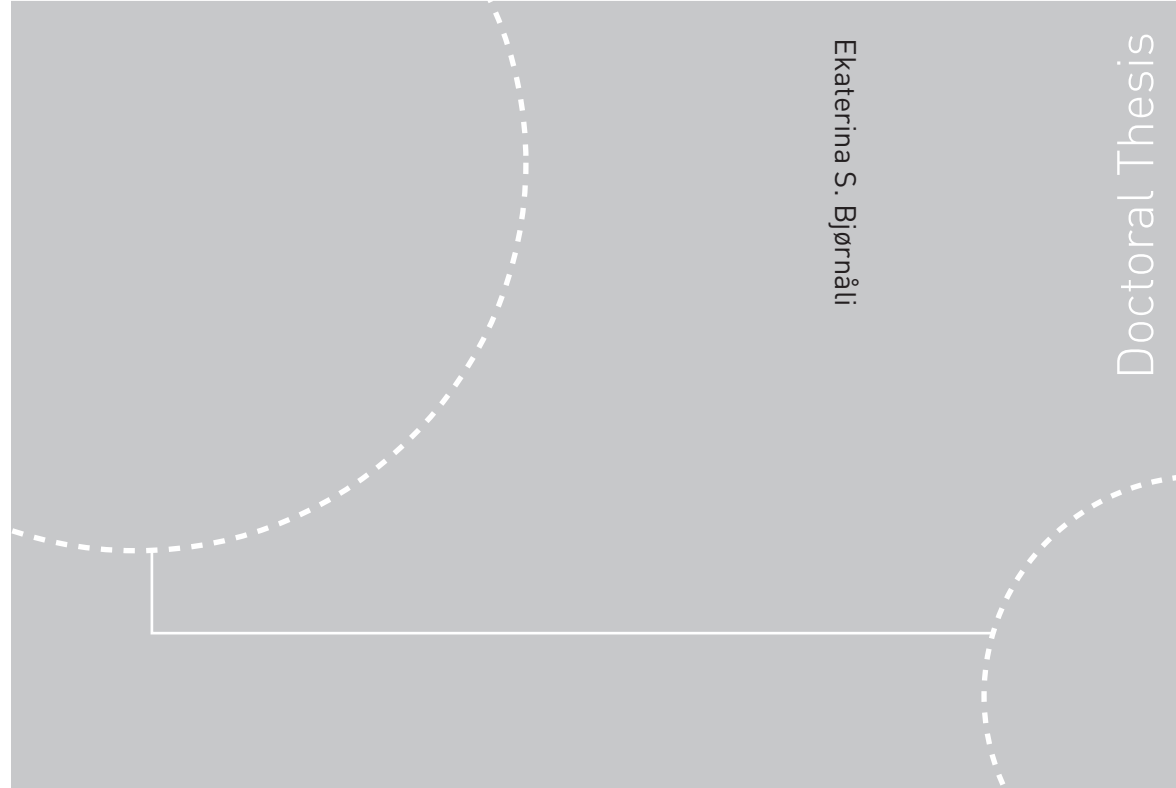


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Ekaterina S. Bjørnåli
**Board of Directors, Top Management
Team and the Development
of Academic Spin-Off Companies**

Ekaterina S. Bjørnåli

Board of Directors, Top
Management
Team and the Development
of Academic Spin-Off Companies

Thesis for the degree of philosophiae doctor

Trondheim, November 2009

Norwegian University of
Science and Technology
Faculty of Social Sciences and Technology Management
Department of Industrial Economics and Technology
Management



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Thesis for the degree of doctor philosophiae

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Science and Technology

Preface / Acknowledgements

The story behind this dissertation dates back to the spring of 2005 when I accepted the offer to work as a PhD scholar at the Sør-Trøndelag University College (HiST). From that day on it was determined that I was going to pursue an academic career. Since the start of the PhD period there were lots of choices I had to make which I, looking back, am happy with. One of the preconditions was doing research on academic entrepreneurship, which I still find to be an exciting research area.

After I was accepted to the PhD program at the Norwegian University of Science and Technology (NTNU), Department of Industrial Economics and Technology Management, it took me a while to formulate my research proposal and the research questions which I was to pursue. Here, I would like to thank people involved in the Doctoral Track on Entrepreneurship and Innovation organized by EIASM who have guided me throughout this process, given me valuable advice and motivated me to pursue case studies. I am grateful to the sponsors, HiST and NTNU, which have made the travelling possible. Through this track I made friends who I looked forward to meet at various entrepreneurship conferences. I also wish to thank the Research Council of Norway for sponsoring my stay at Stanford University, California USA where I was a part of a SCANCOR program and have met many people whom I owe much thanks for their help, tips and advice. My research has gradually taken a direction towards quantitative studies, and I got inspired to conduct a comprehensive survey among academic spin-offs back in Norway.

I owe a great deal of thanks to many people who have offered powerful encouragement throughout the process. Three people deserve special mention. My chief supervisor, Truls Erikson has provided academic advice, professional mentoring, dispersal ideas, on-going optimism and fruitful partnership. My loving husband, Ove, has been very supportive and patient allowing me the freedom to pursue this degree, which on many occasions, happened in my spare time. My dear mother has tried to do her best to understand what I am doing and provide support. Finally, thanks to my co-supervisor, my female colleagues at HiST (who are a closely-knit minority group at our department) and my colleagues at NTNU (you know who you are) for being encouraging and proud of my achievements.

Ekaterina S. Bjørnåli

Trondheim, September, 2009

Abstract

This dissertation addresses the under-studied area of the role of the top management team (TMT) and board of directors in the development of academic spin-off companies (ASOs) originating from public research institutes. ASO research receives growing attention internationally following the rise in commercialization activities in the vast majority of universities. The studies identify the barriers to and facilitators of ASO formation and growth, which are related to faculty attributes and incentives, university technology transfer policies and practices, and the external environment. Few studies examine the founding team demonstrating that it evolves in to a TMT and board during legal incorporation and that the TMT heterogeneity has significant performance consequences. Even fewer studies investigate the board in ASOs. This is surprising since well-networked outside directors may contribute to ASO development by increasing a firm's legitimacy and thus reducing liabilities of newness and providing access to critical external resources that young ASOs need to survive.

In this dissertation I therefore contribute by addressing this research gap and I explore the board formation and changes in board composition and try to relate these changes to the development stages of an ASO. Given limited prior research on board dynamics I employ an inductive multiple case research design. I also examine the role of the board in accessing needed external managerial resources and how the board and TMT themselves can be valuable resources that help an ASO to achieve the important entrepreneurial milestone of acquiring venture capital. For these studies the data on 135 ASOs in Norway are collected and analyzed using logistic regression.

I find that the dynamics of the development stages in an ASO is related to the dynamics of its board. In successful ASOs the board contribution is dynamic. The board chair's social networks seem to be essential when attracting key members to the board of an ASO. Key board members bring in needed resources that the TMT lacks, ranging from finance and industry experience in earlier stages to executive and marketing/sales experience in later development stages. Thus, they help an ASO to prove a venture's viability and approach a stage of sustainable returns. Board size and networking appear to be important when recruiting new TMT members with necessary competences who open for new growth opportunities. ASOs that have value adding boards and TMT members with diverse functional and industry backgrounds succeed in recruiting new team members and acquiring venture capital. The likelihood of attracting venture capital increases if ASOs have previously managed to receive seed capital and support from industrial partners.

Sammendrag

Denne avhandlingen utforsker hvilken rolle ledelse og styre spiller i utviklingen av akademiske spin-off bedrifter (ASO). Forskning på etablering av teknologibaserte bedrifter fra universiteter, dvs. ASO bedrifter, får økende internasjonal oppmerksomhet ettersom kommersialiseringsaktiviteter øker ved de aller fleste universiteter. Studier identifiserer faktorer som hemmer og fremmer ASO formasjon og vekst, for eksempel karakteristika ved fakultetet og insentiver, universitetenes teknologioverførings politikk og praksis, og eksternt miljø. Få studier har sett på etableringsteam og vist at det utvikler seg til lederteam og styre under bedriftens juridiske oppstart, og at lederteamets sammensetning har viktige konsekvenser for bedriftens prestasjonsevne. Færre studier har sett på styret i ASO bedrifter. Dette er overraskende fordi eksterne styremedlemmer med et godt nettverk kan bidra til utvikling av en ASO ved å øke bedriftens legitimitet og skaffe tilgang til kritiske eksterne ressurser som unge ASO bedrifter trenger for å overleve.

Avhandlingens bidrag er derfor å utforske hvordan styrets sammensetning dannes / endres og prøve å sette disse endringene i sammenheng med en ASO utvikling. Fordi tidligere forskning på styredynamikk er begrenset er multiple caseer brukt som forskningsdesign. Videre undersøkes styrets rolle i anskaffelsen av nødvendige eksterne ledelsesressurser og hvordan styret / ledelsesteam selv kan være betydningsfulle ressurser som hjelper ASO til å oppnå en viktig milepæl - venture kapital finansiering. For disse studiene ble det samlet inn data fra 135 norske ASO bedrifter og disse ble analysert ved hjelp av logistisk regresjon.

Funnene i studiene viser at dynamikken i de forskjellige utviklingsfaser som ASO går igjennom henger sammen med dynamikken i styret. Styrets bidrag er dynamisk i vellykkete ASO bedrifter. Styrelederens sosiale nettverk synes å være vesentlig når det gjelder det å finne nye styremedlemmer. Nøkkelpersoner i styret tilfører ressurser som lederteamet mangler og som varierer fra finansiell og industriell erfaring i tidligere faser til ledelses og markedsføring / salgs erfaring i senere utviklingsfaser. Slik hjelper eksterne styremedlemmer bedriften til å styrke sin levedyktighet og nærmer seg da neste fase hvor avkastningen gjerne stabiliserer seg. Styrets størrelse og nettverksbygging fremgår som viktige faktorer når det gjelder det å rekruttere nye medlemmer til lederteamet med nødvendig kompetanse som åpner opp for nye vekstmuligheter. ASO bedrifter som har bidragsytende styre og lederteammedlemmer med variert funksjonell og industriell bakgrunn lykkes med å rekruttere nye teammedlemmer og anskaffe venture kapital. Samtidig øker sannsynligheten for å skaffe venture kapital hvis ASO bedriften tidligere har lyktes med å skaffe finansiell støtte fra såkornfond og industrielle partnere.

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INTRODUCTION

This dissertation relates to the development of academic spin-off firms (ASOs). ASOs are high-tech new firms founded by employees in a public research organization such as a university or research institute, around a technology which had initially been developed at the public research organization (Birley 2002). Academic entrepreneurship and, in particular, research on ASOs is a new research area, which receives growing attention internationally (Shane 2004; Wright et al. 2007a). This may be attributed to the rise in commercial activity and spin-off creation that has recently occurred in the majority of universities (Lockett et al. 2005). Governments increasingly recognise the need to support the process of technological change with the aim of spawning more high-growth knowledge-intensive companies from university research, which are important generators of national growth and societal development (O'Shea et al. 2004; Wright et al. 2004; Lindholm-Dahlstrand and Klofsten 2002). The importance of the topic is also reflected in the increasing spin-off literature, which various researchers have tried to systematize (Autio 2000; O'Shea et al. 2004; Siegel and Phan 2005; Rothaermel et al. 2007; Djokovic and Souitaris 2008).

The research focusing on spin-off creation has tried to identify the barriers to and success factors behind spin-off formation and growth (Rothaermel et al. 2007). The barriers to spin-off creation include informational gaps, lack of competence in founding teams, inadequate funding, lack of structural support, unsupportive university culture, and clash of culture between industry and academia (e.g. Steffensen et al. 2000; Franklin et al. 2001). Among success factors are benefits associated with university involvement in spin-off formation, university policies on intellectual property strategy, networking activities of ASOs, and resource endowments (e.g. Di Gregorio and Shane 2003; Lockett et al. 2003). The success behind new ASO venture creation is attributed to the quality of human resources (i.e. faculty, TTO personnel, founding team), technology endowment, and funding from university, industry, and venture capitalists (e.g. Shane and Stuart 2002; O'Shea et al. 2005).

The research that tries to explain a successful spin-off development on the team level is limited. These studies demonstrate the importance of team heterogeneity (e.g. Ensley and Hmieleski 2005; Vanaelst et al. 2006). Also, the exploration of the board as a locus of analysis when explaining early performance differentials is an under-studied area. This may be attributed to the focus on new firm creation and the university-related factors (e.g. universities' and TTO policies and practices, faculty characteristics) rather than the development of ASO companies after their legal establishment and the success factors outside

their research environment. Hence, in an attempt to address this research gap, I explore the development of ASO companies along two group dimensions: team and board of directors. Team and board in ASOs are curious research objects because the origin of ASOs coming from public research institutes has an impact on the ASO's founding team (Clarysse and Moray 2004) and initial board composition (Vanaelst et al. 2006). Furthermore, ASOs are new ventures in transition, which go through several stages of activity (Vohora et al. 2004), and need to build and develop a team (Ensley and Hmieleski 2005) and board structure and processes (Filatotchev et al. 2006) if they are to succeed.

The development of an ASO may be seen as resource-driven (Penrose 1959; Feldman and Klofsten 2000). Technology is one important growth-driving resource (Autio 2000). Due to an ASO's origin, technology and tacit knowledge around the technology held by the scientist-entrepreneur is a core resource. The fact that a new ASO venture is established around a new research-based product or service implies complexity. This complexity requires more skills than one founder is likely to have, and is therefore most likely responded to by the formation of a team of entrepreneurs, instead of one sole entrepreneur (Gartner 1985). However, started by scientist-entrepreneurs around a core technological innovation, ASOs often have human capital that is technological in nature. An ASO team is, therefore, unbalanced lacking necessary complementary commercial expertise and networks and need to be developed if an ASO is to continue growing (Ensley and Hmieleski 2005; Wright et al. 2007a).

