceRange5.Value
    DestRange6.Value = SourceRange6.Value
    DestRange7.Value = SourceRange7.Value
    DestRange8.Value = SourceRange8.Value
    DestRange9.Value = SourceRange9.Value
    DestRange10.Value = SourceRange10.Value
    DestRange11.Value = SourceRange11.Value
    DestRange12.Value = SourceRange12.Value
    DestRange13.Value = SourceRange13.Value
    DestRange14.Value = SourceRange14.Value
    DestRange15.Value = SourceRange15.Value
    DestRange16.Value = SourceRange16.Value
    DestRange17.Value = SourceRange16.Value

    DestRange21.Value = SourceRange21.Value      'AFP1
    DestRange22.Value = SourceRange22.Value      'AFP2
    DestRange23.Value = SourceRange23.Value      'AFP3
    DestRange24.Value = SourceRange24.Value      'AFP4
    DestRange25.Value = SourceRange25.Value      'AFP5
    DestRange26.Value = SourceRange26.Value      'AFP6
    DestRange27.Value = SourceRange27.Value      'AFP7
    DestRange28.Value = SourceRange28.Value      'AFP8
    DestRange29.Value = SourceRange29.Value      'AFP9
    DestRange30.Value = SourceRange30.Value      'AFP10

    DestRange31.Value = SourceRange31.Value      'AEP1
    DestRange32.Value = SourceRange32.Value      'AEP2
    DestRange33.Value = SourceRange33.Value      'AEP3
    DestRange34.Value = SourceRange34.Value      'AEP4
    DestRange35.Value = SourceRange35.Value      'AEP5
    DestRange36.Value = SourceRange36.Value      'AEP6
    DestRange37.Value = SourceRange37.Value      'AEP7
    DestRange38.Value = SourceRange38.Value      'AEP8
    DestRange39.Value = SourceRange39.Value      'AEP9
    DestRange40.Value = SourceRange40.Value      'AEP10

    ' Increase NRow to move to next row and next file in folder
    NRow = NRow + 1

    ' Close the source workbook without saving changes.
    WorkBk.Close savechanges:=False
```

```
    Loop

    ' Call AutoFit on the destination sheet so that all data is readable.
    Sheet1.Columns.AutoFit

End Sub

Function GetFirmName(NumberInFolder As Integer, Folder As String) As String

        Dim ScriptToGetFirmName As String

        ScriptToGetFirmName = "Tell application ""Finder""" & Chr(13)
        ScriptToGetFirmName = ScriptToGetFirmName & "activate" & Chr(13)
        ScriptToGetFirmName = ScriptToGetFirmName & "get name of file " & NumberInFolder & " of alias " &
Chr(34) & Folder & Chr(34) & Chr(13)
        ScriptToGetFirmName = ScriptToGetFirmName & "end tell"

        GetFirmName = MacScript(ScriptToGetFirmName)

End Function


Function CountFilesInFolder(Folder As String) As Integer

Dim ScriptToCountFilesInFolder As String

ScriptToCountFilesInFolder = "Tell application ""Finder""" & Chr(13)
ScriptToCountFilesInFolder = ScriptToCountFilesInFolder & "activate" & Chr(13)
ScriptToCountFilesInFolder = ScriptToCountFilesInFolder & "count every file in alias " & Chr(34) & Folder &
Chr(34) & Chr(13)
ScriptToCountFilesInFolder = ScriptToCountFilesInFolder & "end tell"

CountFilesInFolder = MacScript(ScriptToCountFilesInFolder)

End Function

Function GetFolderPath() As String

Dim ScriptToGetFolderPath As String

ScriptToGetFolderPath = "Tell application ""Finder""" & Chr(13)
ScriptToGetFolderPath = ScriptToGetFolderPath & "set pathToMe to (choose file with prompt ""Select file in :"")"
& Chr(13)
ScriptToGetFolderPath = ScriptToGetFolderPath & "tell application ""Finder"" to return container of pathToMe
as text" & Chr(13)
ScriptToGetFolderPath = ScriptToGetFolderPath & "end tell"

GetFolderPath = MacScript(ScriptToGetFolderPath)

End Function

Sub XResetSheet()