ASOs are often highly innovative and introduce products and services, which are new and unique in the market internationally (Heirman and Clarysse 2006). This uniqueness adds to existing complexity and implies that an ASO team must learn to manage a firm that is itself new while simultaneously learning to manage a firm that is also different and unique (Ensley et al. 2002). The resulting ambiguity produces liabilities, which are absent in more established firms and labelled the liabilities of newness (Stinchcombe 1965). The liabilities of newness derive from the fact that new ventures are unfamiliar and without precedent. Consequently, ASO teams must learn to rely largely upon themselves for information and for the generation of ideas and solutions. If ASOs are to survive, they must quickly overcome these liabilities by establishing the firm's legitimacy and reduced uncertainty (Singh et al. 1986). This means that ASO teams must in practice learn to run a new firm, cope with a new environment and deal with new stakeholders while utilizing unfamiliar social networks (Ensley et al. 2002). All this must be done quickly in pace with the changes in the external environment and with minimal losses in efficiency and motivation. Thus, the ability to produce novel, off-hand

solutions and to adapt quickly to the external environment is an important attribute of high performing team (Ensley et al. 2002; Wright et al. 2007b). Hence, the team and its performance appear to be the main key to an ASO's survival and successful development.

As the firm grows, the accumulated stock of resources begins to empty the capacity of the firm's existing managerial resources, embodied in the management team, to maintain the coherence of the administrative organization (Penrose 1959). Thus, the nature and composition of the management team may need to change to enable growth. For ASOs, this implies that scientist-entrepreneurs need to bring in professional managers who possess capabilities better suited to running an established firm. This may be problematic since scientist-entrepreneurs tend to select new members from the sources with whom they share scientific network ties (Ensley and Hmieleski 2005; Mosey and Wright 2007). Such a tendency creates team homogeneity towards research and technology backgrounds.

Along with being creative, efficient and flexible, ASO teams may use a board of directors as a mechanism for establishing legitimacy and reducing uncertainty to overcome liabilities of newness (Pfeffer and Salancik 1978). The board may help the new venture overcoming its liability of newness by legitimizing the firm's activities (Selznick 1949) and promoting legitimacy (Harrison 1987). Such strategy involves attracting experienced and well-connected directors to the board of an ASO who can play an important role in accessing critical external resources (Lynall et al. 2003). The board represents a way to get access to the expertise, networks and managerial competence, which ASOs have great demand for. Thus, board may be a source for finding team members with necessary managerial competence or potential external financiers. ASOs often operate in industry niches characterized by high levels of growth (Shane 2004) and require highly skilled board members (Forbes and Milliken 1999). The boards in such firms exhibit higher levels of influence on firm activities compared to other types of firms (Hambrick and Abrahamson 1995). Several entrepreneurial firm studies have demonstrated an active involvement of board members in the firm's strategic decisions playing roles such as providing a sounding board and a source of advice in decision-making rather than merely performing monitoring and control (e.g. Deakins et al. 2000; Rosenstein 1988). Hence, the board may play a great role in the sustainable development of an ASO. Yet, the research on the board in ASOs is limited.

Thus, I address the research gaps, which exist in the academic spin-off literature by exploring the role of the team and board in ASO development. The introduction chapter is structured as follows. First, I account for the objectives, research questions and the contributions made in this work, and describe the context expressed by the Norwegian

innovation system, which supports the creation and development of ASOs. Second, key concepts and the main theoretical perspectives used in the dissertation and their implications are presented. Third, I clarify the epistemological position of my work and present the key methodological issues related to the literature review and the development of multiple case studies and survey. Finally, the main findings of the dissertation, implications and limitations are discussed, and future research directions are suggested.

1. Objectives, research questions and context

The main objective of this research is to add to the existing knowledge on academic spin-off companies, which is dominated by the studies on the firm, university and technology transfer office (TTO) level. There are few spin-off studies on the team level and even fewer studies that focus on the governance in ASO firms. Also, there has been little research on the development of an ASO outside the research environment when an ASO project incorporates in a legal company. Thus, the major contribution of this dissertation is that I address this research gap by focusing on the management in ASOs, which includes the top management team (TMT) and board of directors, and I try to explore which TMT and board features are associated with sustainable ASO development. Also, by doing this, I add to governance research and respond to recent calls for a closer investigation of boards in privately-held firms (Uhlener et al. 2007; Huse 2007). Further, I advance the research on high-tech new ventures, in which the significance of teams has recently been re-emphasized (Wright et al. 2007b). Finally, I add to venture capital research and try to link several types of early stage finance to the ASO's ability to acquire VC, which is one of the main thresholds in ASO development.

The specific research questions in the dissertation are as follows:

In the literature review (paper 1) I try to carry out a comprehensive literature review of the stream of research on team and board in ASOs. The research questions are as follows:

What is the state of the art of research on team and board in academic spin-offs? What are the main research gaps and how can they be addressed?

The objective is to map and assess the existing studies on team and board in ASOs and identify main research gaps. Thus, the paper aims to stimulate and direct future research on team and board in ASO companies.

In paper 2, we (me and my co-supervisor) respond to the calls for a closer investigation into board dynamics, and the purpose of the study is, therefore, to explore how boards are formed and how boards evolve through various stages of a spin-off process. The research questions are as follows:

Which board members do academic spin-offs add, and why, in the start-up stage? When, why and how do the main changes in board composition occur during subsequent stages?

Our paper 2 aims to extend previous research. It studies boards in early stage Norwegian and US spin-offs, rarely addressed by governance studies which mainly focused on mature firms employing cross-sectional data and treating the board as a static concept (Gabrielsson and Huse 2004). Given limited prior research on board evolution we use inductive logic and in-depth cases (Eisenhardt 1989). Second, the paper responds to recent suggestions in governance literature to use other theories than agency theory (Huse 2007). Specifically, we combine stage-based, resource dependence and social network theories. Third, it focuses explicitly on changes in the boards of ASOs. Accordingly, the paper adds to academic entrepreneurship research by linking board changes to development stages (Vohora et al. 2004; Vanaelst et al. 2006).

In paper 3 we (me and my chief supervisor) address the following research question:

What board features are associated with new team member addition in academic spin-offs?

We attempt to provide additional insights into the neglected area of the dynamics of the TMT in high-tech new ventures, rarely addressed by TMT studies, which mainly focused on well-established firms (Ensley et al. 2002). We also respond to suggestions in the entrepreneurial team literature to use a broader definition of team turnover considering team member entry and exit (Ucbasaran et al. 2003). Specifically, we draw on the resource dependence perspective and investigate the role of board composition and networking in the new team member addition process.

Paper 4 investigates the following research question:

What distinctive academic spin-off characteristics are associated with venture capital financing?

The purpose of paper 4 is to examine distinctive ASO characteristics, which are associated with venture capital funding. Particularly, we (my colleague, chief supervisor and I) seek to examine the role of different types of early stage finance such as finance from the portfolio seed funds, informal and industrial investors as important predictors of venture capital (VC) acquisition in ASOs. Moreover, we are concerned with the trade-offs affiliated with team size and diversity in management teams and company boards. Hence, the paper aims to extend our understanding of the role of the TMT (Ensley and Hmieleski 2005), board (Clarysse et al. 2007) and prior finance in ASOs by linking their structural design characteristics to VC acquisition.

1.1 Norwegian context

In 2003, Norway made a legislative change, similar to the Bayh-Dole Act in the US in 1980, where researchers no longer hold title to their inventions (Rasmussen et al. 2006a). Since this change, the universities own the intellectual property rights (IPR), and TTOs have been established in order to commercialize and manage the IPR. The most important government agencies within innovation and industry development are the Research Council of Norway and Innovation Norway (ibid). The Research Council of Norway finances both basic and applied research and is the main funding partner for research activities at the universities, research institutes, and in industry.

FORNY is a joint program between the Research Council of Norway and Innovation Norway (Rasmussen et al. 2006a). It was established as a program in 2000, but has existed as a project since 1995. The goal of the FORNY program is to increase the creation of wealth in Norway by commercializing research-based business ideas with significant market potential. The program is aimed at universities, research institutes, and university hospitals. The financial support is to be channeled towards knowledge-intensive ventures (including academic spin-offs) with a high profit potential. The FORNY program has several initiatives aimed to increase the commercialization of research from Norwegian R&D institutions. The program has funds for idea generation, commercialization, proof of concept, and leave of

absence allowing academics to work on ideas and test their concepts on a full-time basis. Indirectly, through TTOs, FORNY deals with pre-startup ASOs, which are in the research and opportunity framing stages (see Fig. 1). The actors that support an ASO through various development stages are illustrated in Fig. 1 and described below.

Innovation Norway (IN) lends financial and managerial support to the founders of the ventures with growth potential, including ASOs, which have been legally started up (from the interview with the IN officer). In the very early post-startup stage (right after legal incorporation as depicted in Fig. 1) IN helps to build a team around entrepreneurs and reimburse a larger part of incubator expenses (ibid). “After the incubator period and until the ASO may apply for more grants from Innovation Norway, there is a gap” (ibid). This gap may be filled by seed capital, which is usually used to verify technology and map market opportunities and firm’s competitive advantages. There are a number of nationwide and regional public-private seed capital funds. Some of them are supported by IN. Recent evaluations show that Norwegian seed capital funds should be larger to fill in the existing gap (Grünfeld et al. 2009). An additional way to fill the financing gap in the early post-startup stage is to seek finance from informal investors (Sørheim 2003) who are wealthy private individuals. Many of the Norwegian informal investors are well-networked and co-invest with other informal investors (ibid). A small fraction of them are actively involved as board members or consultants in the firms they invest in (ibid).

In later post-startup stages, when the technology is verified and the venture has proved its viability, an ASO may apply for a public and industrial R&D contract grant. By having this scheme, IN stimulates ASOs to cooperate with the public sector (e.g. hospitals, the Norwegian Armed Forces) and industry. One of the aims of the scheme is the joint development of internationally competitive products by ASOs with domestic and international industrial partners (customers). Under an industrial R&D scheme an ASO and a large industrial actor only have to collaborate on new product development.

Whether an ASO is supported by IN through a public or industrial R&D grant or not, an ASO may seek additional venture capital financing to nurture the company’s growth. VC firms usually invest in companies in the growth phase with considerable market-related risk. Various VC firms have different investment focuses and their financing may therefore be overlapped with, for instance, seed financing if the focus is on early stage companies (NVCA 2009).

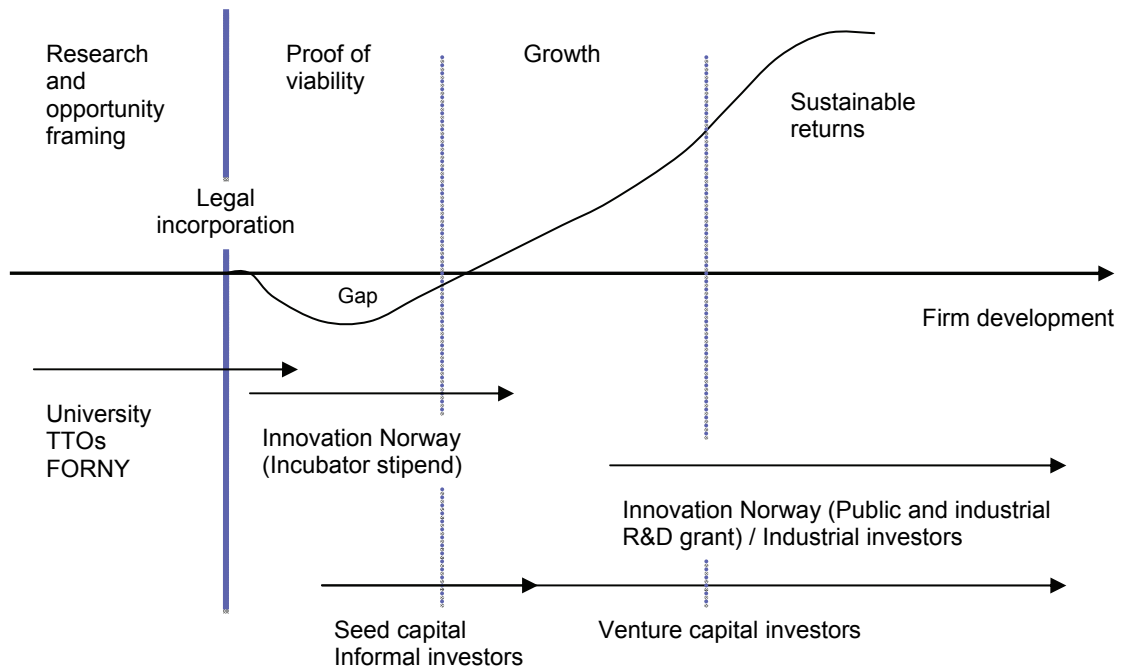


Fig. 1 Support of the academic spin-off development (adapted and modified from Innovation Norway, Trondheim office)

The fraction of late stage investments in the Norwegian venture capital market is relatively smaller, and the fraction of early stage investments is relatively greater, compared to the markets in Europe and North America (Berg-Utby 2007). Whereas the international VC industry is dominated by institutional capital, the Norwegian VC market is prevailed by public capital and private individuals (ibid). Along with finance a VC investor can also provide resources related to strategic and service activities, giving counseling and being “a door-opener” for an ASO.

As with studies in other countries, most spin-off studies in Norway primarily investigated government and university initiatives to promote and support commercialization of academic research (e.g. Rasmussen et al. 2006b; Rasmussen and Sørheim 2006). The contribution of my dissertation is therefore to explore the development of Norwegian ASO companies that were legally established after various government and university initiatives has been introduced.