ActiveWorkbook.Worksheets(1).Delete

Sheets.Add

End Sub
```

Appendix 4 – Variable overview

Descriptive statistics

Variable	SPSSname	N	Min.	Max.	Mean	Std.Dev.	Var.
Founding year	foundyear		1995	2004	2001.21	1.710	2.924
Years since founding	firmage		10	19	12.79	1.710	2.924
At founding		70					
Industrial	afSUMindustrial		0	5	1.00	1.116	1.246
Other ind.	afSUMother		0	4	1.19	1.094	1.197
Academic	afSUMacademic		0	5	1.10	1.144	1.309
Entrpreneurial	afSUMentr		0	2	.19	.460	.211
Senior mgmt..	afSUMsenior		0	4	.96	.999	.998
Sign. board	afSUMsignboard		0	3	.67	.775	.601
# of board members	afSUMboard		2	8	4.30	1.376	1.894
Mean board member age	afNEWFIRMage		22.8	59.3	45.477	6.7400	45.428
At event		70					
Industrial	aeSUMindustrial		0	4	1.07	1.220	1.488
Other ind.	aeSUMother		0	5	1.36	1.373	1.885
Academic	aeSUMacademic		0	8	.76	1.197	1.433
Entrpreneurial	aeSUMentr		0	3	.19	.546	.298
Senior mgmt..	aeSUMsenior		0	6	1.51	1.370	1.877
Sign. board	aeSUMsignboard		0	7	1.37	1.353	1.831
# of board members	aeSUMboard		2	9	3.80	1.593	2.539
Mean board member age	aeNEWFIRMage		25.5	70.7	51.239	7.9770	63.632

Appendix 5 - Logistic regression: af and ae

Logistic Regression

[DataSet1] /Users/eiriksolafischer/Google Drive/NTNU/2014/Masteroppgave/Forskning og design/SPSS/SPSS-filer/Hypothesis 1 /Dataset H1.sav

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	70	100.0
	Missing Cases	0	.0
	Total	70	100.0
Unselected Cases		0	.0
Total		70	100.0

a. If weight is in effect, see classification table for the total number of cases.

Dependent Variable Encoding

Original Value	Internal Value
0	0
1	1

Block 0: Beginning Block

Classification Table[a,b]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 0	success	0	49	0	100.0
		1	21	0	.0
	Overall Percentage				70.0

a. Constant is included in the model.

b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-.847	.261	10.553	1	.001	.429

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	firmage	1.327	1	.249
		software	.233	1	.630
		biopharma	4.709	1	.030
	Overall Statistics		6.466	3	.091

Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	7.321	3	.062
	Block	7.321	3	.062
	Model	7.321	3	.062

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	78.200[a]	.099	.141

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	8.907	8	.350

Contingency Table for Hosmer and Lemeshow Test

		success = 0		success = 1		
		Observed	Expected	Observed	Expected	Total
Step 1	1	7	7.437	1	.563	8
	2	7	7.130	1	.870	8
	3	3	4.764	3	1.236	6
	4	6	4.989	1	2.011	7
	5	6	4.013	0	1.987	6
	6	4	3.986	2	2.014	6
	7	7	6.169	3	3.831	10
	8	5	4.897	3	3.103	8
	9	3	3.354	3	2.646	6
	10	1	2.261	4	2.739	5

Classification Table[a]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 1	success	0	49	0	100.0
		1	19	2	9.5
	Overall Percentage				72.9

a. The cut value is .500

Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	firmage	.226	.165	1.875	1	.171	1.254	.907	1.733
	software	.020	.563	.001	1	.971	1.020	.339	3.073
	biopharma	-1.747	.835	4.376	1	.036	.174	.034	.896
	Constant	-3.416	2.175	2.468	1	.116	.033		

a. Variable(s) entered on step 1: firmage, software, biopharma.

Correlation Matrix

		Constant	firmage	software	biopharma
Step 1	Constant	1.000	-.984	-.215	.096
	firmage	-.984	1.000	.098	-.165
	software	-.215	.098	1.000	.139
	biopharma	.096	-.165	.139	1.000

Block 2: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	14.761	3	.002
	Block	14.761	3	.002