2. Theoretical perspectives used in the dissertation

To avoid possible confusion, this section starts with the definition of three concepts that are central in the dissertation. These concepts are academic spin-off firm development, the top management team and board of directors. Then the main theoretical perspectives used in the dissertation are discussed. These theoretical perspectives are resource dependence and resource-based views.

2.1 Defining key concepts used in the dissertation

2.1.1 Academic spin-off development

To define ASO development I draw on literature on stages in new firm development, which builds on a life-cycle perspective on organization. In general, stage-based models identify the organizational characteristics exhibited within each stage of development and suggest the changes required in the behaviour and practices within an organization if it is to progress to the next stage (e.g. Smith et al. 1985; Miller and Friesen 1984; Kazanjian 1988; Van de Ven and Poole 1995). A key advantage of using literature on life-stage models is that “it adds to our understanding of the rather complex phenomenon of growth, describing how growth happens and the effect that it has on organizations” (Kazanjian 1988: 258). Stage-based approaches were criticized to have “an overly simplistic view of an organization developing through a series of predictable stages” (ibid). More recent stage-based perspectives recognize the role of feedback and the potential for non-linear development (Vohora et al. 2004).

An ASO can be seen as a threshold firm undergoing transitions and moving from one development stage to the next (Clarysse and Moray 2004; Vohora et al. 2004; Vanaelst et al. 2006). To progress to the next stage an ASO venture has to overcome the thresholds it faces. This process is characterized as iterative and non-linear with setbacks and steps forward. Therefore, the successful ASO development is, rather than by sales and profit, defined by whether the ASO has overcome certain thresholds and achieved important entrepreneurial milestones. For instance, attracting external finance, e.g. venture capital, is a key constraint on the development of ASO firms (Wright et al. 2003, 2006). Thus, having achieved VC financing may be seen as an important entrepreneurial milestone marking an ASO’s success.

2.1.2 Top management team and board of directors

A top management team is defined as a group of people who are responsible for managing an ASO and making key strategic decisions related to ASO development. It should be noted that an academic spin-off team is a dynamic concept. Recent studies that build on stage-based models demonstrate that during legal incorporation of the firm the TMT and board of directors are formed (Vanaelst et al. 2006; Filatotchev et al. 2006). The founding team that has led an ASO through the research stage splits into the TMT and board during the legal establishment of the firm. The founding team members become members of the TMT, board or both. For instance, academic founders and surrogate entrepreneurs introduced from outside academia (Franklin et al. 2001) may become part of both the TMT and board (Vanaelst et al. 2006). Other people who help academic founders in the pre-startup stage, such as TTO officers, become board members (Vanaelst et al. 2006; Filatotchev et al. 2006). Thus, the overlap of the TMT and board of directors can emerge.

A concept of ASO development adds to the complexity of team and board concepts. As an ASO develops and reaches growth and maturity, the changes in management and governance structure occur (Vohora et al. 2004; Vanaelst et al. 2006; Filatotchev et al. 2006). That is, new members may be introduced to the team and/or board. Some members may shift their positions from being a top manager to becoming a board member or leave the organization. This implies that with firm development the TMT and board may become less overlapped and even completely separated.

2.2 Resource dependence and resource-based perspectives

The main perspectives used in this dissertation are those pertaining to value creation in the firm. Value creation perspectives deal with resources and strategies. One of these perspectives is a resource dependence view, which has an external focus. Another perspective is a resource-based view of the firm, which provides an internal focus.

2.2.1 Resource dependence perspective

In the resource dependence perspective, which has strong roots in sociology (Weber 1947), the maximization of power defines organization success (Kanter 1979; Pfeffer 1981; cf. Ulrich and Barney 1984: 472). In this perspective, organizations are viewed as coalitions, changing their structure and patterns of behavior to acquire and maintain necessary external

resources. “The ability to acquire and maintain critical external resources is the key to organizational survival” (Pfeffer and Salancik 1978: 2). By acquiring needed external resources an organization decreases its dependence on others and, hence, changes its power relations with other organizations. The resource dependence perspective has three assumptions that explain how organizations work to acquire power. First, organizations are assumed to be comprised of internal and external coalitions (Pfeffer and Salancik 1978). Coalitions emerge from social exchanges that are formed to influence and control behavior. Second, the environment is assumed to contain scarce and valued resources essential to organizational survival (Pfeffer 1978). Hence, organizations have to deal with uncertainty regarding resource acquisition. Uncertainty comprises of the variability and complexity in acquiring resources from other organizations. Third, organizations are assumed to acquire control over resources that minimize their dependence on other organizations and also maximize the dependence of other organizations on themselves. Reaching both goals is thought to affect the exchange between organizations, thus affecting an organization’s power (Pfeffer 1981).

One of the pioneering contributors to resource dependence view, Selznick (1949), has moved the ongoing power discussion (Weber 1947) further and viewed organizations as those that “have capacity to develop distinctive competences” (cf. Ulrich and Barney 1984: 472). Organizations “then draw resources from actors external to the organization to support these central tasks through co-optation” (ibid: 472). Co-optation is a tactic for managing dependence. For instance, the board of directors is “one vehicle for co-opting important segments of the environment” (Pfeffer 1973: 362). Selznick’s original power insights and theme of the organization either adapting to the environment, or adapting the environment itself has subsequently been pursued by other researchers (e.g. Thompson 1967; Pfeffer and Salancik 1978; Pfeffer 1981).

Resource dependence perspective views a firm as an open system, which depends on external organizations and environmental contingencies (Pfeffer and Salancik 1978). Corporate boards represent a mechanism to manage external dependency (Pfeffer and Salancik 1978) and reduce environmental uncertainty (Pfeffer 1972) by linking the organization with its external environment through networking and legitimacy. Within resource dependence perspective, organization survival depends on the acquisition of scarce and valued resources from the environment in a stable and low cost manner. Appointing directors on the board, who have access to and control needed external resources or influential groups that possess these resources, represents reduced uncertainty and lower search costs for

the firm. Thus, in the resource dependence view, the linking task of the board is emphasized by the importance of board composition including having well-networked directors. Boards with a larger number of members are better than smaller boards since each director may provide the organization with different linkages to the external environment.

Resource dependence view suggests that boards span the boundary between organization and its environment (Pfeffer and Salancik 1978). An organization benefits from this boundary-spanning activity by means of co-optation and connection. Co-optation refers to placing the influential stakeholder representatives on the board (Pfeffer 1972). The contacts of such directors with the main stakeholder groups and their prestige in these groups are associated with decreased firm dependency. Directors' connections enable communication between the firm and external organizations. Board members are also seen as the providers of legitimacy (Pfeffer and Salancik 1978). The prestige and reputation of the directors in the stakeholder groups enable the board to legitimize the firm's actions, mobilize external support and acquire critical external resources. Co-optation, connection and legitimacy facilitate the development of stable, low cost resource relations, which as resource dependence view posits, is a precursor to organizational survival over time.

Resource dependence theory was a dominant approach in various disciplines like sociology, strategy and organization theory for many years (Huse 2007). Later, resource dependence perspective has been supplemented with contributions from social network theorists (e.g. Westphal 1999; Carpenter and Westphal 2001). Social network theory is a sociological perspective, which posits that "a firm's economic actions are informed, influenced, and enabled by the network of accumulated stable and preferential social relations" (Granovetter 1985; cf. Lynall et al. 2003: 419). From this perspective, board composition is the reflection of the social networks of the principal stakeholders (ibid: 419). While the resource dependence theory focuses on the board as facilitating the acquisition of resources, social network theory focuses on a firm's existing social networks as predictable paths that may be used to acquire these resources. In the social network perspective, the important board tasks are related to networking, door-opening, legitimacy, and communication in inter-organization relations.

Resource dependence perspective provides an external focus from firm-internal perspective and "views the board as an administrative body linking the organization with its environment" (Huse 2007: 62). Within this perspective, the primary role of boards is to serve as "boundary spanners" and critical resource suppliers to reduce the firm's external dependency and thus to contribute to value creation in the firm. The social network resources

of the board members that are used to attract necessary external resources are emphasized in the resource dependence perspective. The benefit of this perspective is that it helps to explain the acquisition of resources beyond the boundaries of the firm. The shortcoming is that it can not provide a sufficient explanation for the existing resources of the firm, their characteristics, and how and why they enable or constrain new firm growth. For instance, the resource dependence perspective tells us little about the human resources, including competence, knowledge and skills of the people involved in the organization, and how the human resources can be used to achieve organizational success. By turning to a resource-based approach one can account for this shortcoming.

2.2.2 Resource-based perspective

A resource-based perspective views the managerial team and the firm's board as firm internal resources that can give a competitive advantage to a firm and thus be associated with organizational success (Penrose 1959; Wernerfelt 1984; Barney 1991, 2001; Barney and Wright 1998). In this perspective, the managerial team is important because "it is managers that are able to understand and describe the economic performance potential of a firm's endowments" (Barney 1991: 117). A managerial team is a firm resource that "due to causal ambiguity and social complexity, provide greater potential to be a source of sustainable competitive advantage" than individuals (Barney and Wright 1998: 39). A resource-based perspective has been suggested as appropriate for understanding the board in young firms (Zahra and Filatotchev 2004).

The resource-based view of competitive advantage examines the link between a firm's internal characteristics and performance (Barney 1991). This view suggests that firms obtain sustained competitive advantages by implementing strategies that exploit their internal strengths and avoid internal weaknesses. There are two basic assumptions. First, the firms within an industry or group may be heterogeneous with respect to the strategic resources they control. Resources and capabilities can be heterogeneously distributed across competing firms. Second, these strategic resources may not be perfectly mobile across firms, and thus heterogeneity can be long lasting. The long lasting differences due to the resources heterogeneously distributed across competing firms "can help explain why some firms consistently outperform other firms" (Barney 2001: 649). Given these assumptions, it is argued that resources are rare and valuable. When these resources are also simultaneously

difficult to imitate, substitute and transfer they can generate a sustained competitive advantage.

A firm's human resources include all of the knowledge, experience, skill, and commitment of people involved in the organization and their relationships with each other and with external actors (Barney and Wright 1998). Managerial team members of a firm may possess skills that are valuable and rare. The synergy emerges from the managers working together. "The exploitation of the synergistic value is quite costly" and the competitive advantage stemming from the results of the team work is "causally ambiguous", and thus, hard "if not impossible for competitors to imitate" (ibid: 39). Human resources may be divided into general skills and specific skills (Flamholtz and Lacey 1981). General skills like "the knowledge of general management" are transferrable between firms (Barney and Wright 1998). Specific skills such as the knowledge of technology developed by a firm provide value only to one specific firm. Firm-specific skills are difficult to substitute and transfer to other firms. Working together, managerial team members "become involved in socially complex relationships that are not transferrable across organizations, thus only benefiting the organization in which these relationships develop" (ibid: 39). Thus, the human resources embodied in the managerial team of the firm that are simultaneously rare, valuable, inimitable, non-substitutable and non-transferrable create value for the firm and are the source of organization success.

Governance choices may, in the resource-based perspective, affect the creation of economic rents (Huse 2007). The difference in economic rents will appear between boards that may provide access to valuable, rare, costly-to-imitate and non-substitutable resources and boards that only focus on minimizing agency costs, i.e. maximizing value for external stakeholders of the firm (Barney et al. 2001). The research on the service tasks of the board, e.g. networking, advising and mentoring, as opposed to control tasks, has existed several years (Huse 2007). The resource-based researchers made attempts to place the service task approach to the boards into the resource-based framework and consider the board as a strategic resource impacting organization success. Their arguments are that the resource and knowledge of board members may be particularly important for increasing a firm's strategic flexibility and ensuring long-term growth and survival (e.g. Zahra and Filatotchev 2004; Filatotchev et al. 2006).

The resource dependence perspective views board members primarily as connectors to external resource providers. The resource-based perspective suggests that board members may be advisors to the management team and human resource providers themselves supplying the

firm with necessary knowledge, skills and competencies (Aguilera and Jackson 2003). In general, the resource-based perspective implies that including people on the board whose resources are valuable, rare, inimitable and non-substitutable may be a way of providing the firm with sustainable competitive advantage. Boards are valuable for the whole firm and not only for external actors. Highly skilled board members with firm-specific knowledge are scarce. The processes within the boardroom and results of board work are difficult to imitate. The services provided by board members to the firm are non-substitutable.

In brief, the unique configuration of the human resources provided by team and board members will contribute to value creation in the firm and, hence, enhance the firm's prospects for success.

2.3 Implications of theoretical perspectives

In paper 1, which reviews the ASO literature, I draw on a stage-based approach to define ASO development and show how both team and board may evolve. Paper 2 explores board formation and change and draws on the stage-based, resource dependence and social network perspectives. Applying these theories, the initial board members will reflect the personal networks of the founder(s) and bring resources that the founding team needs. Over time, changes in board composition will occur and subsequent board members will be recruited from the social networks of key external stakeholders and bring critical external resources that the TMT lacks. In paper 3, using resource dependence perspective, board size, number of outside directors and their networking activity are hypothesized to be important predictors of acquiring external managerial resources, i.e. adding new member to the TMT.

Paper 4 draws implicitly on resource-based perspective. ASOs are viewed as facing VC financing constraint (Westhead and Storey 1997; Wright et al. 2006). Because VC investors are concerned with managerial talent and credibility, an ASO firm that has the unique configuration of managerial resources may be more likely to overcome this constraint and thus outperform its competitors. Size of and diversity in both the management team and board are, as we contend, the most important structural measures generally considered as advantageous to entrepreneurial firms (e.g. Ucbasaran et al. 2003; Beckman et al. 2007; Zimmerman 2008). Hence, we hypothesize that the size and diversity (heterogeneity in experience and skills) of the team and board will contribute to obtaining VC funding. Diversity refers to heterogeneity in various demographic, personality and more directly task-related cognitive (or background, experience) characteristics of top management members.

Furthermore, on the analogy of the pecking order hypothesis applied in the spin-off literature (Wright et al. 2006), we expect that ASOs look for internal (seed fund) and alternative forms of external financing (from informal and industrial investors) before they seek venture capital. For potential VC investors the way an ASO was previously financed may serve as an indication of the ASO's uniqueness in terms of managerial resources and credibility that can provide an ASO with a competitive advantage. Prior finance configuration of an ASO is therefore also hypothesized to make a contribution to the VC acquisition.

3. Methodological considerations

In this section, I will first account for the epistemological position held in this dissertation. Then, I will discuss the key issues related to the methods used in the thesis.

3.1 Epistemological position

A long-lasting debate has existed between two contrasting views of how social science research should be conducted (Easterby-Smith et al. 2008). These two traditions are positivism and social constructionism (ibid). The key idea of positivism is “that the social world exists externally, and that its properties should be measured through objective methods, rather than being inferred subjectively through sensation, reflection or intuition.” (ibid: 57). The research issue is whether the research results are an accurate reflection of reality. Social constructionism is a new paradigm, which has been developed during the last half century, “largely in reaction to the application of positivism to the social sciences.” (ibid: 58). In this view, the reality is socially constructed and given meaning by people (Berger and Luckman 1966), rather than determined by objective and external factors. The origins of the labels and who influenced their acceptance are of the greatest interest for social constructionists.

The middle epistemological position between positivism and social constructionism is relativism (Easterby-Smith et al. 2008). The relativist position assumes that different observers may have different points of view and that the truth is determined through consensus between different viewpoints (ibid). Thus, the relativist researcher is concerned with that a broad sample of viewpoints has been taken into account. In both the positivist and relativist positions it is assumed that there is a reality which exists independently of the observer, and hence the job of the scientist is to identify this pre-existing reality. From the

relativist position, “the assumed difficulty of gaining direct access to reality means that multiple perspectives will normally be adopted, through both triangulation of methods and the surveying of views and experiences of large samples of individuals” (ibid: 63).

Case studies may be used in quite different ways by different proponents. Although the dominant texts about case method come from the positivist end (e.g. Yin 1994), the method can also be designed in ways consistent with relativist and constructionist perspectives (Easterby-Smith et al. 2008). The relativist position has been developed particularly through the work of Kathy Eisenhardt (Eisenhardt 1989; Eisenhardt and Graebner 2007; cf. ibid). This relativist view on cases is inspired by both positivism and social constructivism. Methodology is, thus, eclectic. Eisenhardt (1989) advises to use prior designs, but allows flexibility about their adaptation; to apply triangulation of methods; and to conduct both analyses, within case (constructionist approach) and across cases (positivism).

The acceptance of a particular epistemology usually leads the researcher to adapt methods that are characteristic of that position (Easterby-Smith et al. 2008). It is also possible to infer, which epistemological position the researcher holds, sometimes implicitly, from the methods employed by the researcher. The triangulation of data and methods used in my thesis, that is the combination of multiple case studies largely inspired by Eisenhardt (1989) and survey of ASO firms, and my attempts to find consensus between different viewpoints to determine truth, place me in a relativist position.

A relativist position is not “a useful compromise” between positivist and social constructionist positions that combines the strengths and avoids limitations of each (Easterby-Smith et al. 2008: 73). It has its own strengths and drawbacks. Acknowledging the value of using multiple sources of data is the main strength. Also, the relativist position may enable generalizations beyond the present sample, and may be conducted efficiently, for instance, when a survey is outsourced to experts. The first drawback is that larger samples are required if results are to have credibility, and this may be costly. For example, if case study is used then not one or two but four to about ten cases should be in the sample. Next, if survey is used and standardization is required, it means that the researcher may not be able to deal effectively with the cultural and institutional difference found within international studies. Finally, it may be hard to reconcile discrepant sources of data that point to different conclusions.

3.2 Development of multiple case studies and survey

In this subsection, I will present some central methodological issues encountered in the literature review and during the development of the multiple case studies and survey. As characteristic of relativist position, the methods in the dissertation studies are both qualitative and quantitative. Data sources and methods used in the studies are summarized in Table 1.

In the literature review a comprehensive and detailed literature analysis was conducted. The resulting data were discussed according to the suggested framework considering structure and processes of the team and board in ASOs. The understudied topic of board dynamics in ASOs is addressed by employing multiple case inductive research design that provides empirical richness and may produce novel and thorough theoretical insights (Eisenhardt 1989). Board features associated with new team member addition in ASOs are analyzed by using logistic regression. The hypotheses about structural design characteristics associated with successful venture capital acquisitions in ASOs are tested with hierarchical logistic regression on the financial, team and board levels.

3.2.1 Background and literature review

Prior to starting my PhD I was not familiar with the exciting topic of commercialization of research results from universities through the creation of spin-off companies. Therefore, to become better acquainted with the topic, I started reading on the topic and I carried out several interviews with the people involved in technology transfer and commercialization processes. These people were from such support organizations as (i) Innovation Norway (local office in Trondheim) which grants incubator and other stipends to ASOs, (ii) technology transfer office NTNU TTO established in 2004, one year after Norway had made the Bayh-Dole Act-like legislative change, (iii) commercialization organization Leiv Eriksson Nyskapning which has existed long before NTNU TTO was established and fulfilled similar functions of facilitating commercialization and spin-off activity from research institutes in Trondheim, (iv) TTO Campus Kjeller in Oslo, and (v) the FORNY program, a unit under the Research Council of Norway, which is in charge of stimulating commercialization of research results nationally. I also interviewed a couple of academic founders with long experience of commercializing their research, asking them about the challenges they met during their endeavours. Some of the problems described by practitioners caught my attention, which helped me to delimit my research and focus on the management in ASOs.

Table 1 Methods used in the dissertation studies

Paper title	Data	Method
Top management team and board in academic spin-offs: a taxonomy of the studies on group level	Published literature. 64 spin-off articles and 40 team and board articles in 27 core management and entrepreneurship journals.	Review, analysis and synthesis of the literature
Exploring board formation and evolution of board composition in academic spin-offs	Case data on eleven academic spin-offs. Secondary data: Brønnøysund Register Center, the official export and trade directory Nortrade, the business search engine Purehelp, the Link Silicon Valley directory, the San Jose Mercury News, extensive web searches.	Multiple case inductive study
Board features associated with new team member addition in academic spin-offs	Collected survey data on 135 academic spin-off companies.	Logistic regression analysis
Design characteristics associated with venture capital acquisitions in academic spin-offs	Collected survey data on 135 academic spin-off companies.	Hierarchical logistic regression analysis

The literature review (paper 1) is mainly based on articles published in core management journals, which were systematically identified using the ABI/INFORM, EBSCO, Science Direct and JSTOR databases. About 65 articles were selected that studied the academic spin-off phenomenon. Then, I read and analyzed each article to create a database in which the following data were coded: (i) author name(s) and journal of publication, (ii) year published, (iii) geographical location of the ASO cases, (iv) theory, (v) method, (vi) unit of analysis, and (vii) research focus of the article. Next, since there are few studies on team and board level in ASO research I tried to identify articles on entrepreneurial teams and board in ASOs and high-tech new ventures. First, I studied the reviews of the new venture team literature by Cooper and Daily (1997) and Birley and Stockley (2000) and a seminal review book on board research by Huse (2007). These works and articles identified in the previous step provided an immediate entry into the literature on team and board in high-tech new firms. Then, to avoid reference bias, I used electronic reference retrieval services to track all relevant articles. Finally, I read and analyzed these articles and designed a detailed database in which I coded the following data: (i) author name(s), year and journal, (ii) theory, (iii) industry/firm type, (iv) dependent variable(s), (v) independent dependent variable(s), (vi) control

variable(s), (vii) method, and (viii) main findings. The resulting data revealed the patterns regarding team and board in ASOs that I discuss in the literature review.

3.2.2 Multiple case studies

Given limited prior research on board evolution, the inductive logic and in-depth cases (Eisenhardt 1989) are used to explore board formation during the start-up stage and changes in board composition in subsequent stages of ASO development (paper 2). Sampling, data gathering and analysis are carefully accounted for in the appended paper 2. Here, I will present some key issues related to the processes.

Following Eisenhardt (1989), the sample of ASOs is selected to give a substantial degree of variance. It was especially important to sample ASOs, which were in different development stages, to better capture the dynamic aspects of board composition during a firm's life cycle. Occurrence of at least one board change (new person added, not merely role change) is a "must" case choice criterion. Another important criterion is the enduring involvement of the scientist-entrepreneur or externally introduced entrepreneur occupying a key position in the firm, e.g. CEO, CTO or board chair. Such a person who has taken the venture through the founding process and is aware of the current operations of the company is expected to provide more detailed and relatively accurate descriptions related to board formation and evolution compared to other employees.

Additional data were collected from other sources, and such triangulation improves reliability by providing a check against the accuracy of informant responses (Yin 1994). Half of the cases were ASOs from US universities, situated in Silicon Valley, a region with strong VC industry tradition, and Michigan, a region with relatively weak developed VC support. In paper 2, we posit that recent legislative changes (that university, not researchers, own the IPR) and a strong public role in the commercialization of research may make Norway representative of smaller western European countries. Hence, ASOs may be seen as fairly common in the US and Norway, but the surrounding networks and support structure, which we try to account for, vary widely.

Data analysis incorporates within-cases analysis and cross-case analysis, relying on methods suggested by Miles and Huberman (1994) and Eisenhardt (1989). Conceptual insights concerning boards in ASOs were drawn out and refined during an iterative process as the case studies progressed. This iteration between theory and data helps sharpen constructs,

strengthens the internal validity of findings, and raises the generalizability of results (Eisenhardt 1989).

As with all methods multiple case studies have both advantages and limitations. Whereas single case studies offer insight into one particular example, multiple cases provide us with empirical richness and may also generate generalizable and more accurate theoretical insights (Eisenhardt 1989). In replication logic, used in this study, cases which confirm emergent relationships enhance confidence in the validity between the relationships (Yin 1984). Cases “which disconfirm the relationships often can provide an opportunity to refine and extend the theory” (Eisenhardt 1989: 542). “When a relationship is supported, the qualitative data often provide a good understanding of the dynamics underlying the relationship, that is, the ‘why’ of what is happening” (ibid: 542). This is crucial for the establishment of internal validity of the findings (ibid). Discovering the underlying theoretical reasons for why the relationship exists also helps to establish the internal validity.

We have conducted one or two interviews per firm using a limited number of cases. Overall, we attempted to address this limitation by studying cases that were in different stages of development, to better capture the evolutionary aspects (i.e. changes) of board composition. As for Norwegian cases we could trace all board changes through the database. This limitation is thus addressed by checking the responses against the database and, if needed, asking additional questions after interviews.

Similar to hypothesis-testing research, multiple case study research involves measuring constructs and verifying relationships. However, these processes are more judgemental in case studies because the researchers can not apply statistical tests (Eisenhardt 1989). Within and across cases analyses of the data help to reduce this bias (Miles and Huberman 1994). Full display of evidence and procedures in the published work (i.e. paper 2) also helps enabling readers to apply their own standards (Eisenhardt 1989). Following Eisenhardt’s advice (1989), to improve internal validity and generalizability of the findings, we have tried to tie the emergent insights to existing literature during data analysis. Yet, the confidence that the findings are valid and generalizable may be further strengthened if other researchers achieve similar findings in a very different context (ibid).

3.2.3 Development of the survey study

Literature review and multiple case studies have given valuable insights into the academic spin-off phenomenon, which were helpful when designing the questionnaire. Quantitative methods are used in papers 3 and 4.

The questionnaire was sent to the CEO of 353 companies considered as originated from Norwegian universities and public research institutes in autumn 2008. The sample contains 318 companies, which are registered as having used the university TTO or technology licensing-like organizations in the FORNY database. The rest of the companies were found in other sources. Anonymity for all companies and informants was assured. 53 firms reported that they are not ASOs or are no longer active. After about two-three rounds of personal phone calls to the CEOs 135 academic spin-off companies returned their questionnaires resulting in a response rate of 45 %.

For both paper 3 and 4, the appropriate method was logistic regression because of the binary dependent variable: new team member addition in the former case and VC acquisition in the latter case. In paper 3, a simple two-step logistic regression analysis was used to test the significance in predicting new member addition of the independent board variables over the control variables. In paper 4, the hierarchical logistic regression analysis assessing multiple themes against a dependent variable was used since we hypothesized on the overall theme level and aimed at testing the significance in predicting the VC acquisition of the independent variables on three levels: finance, TMT and board.

The advantage of quantitative approaches is that they provide objectivity in that hypotheses are tested by applying statistical criteria to the measurements taken (Hair et al. 2006). Since population characteristics are inferred from a sample, cross-sectional studies must carefully consider how well the selected subset represents the larger population (ibid). Due to an active involvement of the Research Council of Norway in facilitating the creation of spin-off companies through the FORNY program there have for about fifteen years been attempts to trace and register all ASOs in the database. This population consists of the spin-off companies created since 1995 (or earlier if it was possible to identify) which involves academic researchers, university technology or both, which all fit the definition of an ASO adopted in this dissertation. As less than ten percent of the start-ups that fit the definition of an ASO were identified through other sources than the FORNY database (e.g. web search), I assume that the characteristics of the sample are comparable to those of the whole population of ASO companies (in Norway).