	Model	22.081	6	.001

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	63.440[a]	.271	.384

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	6.363	8	.607

Contingency Table for Hosmer and Lemeshow Test

		success = 0		success = 1		
		Observed	Expected	Observed	Expected	Total
Step 1	1	7	6.830	0	.170	7
	2	7	6.449	0	.551	7
	3	6	7.143	2	.857	8
	4	5	5.993	2	1.007	7
	5	6	5.627	1	1.373	7
	6	6	5.023	1	1.977	7
	7	5	4.554	2	2.446	7
	8	3	3.726	4	3.274	7
	9	4	2.924	3	4.076	7
	10	0	.732	6	5.268	6

Classification Table[a]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 1	success	0	43	6	87.8
		1	11	10	47.6
	Overall Percentage				75.7

a. The cut value is .500

Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	firmage	.201	.190	1.120	1	.290	1.223	.842	1.775
	software	-.501	.686	.534	1	.465	.606	.158	2.323
	biopharma	-2.330	.934	6.218	1	.013	.097	.016	.607
	afSUMentr	1.897	1.093	3.011	1	.083	6.668	.782	56.841
	afSUMsenior	1.134	.443	6.559	1	.010	3.107	1.305	7.399
	afSUMsignboard	-1.490	.673	4.908	1	.027	.225	.060	.842
	Constant	-3.279	2.528	1.683	1	.195	.038		

a. Variable(s) entered on step 1: afSUMentr, afSUMsenior, afSUMsignboard.

Correlation Matrix

		Constant	firmage	software	biopharma	afSUMentr	afSUMsenior	afSUMsignboard
Step 1	Constant	1.000	-.979	-.153	.050	.038	-.121	-.024
	firmage	-.979	1.000	.063	-.116	-.014	.067	.002
	software	-.153	.063	1.000	.221	-.213	-.100	-.041
	biopharma	.050	-.116	.221	1.000	-.250	-.278	.271
	afSUMentr	.038	-.014	-.213	-.250	1.000	.169	-.455
	afSUMsenior	-.121	.067	-.100	-.278	.169	1.000	-.664
	afSUMsignboard	-.024	.002	-.041	.271	-.455	-.664	1.000

Block 3: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	3.281	3	.350
	Block	3.281	3	.350
	Model	25.362	9	.003

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	60.159[a]	.304	.431

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	14.634	8	.067

Contingency Table for Hosmer and Lemeshow Test

		success = 0		success = 1		
		Observed	Expected	Observed	Expected	Total
Step 1	1	7	6.892	0	.108	7
	2	7	6.667	0	.333	7
	3	6	6.267	1	.733	7
	4	7	5.943	0	1.057	7
	5	5	5.665	2	1.335	7
	6	6	5.385	1	1.615	7
	7	2	4.760	5	2.240	7
	8	3	3.863	4	3.137	7
	9	6	2.847	1	4.153	7
	10	0	.710	7	6.290	7

Classification Table[a]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 1	success	0	43	6	87.8
		1	12	9	42.9
	Overall Percentage				74.3

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	firmage	.225	.209	1.160	1	.281	1.252	.832	1.886
	software	-.324	.715	.206	1	.650	.723	.178	2.937
	biopharma	-2.298	1.017	5.105	1	.024	.100	.014	.738
	afSUMentr	2.293	1.217	3.549	1	.060	9.902	.911	107.565
	afSUMsenior	1.350	.617	4.792	1	.029	3.857	1.152	12.918
	afSUMsignboard	-1.566	.689	5.164	1	.023	.209	.054	.806
	afSUMacademic	-.553	.328	2.839	1	.092	.575	.302	1.094
	afSUMindustrial	.023	.403	.003	1	.954	1.024	.465	2.255
	afSUMother	-.108	.391	.076	1	.782	.898	.417	1.930
	Constant	-3.223	2.843	1.285	1	.257	.040		

a. Variable(s) entered on step 1: afSUMacademic, afSUMindustrial, afSUMother.

Correlation Matrix

		Constant	firmage	software	biopharma	afSUMentr	afSUMsenior	afSUMsignboard
Step 1	Constant	1.000	-.977	-.182	.062	-.054	.151	-.062
	firmage	-.977	1.000	.108	-.131	.084	-.130	.026
	software	-.182	.108	1.000	.183	-.160	.006	-.088
	biopharma	.062	-.131	.183	1.000	-.273	-.300	.311
	afSUMentr	-.054	.084	-.160	-.273	1.000	.144	-.485
	afSUMsenior	.151	-.130	.006	-.300	.144	1.000	-.562