There may be some survival bias in the sample, as in most entrepreneurship studies (Davidsson 2004). This bias is somewhat reduced since our cases represent the whole range of ASO stages, from the very early stages to maturity and decline stages. The cases in early (research) and decline stages amount to 4.4 % of the sample. Non-response bias refers to the mistake one expects to make in estimating a population characteristic based on a sample of survey data, in which, due to non-response, certain types of survey respondents are under-represented (Hair et al. 2006). Testing for non-response bias generally involves comparing two different samples drawn from the same population. The sample of the non-respondents was drawn from the FORNY database, which is, as already mentioned, representative of the entire population. I tested non-response bias using three characteristics, on which there was available data: the amount of employees, firm age and operating revenues in 2007. Mean values and tests for differences in mean values between respondents and non-respondents can be found in the appendix to the dissertation. The respondents had on average fewer employees and lower operating revenues compared to non-respondents. The average age of responding and non-responding firms was approximately the same. This may indicate that our sample is somewhat biased towards the smaller ASOs. However, no statistically significant differences are found, which indicates that non-response bias should not be of concern.

Common method variance, variance that is attributed to the measurement method rather than the constructs of interest, refers to the amount of spurious covariance shared among variables because of the common method used in collecting data (Malhotra et al. 2006). Common method bias is problematic because it may cause bias in the estimates of the true relationship among theoretical constructs. Common method variance can either inflate or deflate observed relationships between constructs. The only feasible method in our setting is the Harman one-factor test (Aulakh and Gencturk 2000; Podsakoff and Organ 1986). If most of the items load on one factor, the common method bias is present. In both paper 3 and 4, the test indicates that common method bias is not a major issue.

The studies are cross-sectional which means that the underlying processes behind the assessed relationships can not be captured. The findings in the studies are representative of Norwegian ASOs.

4. Discussion and conclusions

In this dissertation, I have sought to ascertain the significance of the team and board in academic spin-off companies. Teams and board in ASOs as high-tech new firms represent a promising, yet under-studied, research area. In new ASO start-ups the team and board may overlap. The processes occurring within and across team and board boundaries are so intertwined that it can be hard to isolate one unit from another. Therefore the spin-off studies that focused explicitly on the team in an ASO often looked implicitly at the board (e.g. Vanaelst et al. 2006). And vice versa, studies that focused on boards also considered teams (e.g. Filatotchev et al. 2006; Clarysse et al. 2007). Hence, the contribution of the dissertation is that it explores the role of both team and board in ASO development.

The research on team and board in ASOs seems to be in its infancy, and this offers plenty of research opportunities. As suggested in paper 1, one can distinguish roughly between two basic dimensions: structure and processes of the team and board. Structure refers to the size and composition (i.e. skill mix) of the group. Processes may occur within or across group boundaries, e.g. conflict in the team, new board member addition. While there appear to be a number of studies addressing team and board structure in high-tech new ventures, there are much fewer studies addressing team and board processes. Yet, there are many research gaps (as paper 1 shows) with regard to both dimensions that future research on team and board in ASO firms could fill.

Previous spin-off research finds that ASO teams are homogeneous in terms of background makeup, with less developed intra-team processes compared to independent high-tech firms (Ensley and Hmieleski 2005). Backgrounds and skills of the board members in ASOs are found to be complementary to those of the team (Clarysse et al. 2007). However, spin-off studies tell us little about to what extent the amount and nature of human resources, i.e. team and board size and diversity, contribute to sustainable ASO development. Paper 4 attempts to address this research gap.

In paper 4, I (and my co-authors) measure ASO development as overcoming one of the most important entrepreneurial milestones, namely attracting VC financing. The findings show that ASOs with larger teams and higher diversity in functional and industry backgrounds among the team members (with support from seed funds and industry) are more likely to attract VC financing than ASOs with board members who are diverse in their educational backgrounds (and with support from informal investors). These findings extend and refine previous research, confirming that the human capital of the management team may

usefully predict entrepreneurial success (Shane and Stuart 2002; Ucbasaran et al. 2003; Beckman et al. 2007; Zimmerman 2008). While we did not find the board to be an important predictor of VC acquisition, it became apparent that in order to contribute to ASO development a board would require the inclusion of members with certain backgrounds and skills. Paper 2 sheds light on which members ASO firms recruit during start-up and in the subsequent development stages, how and why; e.g. which social networks are utilized when looking for new board members and which resources new board members bring to the venture.

Paper 2 contributes by studying board processes, i.e. how the board is formed and how it evolves. It also tries to relate board changes to the stages of development. We propose that the board at founding will most likely consist of the scientist-entrepreneurs and people from the scientist-entrepreneurs' networks. The board is therefore quite homogenous in terms of board member background. The board composition changes over time and new board members bring critical resources that the top management team lacks. These resources range from finance and industry experience in earlier stages, to executive and marketing/sales experience in later stages. New board members are found primarily through the chair's networks, regardless of the size of the firm stake held by the board chair. Further, we propose that the additions of key board members are associated with the progress of a spin-off. That is, outside directors help the ASO to achieve credibility, thus, proving the viability of the venture, and to move the spin-off closer towards the next development stage, in which the ASO achieves sustainable returns.

As prior spin-off studies demonstrate, recruiting new members is a key element in ASO team formation and further team development (e.g. Clarysse and Moray 2004; Forbes et al. 2006; Vanaelst et al. 2006). Recruitment of new members depends on the competences needed and existing social networks. Adding new members to the team is critical when high-tech firms experience very rapid growth, and hence need more managerial resources, or when high-tech firms have very slow growth and need new top managers who could improve this situation (Boeker and Wiltbank 2005). While existing research focuses on the team structural characteristics (e.g. heterogeneity in functional and educational specialization) that are associated with new team member addition (e.g. Ucbasaran et al. 2003; Chandler et al. 2005), we know little about the role of the board in recruiting activity. Paper 3 addresses this gap. The findings in paper 3 suggest that ASO companies which have larger and more active networking boards are more likely to add new members to the team. The lack of growth in ASOs seems to increase the likelihood of adding a new member. Overall, paper 3 proposes

that the joint networking effort of both internal (employed in the firm) and external board members contributes to the recruiting of new team members.

4.1 Implications

The nature of ASO research is mostly empirical; however, the number of theoretical contributions is increasing. This dissertation draws on several theoretical perspectives and has therefore several theoretical implications. First, the research demonstrates that the stage-based perspective can successfully be used to measure an ASO development in terms of overcoming key thresholds, that is, achieving credibility and sustainability (paper 2) and acquiring VC financing (paper 4). Next, we combine stage-based, resource dependence and social network theories to describe changes in board composition (paper 2). We find that these theories are important complements to research on boards in new ventures, dominated by agency theory (Huse 2007; Uhlaner et al. 2007). These perspectives all provide partial explanations for board change processes, but have to be employed in combination to better understand the phenomenon. At last, the resource dependence perspective provides an explanation for the board's role in attracting necessary external managerial resources in ASOs (paper 3). Resource-based perspective was drawn on to explain to what extent a firm's internal resources contribute to achieving an important entrepreneurial milestone – VC acquisition (paper 4). Thus, resource dependence and resource-based perspectives give supplementary explanations of the board's role in ASO development. While the former provides an explanation as to how the board can facilitate ASO development by attracting new members to the team, the latter may explain how the board and team themselves can be useful resources and, hence, sources for sustainable ASO development.

Understanding team and board also has important implications for practitioners. When forming a team, TTOs and entrepreneurs should pay attention to cognitive diversity. The diversity in functional and industrial backgrounds of the team members is positively related to new team member addition (paper 3) and the ASO's ability to attract VC funding (paper 4). This is in line with prior research, which shows that early stage technology-based firms overcome various thresholds (e.g. receiving VC funding, going public) when they have teams that are complete in terms of the functions of marketing, finance, operations, and engineering (Zimmerman 2008; Beckman et al. 2007) and heterogeneous in industry experience (Chandler et al. 2005). For practitioners seeking sustained ASO development, this implies that they

should adjust the team's functional and industrial diversity as early as possible by adding members with relevant expertise to the management team.

Next, the findings suggest that changes in the board may be seen both as an effect of an ASO's development and progress to a new stage, and as a driving force in this development (paper 2). The board chair's social networks seem to be essential when attracting new members to the board who could supply an ASO with needed external resources. This result emphasizes the importance of the professional board chair in ASO development. The networking activity of the whole board appears to be significant when recruiting new members to the top management team (paper 3). An important policy message is therefore to include the perspective of board networking contribution and dynamics in mechanisms intended to support ASO development. For instance, certain types of public funding seeking to stimulate spin-off creation could be made contingent on the ability to attract professional outside directors to the board of an ASO. Hence, for policy-makers and practitioners, this implies that it may be necessary to develop policies that meet the needs of ASOs in finding well-networked outside directors. Further, the findings suggest that the seed funding and alliances with industrial partners are positively related to an ASO's ability to obtain VC funding (paper 4). Consequently, efforts to develop networks and relationships with early stage investors, industrial partners and executives who can be potential professional board members may be an important additional component in general and specific assistance programs. This may imply that TTOs should recruit staff or hire experts with working experience in established companies in private high-tech sectors, not only in start-ups. Policy makers should also consider the possibility of extending seed funding, which ASOs may apply for, and designing support schemes that could stimulate to greater involvement of strategic industrial partners in ASOs. Such actions may help address the concerns that ASOs are being created when they are immature in terms of human capital with quite homogeneous teams and boards and, thus, unable to move the business forward. These actions may also help the teams to increase the chances that they will obtain necessary external financing from VC investors.

4.2 Limitations and suggestions for further research

Since the nature of most ASO studies is empirical, and there are still few studies on team and board in ASOs, I tried to make a comprehensive and detailed literature analysis of

the stream of research on both team and board in primarily ASOs, but also other high-tech new ventures (paper 1). In the literature review I attempted to provide some directions for future research which could develop the area. In this dissertation I contribute to the dimensions of structure and processes across the group boundaries; still, the theme of intra-group dynamics is left out. Hence, future researchers may try to further explore the internal processes and relationships between the variables, which have been extensively studied in other contexts or disciplines, and theorize about, or even test the applicability of, these relationships in an ASO context.

Next, due to multiple cases research design the model developed in paper 2 is related to specific phenomena pertaining to board dynamics in ASO firms. Other papers (3 and 4) are cross-sectional studies of Norwegian ASOs. Hence, more studies in other countries and contexts could be done to strengthen the generalizability of the findings. Future researchers may also attempt to conduct longitudinal studies to better capture the evolutionary aspects of team and board composition and to ensure the proper sequence of events and changes in characteristics through development stages. Future studies could explore in-depth the role of team and board in various stages of firm development.

Finally, we have only focused on team member addition, and have been able to explain the drivers of board member additions. Future research may investigate the other side of turnover – member exit – in more details, as the drivers of member entry and exit vary (Ucbasaran et al. 2003). Consequences of both team and board member addition are important as well. For instance, Beckman et al. (2007) show that high-tech venture teams that add members obtain initial public offering faster. The qualitative findings of the dissertation show that external board members add value by bringing additional resources that the management team lacks and, thus, contribute to ASO development. The results of the survey indicate that most important additions to the team were usually positive with needed competence brought by the new member, resulting in the emergence of new growth opportunities and even increased sales. Still, future research could address the question of the consequences of team and board member entries and departures for ASO development. For instance, additions to and departures raise important governance issues in terms of how changes in the equity holdings are negotiated and may disturb intra-group processes, which in turn may affect firm performance. We have been able to observe some effects of additions on firm development. Further research may explore departures of team and board members, negotiation and tension issues, and examine whether the membership changes are conflict-loaded or imposed by powerful stakeholders and how this would affect group cohesion and effectiveness.

4.3 Conclusion

Team and board are important factors that affect academic spin-off development. The dynamics of the development stages in an ASO is related to the dynamics of its board. In successful academic spin-offs the board contribution is dynamic. Larger and actively networking boards contribute to attracting new team members with necessary competences who open for new growth opportunities and help ASO business to move forward. Key board members bring in needed resources that the team lacks, ranging from finance and industry experience in early stages to executive and marketing/sales experience later. Thus, they help an ASO to prove a venture's viability and approach a stage of sustainable returns. Key board members are found primarily through the social networks of the professional board chair. ASOs that have contributing boards and team members with diverse functional and industry backgrounds succeed in recruiting new team members and achieving an important entrepreneurial milestone of acquiring venture capital. The problem of achieving this milestone may be reduced if ASOs have previously managed to receive seed capital and support from industrial partners. The top management team and board that contribute to commercialization of university research by facilitating sustainable spin-off firm development represent an exciting research area with numerous opportunities for future research.

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PAPER 1

Top management team and board in academic spin-offs: a taxonomy of the studies on group level

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Top management team and board in academic spin-offs: a taxonomy of the studies on group level

Abstract

Reviewing the state of the art of academic spin-off firm (ASO) research by collating 65 spin-off articles published in a variety of academic journals, I identify that there are few studies on group level, which all point to a need for more research on team and board in ASOs. Arguing that team and board and their role in ASO development is an important, yet complex and under-researched topic, I try to carry out a comprehensive literature review of the stream of research on team and board in primarily ASOs and other high-tech new ventures, comprising of 40 articles. I suggest a framework for considering team and board in ASOs, which includes structure and processes, and discuss the findings and future research opportunities within this framework. Finally, I present conclusions, implications and limitations of the study.

Keywords: literature review, academic spin-offs, top management team, board

1. Introduction

Entrepreneurship research has undergone drastic changes in the past thirty years (Landström 2000). In response to the changing world economy and research needs, several new areas have emerged. One of these new areas that receives growing attention internationally is academic entrepreneurship (Shane 2004). In particular, research on academic spin-offs (ASOs) has recently grown. This may be attributed to the rise in commercial activity and spin-off creation that has recently occurred in the majority of universities and research institutes (Lockett et al. 2005).

ASOs are high-tech new firms founded by employees of the public research organization (PRO) such as a university or research institute around a core technological innovation which had initially been developed at PRO (Birley 2002). Governments increasingly recognise the need to support the process of technological change with the aim of spawning more high-growth knowledge-intensive companies from university research (O'Shea et al. 2004; Wright et al. 2004). Despite the importance of ASO companies as generators of national growth and societal development (Lindholm-Dahlstrand and Klofsten

2002; Steffensen et al. 2000), researchers only recently started to focus explicitly on ASO firms (Djokovic and Souitaris 2008). There were attempts to review and categorize spin-off literature, which rapidly increased in the new millennium (Autio 2000; O'Shea et al. 2004; Siegel and Phan 2005; Rothaermel et al. 2007; Djokovic and Souitaris 2008).

Previous studies on spin-off creation have tried to explain the variation in spin-off formation and suggest policies that would increase this activity at universities (Autio 2000; O'Shea et al. 2005). These studies mainly identify the factors which affect the spin-off creation process related to faculty attributes and incentives, university and technology transfer offices' (TTO) commercialization policies and practices, and region or industry specifics (O'Shea et al. 2005; Rothaermel et al. 2007; Autio 2000; Shane 2004). However, the research that tries to explain a successful spin-off development on the team level is limited (Rothaermel et al. 2007). These studies focus on team networks, composition, formation and evolution of team heterogeneity and attempt to link team characteristics to ASO growth (Nicolaou and Birley 2003b; Clarysse and Moray 2004; Vanaelst et al. 2006; Ensley and Hmieleski 2005). Although the entrepreneurial team is recognized as a crucial factor to new venture growth (Cooper and Daily 1997; Birley and Stockley 2000), it has yet to be extensively studied yet in academic entrepreneurship (Shane 2004).

The exploration of the board as a locus of analysis when explaining early performance differentials between ASO firms is an area which has not been studied thoroughly. An exception is the study by Clarysse et al. (2007) that shows that the outside board members in ASOs have skills which are complementary to those of the team members. The lack of research on boards in ASOs is surprising since many ASOs as high-tech firms operate in industry niches characterized by high levels of growth and this, in contrast to large companies, requires highly skilled board members (Forbes and Milliken 1999) and greater involvement of the board in the firm's strategic decisions (Hambrick and Abrahamson 1995). Thus, the boards in ASOs may exert a stronger influence on firm performance compared to other companies. In addition, due to newness and a lack of basic resources, the boards in young ASO start-ups may be helpful by offering legitimacy, networking and access to resources (not only monitoring and control) (Lynall et al. 2003; Huse 2007). This may require close interaction between the team and board members, who make decisions about ASO development strategy, and an active involvement of board members in the firm's activities.

ASOs can be seen as transition firms, which try to overcome various thresholds, e.g. gathering human resources, and achieve entrepreneurial milestones, e.g. attracting external funding (Vohora et al. 2004; Clarysse and Moray 2004; Vanaelst et al. 2006). To enable a

firm's transition from academia to market, both the team and board of an ASO need to be developed (Ensley and Hmieleski 2005; Filatotchev et al. 2006). As shown by Vanaelst et al. (2006), during legal incorporation, the founding team divides into two major teams: the top management team (TMT) and the board of directors. The TMT and board may represent separate entities or they may overlap, as illustrated in Fig. 1. For instance, a scientist-entrepreneur may be a member of both the TMT and board, while a university TTO may place its representative on the board of the ASO (ibid). To increase chances of acquiring external funding, ASOs should attract people with commercial expertise and/or those who could enhance the firm's credibility in the eyes of customers and exchange partners (Vohora et al. 2004; Wright et al. 2004, 2006). Such people may be recruited to the TMT or board (ibid, Lynall et al. 2003). Once agreed to invest in an ASO, the external financiers often require seats on the board (Clarysse et al. 2007). An increasing stake for external owners represents a reduction in TMT ownership. This may imply that some scientist-entrepreneurs have to leave the board. Therefore, one might expect that, as an ASO develops, the TMT and board undergo changes. Thus, the board represents a management unit, which overlaps the TMT in the period of legal incorporation. After changes/transitions, the TMT and board may become less overlapped and eventually completely separated (see Fig. 1).

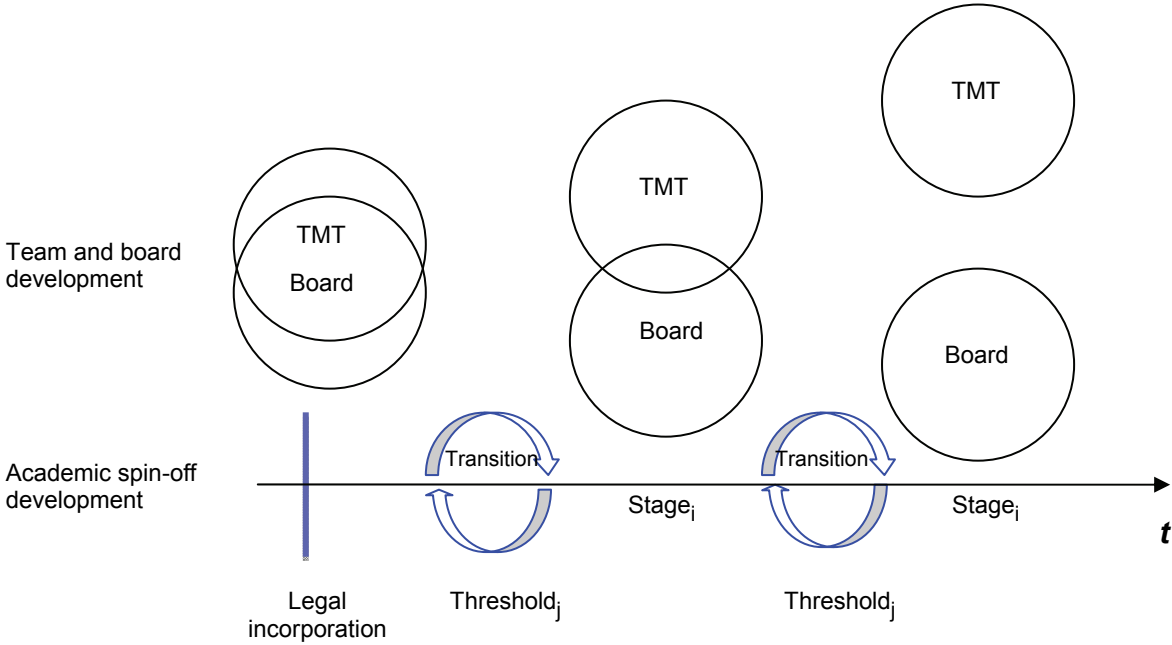


Fig. 1 Team, board and academic spin-off development

Thus, the board in ASOs is apparently an important component of the ASO management and represents a crucial factor, which may affect ASO development. Hence, I argue that the spin-off studies aiming to contribute to research on group level should consider both the team and board. The objective of this paper is, therefore, to map and assess the existing studies on team and board in ASOs and to identify specific research gaps. In particular, I try to conduct a comprehensive review of the literature on team and board in primarily ASOs and other high-tech new ventures. The assessment and synthesis should make this research topic more accessible to scholars, contributing to its diffusion in the scientific community. I suggest the framework for considering team and board in ASOs containing the group structure and processes. Finally, I try to provide some directions for future research through which the number of scholars, who wish to participate in the growing academic spin-off research and contribute to the studies on group level, will hopefully be increased.

The paper is structured in several parts. This introduction (section 1) is followed by a methodology (section 2). Next, I present the results of the scope study of prior academic spin-off and new venture team/board research (section 3). Then, I discuss findings along two dimensions, structure and processes in the team/board, and propose future research directions (section 4). Finally, I conclude and present implications and limitations of this study (section 5).

2. Methodology

The literature review process is “a key tool used to manage the diversity of knowledge for a specific academic inquiry” (Tranfield et al. 2003: 208). Conducting a literature review often enables the researcher to map and assess the existing body of knowledge and to identify specific research questions to direct future research (ibid). A rigorous literature review starts with the scope study to assess the relevance and size of the literature and to delimit the subject area (ibid). Within management, scope studies may need to consider cross-disciplinary perspectives and alternative ways in which a research topic has previously been tackled. In this paper, the scope study of academic spin-off research provided an indication that there is a need for more studies on team and board. The importance of the topic was ascertained by considering previous studies on team and board in high-tech new ventures.

To develop a comprehensive overview of the ASO research and studies on team and board, I applied a three step exploration process. For initial access to the literature, I began by

studying a seminal book on academic entrepreneurship by Scott Shane (2004). By collating the spin-off papers, which had previously been published in various academic journals and using own research, Shane's book provided an immediate and accessible entry into the literature on academic entrepreneurship. Next, I identified and studied the special issues and review articles published on topics related to academic entrepreneurship.

In step two I attempted to track all relevant articles referred to by any of the articles analyzed in the previous step. To avoid reference bias, I used electronic databases like ABI/INFORM, EBSCO, Science Direct and JSTOR to identify all scholarly spin-off articles published in refereed journals. About 65 articles that studied the academic spin-off phenomenon were selected. Next, I read and analyzed each article to create a database in which the following data were coded: (i) author name(s) and journal of publication, (ii) year published, (iii) geographical location of the ASO cases, (iv) theory, (v) method, (vi) unit of analysis, and (vii) research focus of the article (see Table 1). The database is mainly adapted from the spin-off literature review by Djokovic and Souitaris (2008). However, I additionally identified ASO studies published in 2006-2007, and for all reviewed articles I specified the geographical location of the focal cases (not authors), sample size and content, unit of analysis, and research focus. The unit of analysis, following Lockett et al. (2005), may be region, public research organization (e.g. university or research institute), technology transfer office (TTO), incubator, venture, network, team, or individual. I also re-categorized theories used in the articles and noted which theory was used in-stead of the basic distinction between empirical, conceptual and theoretical papers applied by Djokovic and Souitaris (2008). This additional re-categorization is marked by a star symbol in the table overhead and in italics in table 1.

In the final step, since there are few studies on team and board level in ASO research I went through a process similar to the one described above to identify articles pertaining to the topic of entrepreneurial teams and boards in high-tech new ventures. I studied the reviews of the new venture team literature by Cooper and Daily (1997) and Birley and Stockley (2000) and a seminal review book on board research by Huse (2007), which provided me with initial references. Then I used electronic reference retrieval services to track all relevant articles. Finally, I read and analyzed these articles and created a detailed database in which I coded the following data: (i) author name(s), year and journal, (ii) theory, (iii) industry/firm type, (iv) dependent variable(s), (v) independent dependent variable(s), (vi) control variable(s), (vii) method, and (viii) main findings. The database is presented in Table 2. Five of the fourteen board articles consider small and medium firms without specifying industry, and two articles

consider firms in hotel and banking industry. Their inclusion is justified due to few studies on boards in high-tech new ventures, and that they use value-added, as opposed to agency, approach.

Research synthesis relates to methods for summarizing, integrating and, where possible, accumulating the findings of different studies on a topic or research question (Mulrow 1994; cf. Tranfield et al. 2003). The simplest and widely used form of synthesis is a narrative review that attempts to identify what has been written on a subject or topic (Tranfield et al. 2003). An alternative approach to synthesis is meta-analysis, which enables the pooling of data from individual studies to allow for an increase in statistical power and a more precise estimate of effect size (Glass 1976; *ibid*). The qualitative nature of most studies on spin-off creation, which use case-based methods and are mainly concerned with processes (Rothaermel et al. 2007), makes a meta-analysis difficult to implement, since such studies rarely measure the phenomenon in the same way.

Following Tranfield et al. (2003), I use a meta-synthesis approach, which enables researcher to take into account “all important similarities and differences in language, concepts, images, and other ideas around a target experience” (Sandelowski et al. 1997: 669) The advantage of meta-synthesis is that it allows the conducting of synthesis in an interpretive and inductive manner, which is suitable when the studies are qualitative. Further, meta-synthesis is aimed at improving upon traditional narrative reviews, which have been widely criticized (Fink 1998; Hart 1998), by adopting explicit processes of bringing together the findings on a chosen theme. The results of meta-synthesis help the investigator to achieve a greater level of understanding of the topic or subject chosen.

I combine “reciprocal translations” and “lines of argument synthesis” techniques (Beck 2001), which are used when different reports address similar issues and when reports examine different aspects of the same phenomenon. The resulting data reveal the patterns regarding team and board, the analysis of which enables to distinguish between the studies of team/board structure and processes as dependent and/or independent variables. In the sections below, I will proceed with a report of the results and discussion. Following Tranfield et al. (2003), I start with providing a “descriptive analysis” of the field, presenting the results based on the conducted scope study of the ASO and new venture team/board research. Then, the “thematic analysis” is presented based on the meta-synthesis where findings, emerging patterns and future research directions are discussed.

3. Results

This section describes the results based on the scope study of the research on academic spin-off creation and the team/board in high-tech new ventures.

3.1 Academic spin-off research

There is an agreement between researchers that the spin-off stream, while producing a wealth of empirical data, is mainly a-theoretical (Nicolaou and Birley 2003a; Djokovic and Souitaris 2008; Rothaermel et al. 2007), describing different aspects of the spin-off phenomenon or exploring relationships between constructs without providing a consistent explanation to account for those relationships (O’Shea et al. 2004). Possible reasons for it are the relative novelty of the ASO phenomenon and its complexity (Djokovic and Souitaris 2008) and the embryonic stage of academic entrepreneurship in the life cycle of academic fields (Kuhn 1962), where “a 25-year history is considered a very short time when compared with, for example, the 50-year history of strategy or the more than 225-year history of economics” (Rothaermel et al. 2007: 9). In addition, as Davidsson et al. (2001) note, there is no normative or overarching theory of entrepreneurship, which also may be the reason for the empirical / a-theoretical nature of most ASO studies.