	afSUMsignboard	-.062	.026	-.088	.311	-.485	-.562	1.000
	afSUMacademic	.011	-.084	-.117	.040	-.177	-.292	.092
	afSUMindustrial	-.354	.312	.113	.030	.180	-.295	-.065
	afSUMother	-.181	.127	-.144	.089	-.069	-.536	.216

Correlation Matrix

		afSUMacademic	afSUMindustrial	afSUMother
Step 1	Constant	.011	-.354	-.181
	firmage	-.084	.312	.127
	software	-.117	.113	-.144
	biopharma	.040	.030	.089
	afSUMentr	-.177	.180	-.069
	afSUMsenior	-.292	-.295	-.536
	afSUMsignboard	.092	-.065	.216
	afSUMacademic	1.000	.034	.182
	afSUMindustrial	.034	1.000	-.146
	afSUMother	.182	-.146	1.000

Block 4: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	.628	2	.730
	Block	.628	2	.730
	Model	25.990	11	.007

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	59.531[a]	.310	.440

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	8.015	8	.432

Contingency Table for Hosmer and Lemeshow Test

		success = 0		success = 1		
		Observed	Expected	Observed	Expected	Total
Step 1	1	7	6.889	0	.111	7
	2	7	6.646	0	.354	7
	3	6	6.280	1	.720	7
	4	6	6.092	1	.908	7
	5	7	5.758	0	1.242	7
	6	5	5.392	2	1.608	7
	7	3	4.758	4	2.242	7
	8	3	3.629	4	3.371	7
	9	5	2.853	2	4.147	7
	10	0	.703	7	6.297	7

Classification Table[a]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 1	success	0	42	7	85.7
		1	11	10	47.6
	Overall Percentage				74.3

a. The cut value is .500

Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	firmage	.227	.214	1.123	1	.289	1.255	.825	1.910
	software	-.408	.754	.292	1	.589	.665	.152	2.917
	biopharma	-2.239	1.047	4.572	1	.033	.107	.014	.830
	afSUMentr	2.399	1.265	3.597	1	.058	11.015	.923	131.460
	afSUMsenior	1.271	.631	4.059	1	.044	3.566	1.035	12.286
	afSUMsignboard	-1.391	.728	3.654	1	.056	.249	.060	1.036
	afSUMacademic	-.475	.342	1.934	1	.164	.622	.318	1.215
	afSUMindustrial	.043	.439	.010	1	.922	1.044	.441	2.468
	afSUMother	-.086	.414	.043	1	.836	.918	.408	2.066
	afNEWFIRMage	-.040	.052	.606	1	.436	.960	.867	1.063
	afSUMboard	-.067	.354	.036	1	.850	.935	.467	1.873
	Constant	-1.284	3.743	.118	1	.732	.277		

a. Variable(s) entered on step 1: afNEWFIRMage, afSUMboard.

Correlation Matrix

		Constant	firmage	software	biopharma	afSUMentr	afSUMsenior	afSUMsignboard
Step 1	Constant	1.000	-.698	-.179	.049	.046	.024	.125
	firmage	-.698	1.000	.093	-.168	.114	-.179	.083
	software	-.179	.093	1.000	.130	-.154	-.021	-.086
	biopharma	.049	-.168	.130	1.000	-.302	-.214	.250
	afSUMentr	.046	.114	-.154	-.302	1.000	.105	-.420
	afSUMsenior	.024	-.179	-.021	-.214	.105	1.000	-.582
	afSUMsignboard	.125	.083	-.086	.250	-.420	-.582	1.000
	afSUMacademic	.189	-.032	-.129	-.006	-.117	-.308	.177
	afSUMindustrial	-.157	.322	.188	-.074	.207	-.350	.002
	afSUMother	-.074	.203	-.076	-.024	-.019	-.553	.250
	afNEWFIRMage	-.613	-.025	.188	-.068	-.121	.104	-.265
	afSUMboard	-.251	-.158	-.202	.237	-.125	.214	-.182

Correlation Matrix

		afSUMacademic	afSUMindustrial	afSUMother	afNEWFIRMage	afSUMboard
Step 1	Constant	.189	-.157	-.074	-.613	-.251
	firmage	-.032	.322	.203	-.025	-.158
	software	-.129	.188	-.076	.188	-.202
	biopharma	-.006	-.074	-.024	-.068	.237
	afSUMentr	-.117	.207	-.019	-.121	-.125
	afSUMsenior	-.308	-.350	-.553	.104	.214
	afSUMsignboard	.177	.002	.250	-.265	-.182
	afSUMacademic	1.000	.080	.237	-.264	-.195
	afSUMindustrial	.080	1.000	.002	-.002	-.392
	afSUMother	.237	.002	1.000	-.040	-.327
	afNEWFIRMage	-.264	-.002	-.040	1.000	.114
	afSUMboard	-.195	-.392	-.327	.114	1.000

```
LOGISTIC REGRESSION VARIABLES success
  /METHOD=ENTER firmage software biopharma /*Control variables
  /METHOD=ENTER aeSUMentr aeSUMsenior aeSUMsignboard /*High level network
  /METHOD=ENTER aeSUMacademic aeSUMindustrial aeSUMother /* Profession related network
  /METHOD=ENTER aeNEWFIRMage aeSUMboard /*Board specifics
  /PRINT=GOODFIT CORR CI(95)
  /CRITERIA=PIN(0.05) POUT(0.10) ITERATE(20) CUT(0.5).
```

Logistic Regression

```
[DataSet1] /Users/eiriksolafischer/Google Drive/NTNU/2014/Masteroppgave/Forskning og design/
SPSS/SPSS-filer/Hypothesis 1 /Dataset H1.sav
```

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	70	100.0
	Missing Cases	0	.0
	Total	70	100.0
Unselected Cases		0	.0
Total		70	100.0

a. If weight is in effect, see classification table for the total number of cases.

Dependent Variable Encoding

Original Value	Internal Value
0	0
1	1

Block 0: Beginning Block

Classification Table[a,b]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 0	success	0	49	0	100.0
		1	21	0	.0
	Overall Percentage				70.0

a. Constant is included in the model.

b. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-.847	.261	10.553	1	.001	.429

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	firmage	1.327	1	.249
		software	.233	1	.630
		biopharma	4.709	1	.030
	Overall Statistics		6.466	3	.091

Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	7.321	3	.062
	Block	7.321	3	.062
	Model	7.321	3	.062

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	78.200[a]	.099	.141

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	8.907	8	.350

Contingency Table for Hosmer and Lemeshow Test

		success = 0		success = 1		
		Observed	Expected	Observed	Expected	Total
Step 1	1	7	7.437	1	.563	8
	2	7	7.130	1	.870	8
	3	3	4.764	3	1.236	6
	4	6	4.989	1	2.011	7
	5	6	4.013	0	1.987	6
	6	4	3.986	2	2.014	6
	7	7	6.169	3	3.831	10
	8	5	4.897	3	3.103	8
	9	3	3.354	3	2.646	6
	10	1	2.261	4	2.739	5

Classification Table[a]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 1	success	0	49	0	100.0
		1	19	2	9.5
	Overall Percentage				72.9

a. The cut value is .500

Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	firmage	.226	.165	1.875	1	.171	1.254	.907	1.733
	software	.020	.563	.001	1	.971	1.020	.339	3.073
	biopharma	-1.747	.835	4.376	1	.036	.174	.034	.896
	Constant	-3.416	2.175	2.468	1	.116	.033		

a. Variable(s) entered on step 1: firmage, software, biopharma.

Correlation Matrix

		Constant	firmage	software	biopharma
Step 1	Constant	1.000	-.984	-.215	.096
	firmage	-.984	1.000	.098	-.165
	software	-.215	.098	1.000	.139
	biopharma	.096	-.165	.139	1.000

Block 2: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	22.287	3	.000
	Block	22.287	3	.000
	Model	29.608	6	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	55.913[a]	.345	.489

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	2.237	8	.973

Contingency Table for Hosmer and Lemeshow Test

		success = 0		success = 1		
		Observed	Expected	Observed	Expected	Total
Step 1	1	7	6.892	0	.108	7
	2	7	6.780	0	.220	7
	3	7	7.378	1	.622	8
	4	6	6.252	1	.748	7
	5	6	5.739	1	1.261	7
	6	6	5.284	1	1.716	7
	7	4	5.105	4	2.895	8
	8	4	3.651	3	3.349	7
	9	2	1.662	5	5.338	7