The number of theory-driven papers has been increased in the past seven years. Similarly to Djokovic and Souitaris (2008), I identified whether the article was conceptual, empirical or phenomenon-focused (see Table 1). Such judgement is subjective, and the categorization is therefore an approximation. When the paper was theory-driven, I noted which theories were used (see Table 1). Alike the broader field of entrepreneurship (Davidsson et al. 2001), academic entrepreneurship “borrows” theories from existing disciplines and fields. Among the most often used theoretical perspectives are resource-based view (31 % of reviewed ASO articles), followed by different network perspectives (23 %), including social networks, social capital, university-firm and university-industry linkages, and followed by stage-based (15 %) and evolutionary views (15 %) of the firm. The remaining 15 % had other approaches (e.g. institutional, pecking order). About a quarter of these studies have mixed approaches, e.g. the study may combine the resource-based and stage-based views.

Most of the research on academic spin-offs has been conducted in the U.S., closely following by the studies mostly of single countries in continental Europe and the studies of ASOs in U.K. Similar to the published entrepreneurship research (Davidsson 2004), the

majority of ASO studies consider the venture level of analysis (46 %). The venture-level studies are followed by the studies with public research organization (23 %), TTO (9 %) and team (9 %) as units of analysis. Thirty percent of the articles have mixed units of analysis. The reason that so few studies consider team level can be that, as Davidsson (2004) notes, it is difficult to obtain a sampling frame and/or secondary data on them.

Quantitative regression methods are most often used when studying the factors associated with the successful TTOs and public research organizations where the spin-off formation rates are high. There are slightly more qualitative, case-based methods than quantitative ones in the venture-level studies. As Rothaermel et al. (2007: 15) assess it, “the choice of methods appears to be not only a reflection of the underlying research questions, but also conditioned upon the availability of appropriate data”. Hence, it seems that it is difficult to obtain needed, preferably longitudinal data at the venture-level of analysis. Only two of six team-level spin-off articles are quantitative, and the remaining articles are qualitative and case-based reflecting the challenge of obtaining data on teams. All papers at team level are recent and theory-driven. The paper on board level is also recent and adopts a multiple-theoretical approach, with theories traditionally used in the studies of large corporations, and quantitative method. The team/board-level studies represent valuable contributions to the area and emphasize the need for more studies of team and board to better understand how these groups affect ASO development/growth.

3.2 New venture team and board studies

The studies on team and board in ASOs and high-tech new ventures are summarized in Table 2. Previous new venture team studies demonstrate that entrepreneurial teams are at the center of the crucial activities of new firms (Cooper and Daily 1997). It is recognized that many other factors influence firm performance, including the environment, the financing available, and the strategy adopted (ibid). Nevertheless, these factors are more or less related to the team which makes decisions about what markets to enter, how to compete, and how to raise financing. Thus, entrepreneurial teams are significant in their impact on their firm’s performance (Virany and Tushman 1986; Kamm et al. 1990; Eisenhardt and Schoonhoven 1990; Shane 2004). Yet, despite its importance, the entrepreneurial teams have not been extensively studied (Birley and Stockley 2000).

Table 1 A list of the reviewed spin-off articles

Authors	Year	Country*	Theory*	Method*	Unit of analysis*	Research focus*
McQueen and Wallmark (Technovation)	1982	Sweden	Empirical	Quantitative, 36 spin-offs	PRO / venture	Quantitative analysis of innovative activity and its relation to traditional academic activity at Chalmers is described.
Doutriaux (JBV)	1987	Canada	Phenomenon-focused	Quantitative, 38 firms	venture	The author observes the evolution of academic entrepreneurial firms and evaluated the effect of their links with a university.
Smilor, Gibson, Kozmetsky (JBV)	1989	US	Phenomenon-focused	Qualitative and quantitative	region	The authors develop the conceptual framework of a technopolis wheel from studying the dynamics of high-technology development and economic growth in Austin, Texas.
Smilor, Gibson, Dietrich (JBV)	1990	US	Empirical	Quantitative, 23 spinoffs	venture	Assess the factors that enhance and inhibit the formation and development of spin-out companies from University of Texas at Austin.
Roberts, Malone (R&D Manage)	1996	US / UK	Phenomenon-focused	8 R&D organizations	PRO	This paper develops five alternative structural 'models' for formal efforts aimed at spinning off new companies from universities, government laboratories, and other research and development organizations.
Carayannis, Rogers, Kurihara, Allbritton (Technovation)	1998	Various	Conceptual	Qualitative, 7 cases	venture	Examine the high-tech spin-off process through which a new company is formed from a parent organization.
Klofsten, Jones-Evans, Scharberg (JIT)	1999	Sweden	Phenomenon-focused	Qualitative	various	Examine and describe the different actors that have contributed to the development of Linköping (technological) Region.
Rappert, Webster, Charles (Res Policy)	1999	UK	Empirical	Qualitative, interview of 94 individuals in 59 spin-offs	PRO / venture	Examine the exchange of knowledge in commercial and academic networks and the implications of changes in the sponsorship, ownership, and proprietary status of knowledge for these patterns of exchange.
Steffensen, Rogers, Speakman (JBV)	2000	US	Phenomenon-focused	Qualitative, 6 cases	venture	Investigate the spinoff process of new high-technology companies from university-based research centers at university of New Mexico.
Klofsten, Jones-Evans (SBE)	2000	Ireland, Sweden	Phenomenon-focused	Quantitative	individual	Examine the activities of those academics involved with industry in Sweden and Ireland.
Feldman, Klofsten (European Planning Studies)	2000	Sweden	Evolutionary	Qualitative, one case	venture	Explore potential barriers to growth in key areas which can become increasingly problematic for some smaller to medium-sized firms as they grow and evolve from their early status as small scale spin-offs.
Chiesa, Piccaluga (R&D Manage)	2000	Italia	Empirical	Quantitative, 48 spinoffs	venture	Focus on the analysis of USOs, described USOs using both international evidence and a survey of Italian USOs.
Bray, Lee (JBV)	2000	US	Phenomenon-focused	Qualitative, 10 TTOs	venture	The paper analyzes the financial return of universities' taking equity in their spin-off companies, and the prevailing attitudes toward taking equity.

Siegel, Thursby, Thursby, Ziedonis (JTT)	2001	N/A	N/A	Overview of the Special Issue	N/A	N/A	Organizational issues in university-industry technology transfer.	
Owen-Smith, Powell (JTT)	2001	US	Qualitative, two universities	Phenomenon-focused	Case of New Mexico region, university, ASOs	PRO	Develop an explanation for widely disparate rates of new invention disclosure	
Rogers, Takegami, Yin (Technovation)	2001	US	Empirical	Empirical	Quantitative, 57 universities	PRO / TTO	Derive lessons learned about effective technology transfer from research on the technology transfer process in New Mexico over the past several years.	
Franklin, Wright, Lockett (JTT)	2001	UK	Empirical	Empirical	Quantitative, 116 universities	PRO	Examine perceptions regarding the advantages and disadvantages of inventor-entrepreneur and surrogate entrepreneur approach.	
Di Gregorio, Shane (Res Policy)	2002	US	Phenomenon-focused	Phenomenon-focused	Qualitative, case-study	venture	Investigate why some universities generate more start-ups than others by comparing the availability of VC in the university area, the commercial orientation, intellectual eminence, university policies	
Ndonzuau, Pirnay, Surllemont (Technovation)	2002	Various	Stage-based	Stage-based	Qualitative, case-study	venture	Build up a general model consisting of four key stages in the process of valorisation by spinoff.	
Davenport, Carr, Bibby (R&D Manage)	2002	New Zealand	Organizational	Organizational	Qualitative, 8 spinoffs	venture	Chart the development of Industrial Research's spin-off strategy over the past 8 years. A three-stage model is developed to describe the spin-off strategy evolution and the risks.	
Shane, Stuart (MS)	2002	USA	Social and Venture Capital	Social and Venture Capital	Quantitative, 134 start-ups	venture	Analyze how resource endowments affect the likelihood of three critical outcomes: that new ventures attract venture capital financing, experience initial public offerings, and fail.	
Feldman, Feller, Bercovitz, Burton (MS)	2002	USA	Phenomenon-focused	Phenomenon-focused	Quantitative, 124 research universities	PRO	Discuss mechanisms available to universities in managing the commercialization of intellectual property, considering equity as a technology transfer mechanism.	
Grandi, Grimaldi (SBE)	2003	Italia	External networks	External networks	Qualitative, 40 spin-offs	team	Explore the networking characteristics of the new venture founding teams.	
Nicolaou, Birley (MS)	2003	UK	Social networks	Social networks	Quantitative, 45 spinouts	team / network	Examine the network structure of the spin-off at the team level analysis.	
Lockett, Wright, Franklin (SBE)	2003	UK	Phenomenon-focused	Phenomenon-focused	Quantitative, 57 universities	PRO	Examine the option of using technology-based spinout companies.	
Siegel, Potterie (JTT)	2003	N/A	Overview of the Special Issue	Overview of the Special Issue	Applied Econometrics	N/A	Economic and managerial implications of university technology transfer.	
Nicolaou, Birley (JBV)	2003	N/A	Social Networks	Social Networks	N/A	venture	Present a typological framework of the spinout phenomenon.	
Bower (R&D Manage)	2003	Various	Empirical	Empirical	Qualitative, cases	individual	Explores a number of key issues which surround the decisions to select business models and their relation to the changing business environment.	

Meyer (R&D Manage)	2003	Various	Phenomenon-focused	Qualitative, 4 cases	PRO / venture	Discusses the phenomenon of academic entrepreneurship in the context of public support mechanisms and incentive structures.
Perez, Sanchez (Technovation)	2003	Spain	Dynamic networks	Qualitative, 10 spin-offs	venture	The paper addresses two exploratory research questions. The empirical results suggest that technology transfer and networking at university spin-offs decreased after their early years but at the same time the relationships with customers increased. Explore the joint venture route to commercializing university owned intellectual property.
Wright, Vohora, Lockett (JIT)	2004	UK	RBV, Stage-based	Qualitative, 4 cases	venture	Synthesize existing research by presenting a framework that captures the determinants and consequences of spin-off activity.
O'Shea, Allen, O'Gorman, Roche (Irish Journal of Management)	2004	Various	Academic entrepreneurship	Literature Review	N/A	Investigate the development of spinouts.
Vohora, Wright, Lockett (Res Policy)	2004	UK	RBV, Stage-based	Qualitative, 9 cases	venture	Explore whether the spinoff policies in environments outside of high tech clusters could explain the lack of growth potential of ASOs.
Degroof, Roberts (JIT)	2004	Belgium	Phenomenon-focused	Qualitative, 47 spinoffs	region	Entrepreneurship and University Technology Transfer.
Wright, Birley, Mosey (JIT)	2004	Various	Overview of the Special Issue	N/A	N/A	Explore typologies of spinoffs, using a Penrosean conceptualization of entrepreneurial activity.
Druilhe, Garnsey (JIT)	2004	UK	RBV, Evolutionary	Quantitative, 109 cases	venture	Describe how a team of entrepreneurs is formed in a high-tech start-up, how the team copes with crises situation and learn from these crises.
Clarysse, Moray (JBV)	2004	Belgium	Entrepreneurial teams	Qualitative, 1 ASO case	team	How and why do research-based start-ups differ at founding? A resource-based configurational perspective.
Heirman, Clarysse (JIT)	2004	Belgium	RBV	Combined, 123 research-based start-ups, 18 VCs	venture	Proximity as a resource base for competitive advantage: University-industry links for technology transfer
Lindelof, Lofsten (JIT)	2004	Sweden	University-industry links	134 on-park firms, 139 off-park firms	PRO, venture incubator	Investigate the impact of internal characteristics on university spin-off activity. Focus on resources and capabilities explaining variation in spinoff behavior.
O'Shea, Allen, Chevalier, Roche (Res Policy)	2005	US	RBV	Quantitative, 141 universities	PRO, incubator	Investigate the effects of particular resource sets on two university commercialization activities: the number of spin-offs and the number of IPO firms to which university had previously licensed a technology.
Powers, McDougall (JBV)	2005	US	RBV	Quantitative, 120 institutions	incubator	Assess the impact of university resources and routines/capabilities on the creation of spinout companies
Lockett, Wright (Res Policy)	2005	UK	RBV	Quantitative, 122 universities	TTO	

Grandi, Grimaldi (JBV)	2005	Italia	Phenomenon-focused	Quantitative, 42 spin-offs	Venture, individual	Investigate organizational factors affecting the process through which new ventures are established by academics and are likely to affect their performance.
Clarysse, Wright, Lockett, Velde, Vohora (JBV)	2005	Various	Stage-based, Evolutionary	Qualitative and Quantitative	incubator	Explore the different incubation strategies for spinning-out companies employed by European Research Institutions.
Leitch, Harrison (R&D Manage)	2005	UK	Phenomenon-focused	Qualitative	TTO	Consider the efficacy and appropriateness of the university technology transfer office becoming involved in second-order spinout activities.
Markman, Phan, Balkin, Gianiodis (JBV)	2005	US	Phenomenon-focused	Quantitative, 91 interviews with TTOs	TTO	Examine the impact of the involvement of TTOs on the speed of the innovation.
Lockett, Siegel, Wright, Ensley (Res Policy)	2005	UK	Knowledge-based view	Overview of the issue	various	Consider the managerial and policy implications of the rise of spinoffs at public research institutions, based on knowledge-based view of the firm.
Johansson, Jacob, Hellström (JTT)	2005	Sweden	Social networks	Qualitative, 4 cases	venture / PRO	The relationship between universities and ASOs is investigated, with special emphasis on the antecedent conditions of, and the nature of the PRO linkages that the spinoffs form, as well as the means for sustaining them.
Link, Scott (Res Policy)	2005	US	Empirical	Quantitative	venture	Present findings from an analysis of the determinant of the formation of ASOs within the university's research park.
Ensley, Hmieleski (Res Policy)	2005	US	Institutional isomorphism	Quantitative, 102 spinoffs, 154 high-tech firms	team	Test for differences in top management team composition, dynamics and performance between ASOs and independent high-technology new ventures.
Markman, Phan, Balkin, Gianiodis (Res Policy)	2005	US	Organizational entrepreneurship	Quantitative, 128 TTO directors	TTO	Consider a complex set of relationships between university TTO structure, strategy, new venture formation, and business incubation.
De Coster, Butler (Technovation)	2005	UK	Empirical	Quantitative	venture	Assessment of proposals for new technology ventures: characteristics of ASOs.
Moray, Clarysse (Res Policy)	2005	Belgium	RBI, institutional	Qualitative, 1 PRO	PRO	Institutional change and resource endowments to science-based entrepreneurial firms.
Rothaermel, Thursby (Res Policy)	2005	US	RBI, absorptive capacity	Quantitative, 79 spin-offs	venture	The authors focus on two types of university linkages to the sponsoring institution: a license obtained from the university and a link to university faculty, while controlling for incubator firm linkages to non-sponsoring research universities.
Walter, Auer, Ritter (JBV)	2006	Various	Networks	Quantitative, 149 spin-offs	venture	Investigate the impact of network capability and entrepreneurial orientation on university spin-off performance.
Mustar, Renault, Colombo, Piva et al. (Res Policy)	2006	Various	Review spinoff typology	N/A	venture	Review the literature on research-based spinoff (RBSOs) typologies to develop a taxonomy of RBSOs.