	10	0	.258	5	4.742	5

Classification Table[a]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 1	success	0	45	4	91.8
		1	11	10	47.6
	Overall Percentage				78.6

a. The cut value is .500

Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	firmage	.405	.244	2.760	1	.097	1.499	.930	2.417
	software	-1.010	.786	1.650	1	.199	.364	.078	1.701
	biopharma	-2.249	.998	5.076	1	.024	.105	.015	.746
	aeSUMentr	-.510	.908	.316	1	.574	.600	.101	3.557
	aeSUMsenior	1.279	.428	8.931	1	.003	3.592	1.553	8.309
	aeSUMsignboard	.127	.315	.162	1	.687	1.135	.612	2.104
	Constant	-7.458	3.319	5.049	1	.025	.001		

a. Variable(s) entered on step 1: aeSUMentr, aeSUMsenior, aeSUMsignboard.

Correlation Matrix

		Constant	firmage	software	biopharma	aeSUMentr	aeSUMsenior	aeSUMsignboard
Step 1	Constant	1.000	-.980	.093	.271	.078	-.437	-.015
	firmage	-.980	1.000	-.123	-.298	-.059	.347	-.025
	software	.093	-.123	1.000	.183	.324	-.367	-.055
	biopharma	.271	-.298	.183	1.000	-.151	-.181	-.083
	aeSUMentr	.078	-.059	.324	-.151	1.000	-.425	.025
	aeSUMsenior	-.437	.347	-.367	-.181	-.425	1.000	-.399
	aeSUMsignboard	-.015	-.025	-.055	-.083	.025	-.399	1.000

Block 3: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	8.015	3	.046
	Block	8.015	3	.046
	Model	37.623	9	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	47.898[a]	.416	.590

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	6.435	8	.599

Contingency Table for Hosmer and Lemeshow Test

		success = 0		success = 1		
		Observed	Expected	Observed	Expected	Total
Step 1	1	7	6.974	0	.026	7
	2	7	6.902	0	.098	7
	3	6	6.712	1	.288	7
	4	6	6.449	1	.551	7
	5	7	6.167	0	.833	7
	6	5	5.727	2	1.273	7
	7	5	4.631	2	2.369	7
	8	5	3.283	2	3.717	7
	9	1	1.835	6	5.165	7
	10	0	.320	7	6.680	7

Classification Table[a]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 1	success	0	46	3	93.9
		1	6	15	71.4
	Overall Percentage				87.1

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	firmage	.724	.307	5.576	1	.018	2.063	1.131	3.763
	software	-1.474	.927	2.530	1	.112	.229	.037	1.408
	biopharma	-3.042	1.206	6.362	1	.012	.048	.004	.508
	aeSUMentr	-1.256	1.191	1.112	1	.292	.285	.028	2.939
	aeSUMsenior	1.124	.540	4.329	1	.037	3.078	1.067	8.879
	aeSUMsignboard	.062	.392	.025	1	.874	1.064	.494	2.293
	aeSUMacademic	-.614	.409	2.250	1	.134	.541	.243	1.207
	aeSUMindustrial	.903	.457	3.898	1	.048	2.466	1.007	6.043
	aeSUMother	.252	.371	.461	1	.497	1.287	.621	2.665
	Constant	-11.775	4.308	7.472	1	.006	.000		

a. Variable(s) entered on step 1: aeSUMacademic, aeSUMindustrial, aeSUMother.

Correlation Matrix

		Constant	firmage	software	biopharma	aeSUMentr	aeSUMsenior	aeSUMsignboard
Step 1	Constant	1.000	-.985	.282	.494	.381	-.331	-.053
	firmage	-.985	1.000	-.296	-.511	-.356	.292	.019
	software	.282	-.296	1.000	.263	.404	-.310	-.132
	biopharma	.494	-.511	.263	1.000	.193	-.239	-.048
	aeSUMentr	.381	-.356	.404	.193	1.000	-.361	-.061
	aeSUMsenior	-.331	.292	-.310	-.239	-.361	1.000	-.234
	aeSUMsignboard	-.053	.019	-.132	-.048	-.061	-.234	1.000
	aeSUMacademic	.115	-.152	.035	.107	.076	-.086	.158
	aeSUMindustrial	-.545	.518	-.428	-.359	-.433	-.091	.154
	aeSUMother	-.122	.103	.104	-.040	-.023	-.366	-.389

Correlation Matrix

		aeSUMacademic	aeSUMindustrial	aeSUMother
Step 1	Constant	.115	-.545	-.122
	firmage	-.152	.518	.103
	software	.035	-.428	.104
	biopharma	.107	-.359	-.040
	aeSUMentr	.076	-.433	-.023
	aeSUMsenior	-.086	-.091	-.366
	aeSUMsignboard	.158	.154	-.389
	aeSUMacademic	1.000	-.158	-.146
	aeSUMindustrial	-.158	1.000	.148
	aeSUMother	-.146	.148	1.000

Block 4: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	.292	2	.864
	Block	.292	2	.864
	Model	37.915	11	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	47.606[a]	.418	.593

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	5.225	8	.733

Contingency Table for Hosmer and Lemeshow Test

		success = 0		success = 1		
		Observed	Expected	Observed	Expected	Total
Step 1	1	7	6.975	0	.025	7
	2	7	6.912	0	.088	7
	3	6	6.715	1	.285	7
	4	6	6.479	1	.521	7
	5	6	6.178	1	.822	7
	6	7	5.687	0	1.313	7
	7	5	4.580	2	2.420	7
	8	4	3.386	3	3.614	7
	9	1	1.789	6	5.211	7
	10	0	.300	7	6.700	7

Classification Table[a]

			Predicted		
			success		Percentage Correct
	Observed		0	1	
Step 1	success	0	46	3	93.9
		1	6	15	71.4
	Overall Percentage				87.1

a. The cut value is .500

Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	firmage	.725	.312	5.417	1	.020	2.065	1.121	3.804
	software	-1.449	.945	2.353	1	.125	.235	.037	1.496
	biopharma	-3.016	1.229	6.019	1	.014	.049	.004	.545
	aeSUMentr	-1.247	1.242	1.008	1	.315	.287	.025	3.280
	aeSUMsenior	1.106	.569	3.772	1	.052	3.022	.990	9.224
	aeSUMsignboard	.152	.455	.112	1	.738	1.164	.477	2.841
	aeSUMacademic	-.568	.431	1.736	1	.188	.567	.243	1.319
	aeSUMindustrial	.921	.486	3.596	1	.058	2.512	.970	6.507
	aeSUMother	.210	.395	.282	1	.595	1.233	.569	2.674
	aeNEWFIRMage	-.027	.054	.245	1	.620	.974	.876	1.082
	aeSUMboard	-.013	.386	.001	1	.973	.987	.463	2.103
	Constant	-10.489	4.943	4.503	1	.034	.000		

a. Variable(s) entered on step 1: aeNEWFIRMage, aeSUMboard.

Correlation Matrix

		Constant	firmage	software	biopharma	aeSUMentr	aeSUMsenior	aeSUMsignboard
Step 1	Constant	1.000	-.862	.292	.453	.357	-.352	.073
	firmage	-.862	1.000	-.308	-.511	-.365	.322	.078
	software	.292	-.308	1.000	.315	.426	-.343	-.158
	biopharma	.453	-.511	.315	1.000	.212	-.313	-.125
	aeSUMentr	.357	-.365	.426	.212	1.000	-.374	-.113
	aeSUMsenior	-.352	.322	-.343	-.313	-.374	1.000	-.117
	aeSUMsignboard	.073	.078	-.158	-.125	-.113	-.117	1.000
	aeSUMacademic	.133	-.098	-.018	.029	.027	-.008	.265
	aeSUMindustrial	-.450	.520	-.448	-.379	-.467	-.009	.279
	aeSUMother	-.215	.109	.025	-.061	-.106	-.235	-.328
	aeNEWFIRMage	-.475	.017	-.125	-.087	-.086	.165	-.227
	aeSUMboard	.122	-.123	.200	.206	.204	-.303	-.329

Correlation Matrix

		aeSUMacademic	aeSUMindustrial	aeSUMother	aeNEWFIRMage	aeSUMboard
Step 1	Constant	.133	-.450	-.215	-.475	.122
	firmage	-.098	.520	.109	.017	-.123
	software	-.018	-.448	.025	-.125	.200
	biopharma	.029	-.379	-.061	-.087	.206
	aeSUMentr	.027	-.467	-.106	-.086	.204
	aeSUMsenior	-.008	-.009	-.235	.165	-.303
	aeSUMsignboard	.265	.279	-.328	-.227	-.329
	aeSUMacademic	1.000	-.047	-.112	-.063	-.258
	aeSUMindustrial	-.047	1.000	.189	.023	-.304
	aeSUMother	-.112	.189	1.000	.270	-.234
	aeNEWFIRMage	-.063	.023	.270	1.000	-.334
	aeSUMboard	-.258	-.304	-.234	-.334	1.000