Author(s)	Year	Country	Entrepreneurial teams	Qualitative, 10 cases	team	Examine the dynamics of entrepreneurial teams as they evolve through the different stages of a spin-out process.
Vanaelst, Clarysse, Wright, Lockett, Moray, S'Jegers (ETP)	2006	Various	Entrepreneurial teams	Qualitative, 10 cases	team	Examine the dynamics of entrepreneurial teams as they evolve through the different stages of a spin-out process.
Wright, Lockett, Clarysse, Binks (Res Policy)	2006	Europe	Peking order	175 universities, TTOs, 119 VC funds / firms	PRO, TTO, venture, VCs	Examine the problems faced by those university spin-out companies seeking to access venture capital and compare perceptions of high-tech venture capital firms that invest in spin-outs with those that do not, and also consider VCs' views on spin-outs versus other high-tech firms.
Forbes, Borchert, Zellmer-Bruhn, Sapienza (ETP)	2006	US	Resource-based, social networks	Qualitative, 3 ASOs	team	Explore the process of entrepreneurial team formation and identified resource-seeking and interpersonal attraction as primary alternative motivators for new teammate addition.
Jong (Industrial and Corporate Change)	2006	US	Organizational capabilities	Qualitative, 2 cases	region, PRO, venture	Examines how the organizational capabilities of ASOs in new industries are shaped by the organization of the research communities in universities from which these spin-off firms emerge.
Clarysse, Knockaert, Lockett (SBE)	2007	Belgium	Agency theory, resource dependence, social network	Quantitative, 140 firms	team / board	The authors examine the tensions that exist between the founding team and external equity stakeholders in determining the presence of outside board members. In particular they focus on whether or not the outside board members have either complementary or substitute human capital to the founding team.
Mosey, Wright (ETP)	2007	UK	Human capital, social capital	Quantitative, 44 interviews with people involved in ASOs	individual	Examine the development of social capital by three types of academic entrepreneurs with differing levels of entrepreneurship experience: nascent, novice, and habitual entrepreneurs using a longitudinal study.
Rothaermel, Agung et al. (Industrial and Corporate Change)	2007	All	Literature review	N/A	All	Present a detailed literature analysis of the stream of research on university entrepreneurship. Four major research streams emerge in this area of study: (i) entrepreneurial research university, (ii) productivity of technology transfer offices, (iii) new firm creation, and (iv) environmental context including networks of innovation.
Djokovic, Souitaris (JBV)	2008	All	Literature review	N/A	All	Provide a comprehensive literature review of the phenomenon of spinouts from academic institutions.

* This table is adapted from Djokovic and Souitaris (2008) and updated with regard to the articles published in 2006-2007, geographical location of the focal cases (not authors), sample size and content, unit of analysis, and research focus.

Notes: *Phenomenon-focused* studies describe or explore the new phenomenon, or identify relationships between constructs based on a practical logic (i.e. without building on theoretical perspectives).

Abbreviations: **ASO** academic spin-off firm; **PRO** public research organization (university, research institute); **RBV** resource-based view; **TTO** technology transfer office; **VC** venture capital firms.

Journals: **ETP** Entrepreneurship Theory and Practice; **JBV** Journal of Business Venturing; **JTT** Journal of Technology Transfer; **MS** Management Science; **R&D Manage** R&D Management; **Res Policy** Research Policy; **SBE** Small Business Economics; **VC** Venture Capital: An International Journal of Entrepreneurial Finance.

Team characteristics have been carefully examined by the researchers of strategic management, organizational behaviour and social psychology (cf. Clarysse and Moray 2004). One may distinguish between roughly two research streams: the social psychology and demographic stream (ibid; Birley and Stockley 2000). The social psychologists have studied conflict, problem-solving, decision-making and other processes and outcomes within the boundaries of the group. The demography researchers have used e.g. age and tenure as proxies for experience and maturity accordingly and other demographic characteristics, which could be measured more accurately than the processes. The “upper-echelons” demography researchers applied the demographic proxies to top management teams.

The relatively infant research on new high-tech venture teams seems to be influenced by the team theories and frameworks used in neighbouring disciplines. The theory-driven new venture team studies therefore adopt either group psychology (e.g. Ensley et al. 2002; Ruef et al. 2003) or demographic approaches (Beckman et al. 2007; Zimmerman 2008). Hence, there is a high percentage of quantitative studies, which link team characteristics to firm performance at a certain point in time (see Table 2 pages i-iii) or link team, firm and other characteristics to team change/turnover (see Table 2 pages iv-vii). A handful of the studies are qualitative and look at team processes primarily in ASOs.

Due to the overlap of the team and board (see Fig. 1) and an active involvement of outside directors in ASOs, the spin-off studies that focus explicitly on the team in an ASO often look implicitly at the board (e.g. Vanaelst et al. 2006). And vice versa, studies that focused on boards also considered teams (e.g. Filatotchev et al. 2006; Clarysse et al. 2007). Confusion related to what constitutes an entrepreneurial team in growth-oriented new ventures also exists (Cooper and Daily 1997). This is not clear since various studies define a team differently. Kamm et al. (1990) suggest that a team consists of two or more individuals who are involved in the pre-startup activities and who formally establish and share ownership of their new firm. Eisenhardt and Schoonhoven (1990) define team members to be founders if they worked full-time in executive-level positions when the firm was founded. Ensley et al. (1998) state that individuals have to fulfill three criteria in order to be considered members of the team: they (1) have jointly established a firm; (2) have a financial interest; and (3) have a direct influence on the strategic decisions of the firm. Other researchers have made the equity stake condition stricter and have imposed a minimum equity stake before one can be considered a member of the entrepreneurial team (Ucbasaran et al. 2003).

Table 2 Summary of the reviewed studies on team and board in academic spin-offs and other high-tech new ventures

<i>(i) Team studies with team structure and processes as independent variables (and firm performance as dependent variable)</i>							
Article	Theory	N, industry	Y (DV)	X ₁ , etc. (IV)	Controls	Method	Main findings
Beckman, Burton, O'Reilly 2007 (JBV)	Human capital, social capital, TMT demography	161 young HTBFs, <10 years old, Silicon Valley	<i>Firm performance</i> : Obtaining VC funding, going public	Team functional diversity; affiliation diversity (n. of unique prior companies), affiliation overlap (the same prior comp.); TMT entrances, TMT departures	Team size, Prior start-up and senior management experience, tenure, Firm size, Industry type, VC funding (in IPO analyses)	Event-history analysis, Cox models	Functional and affiliation diversity of the TMT increase the likelihood of Y. Entries to and founder exits from the TMT increase the likelihood of IPO.
Eisenhardt, Schoonhoven 1990 (ASQ)	Upper-echelon theory	92 semiconductor firms 1978-1985	<i>Firm growth</i> (difference in sales in each year through 1988 relative to sales at founding)	Environmental measures (market size, stage, competitive concentration). Strategy measures (technical innovation). TMT joint experience, size, industry experience.	n/a	Regression model a 4-year lag, event history analysis, other regressions	Team size, joint experience, and heterogeneity in industry experience are linked to growth. Strong teams established firms in non-growth markets, weak teams started in growth markets.
Ensley, Pearson, Amason 2002 (JBV)	Conflict and cohesion literature	70 new ventures Inc. 500. Founders with least 10% equity stake	<i>New venture performance</i> (sales growth, profitability)	Cognitive and affective conflict, cohesion	Firm size, age, TMT size.	ANOVA Subgroups: odd and even number of team members.	Cognitive and affective conflicts are positively related. Cohesion positively relates to new venture performance: sales growth, not profitability.
Francis, Sandberg 2000 (ETP)	Friendship within entrepreneurial teams, entrepreneurial team literature	n/a	<i>Team and venture performance</i>	They consider different friendship's effects on team formation, functioning and stability (reversed turnover) and on venture performance	n/a	Conceptual paper	Friendship is negatively related to subsequent turnover. Higher levels of friendship within a team may increase the likelihood of turnover (following the departure of the founding CEO) and simple departure from the team.

<i>(ii) Team studies with team structure and processes as independent variables (and firm performance as dependent variable)</i>							
Article	Theory	N, industry	Y (DV)	X₁, etc. (IV)	Controls	Method	Main findings
Hmieleski, Ensley 2007 (JOB)	Leadership and team literature	Inc. 500 sample and random sample of new ventures	<i>New venture performance</i> (revenue growth and employment growth)	Empowering and directive leadership behaviour, TMT heterogeneity (functional, educational, level, and skill), industry environmental dynamism (# establishments, employees, revenue, R&D intensity)	Firm age, revenue and TMT size	Confirmatory factor analysis of IVs in LISREL. Hierarchical moderated regression analysis	In dynamic industry environments, start-ups with heterogeneous TMTs were found to perform best when led by directive leaders and those with homogeneous TMTs performed best when led by empowering leaders. Reverse for stable industry environments.
Packalen 2007 (ETP)	The role of status, demographic features and social capital in founding teams' abilities to obtain resources	n/a	<i>Venture/team performance:</i> Ability to obtain outside resources, via initial cognitive legitimacy	Status of the founding team, firm's initial cognitive legitimacy. Demographics: prior management, founding and joint work experience. Industry status. Social capital - number organizations affiliated with team members.	n/a	Theoretical paper with two illustrative cases	Propositions and cases suggest that the presence of one type of capital may reduce the dependence on or need for others. The model is applicable to many industries from high-tech (bio-, nanotechnology, ICT) to restaurant and movie.
Smith, Smith, Olian, Sims, O'Bannon, Scully 1994 (ASQ)	The impact of team demography and processes on firm performance	53 high-tech firms	<i>Firm performance:</i> Growth in sales, ROI	Team demography: size, tenure, heterogeneity. Team processes: social integration, communication frequency, informal communication	Firm size, past performance, industry growth rate	Hierarchical regression and path analysis in LISREL	Not only demography, but also team processes have a direct impact on performance. (+) relationship between team social integration and performance (ROI, sales growth) and (-) relationship between communication frequency and performance are supported.

<i>(iii) Team studies with team structure and processes as independent variables (and firm performance as dependent variable)</i>							
Article	Theory	N, industry	Y (DV)	X _i , etc. (IV)	Controls	Method	Main findings
Weinzimmer 1997 (Journal of Small Business Management)	Article tests the applicability of TMT variables on small-firm growth	74 firms with mean # of 54 employees.	<i>Firm performance:</i> Sales growth	Team heterogeneity, size, age of team members.	Compared with 114 large firms with over 100 employees.	Correlation analysis	Support: Functional heterogeneity (+); team size (+); average age of team members (+). No Support: industrial heterogeneity (+).
Virany, Tushman 1986 (JBV)	The authors argue for demographic data. Both CEO and team are important.	59 minicomputer firms established 1968-71	<i>Firm performance:</i> ROA	Industry and functional background. Organisational crisis. Tenure for CEO, executive team. Presence of founder: whether CEO is founder, whether CEO is board chair. Inside CEO recruitment. Management owned firm	Average Industry ROA	Quantitative	Successors recruited in response to organizational crisis will have characteristics which differ from their predecessors. High performing firms are more likely to have the founder present. The characteristics of successful teams will shift over time.
Zimmerman 2008 (ETP)	Signalling theory. TMT characteristics: functional and educational team background, age, tenure	172 software firms undergoing IPO in 1993-1997	<i>Firm performance:</i> The amount of capital raised at IPO	Heterogeneity in the TMT's functional background, education, age, tenure	Year of IPO, high IPO activity, Firm age, TMT size, Equity raised, Prior sales, Team tenure, Underwriter reputation, VC backing, entrepreneurial and founder experience heterogeneity	Hierarchical multiple regression analysis	Support for functional and educational background heterogeneity (+). No support for age (+) and tenure (+).

<i>(iv) Team studies with team structure and processes as dependent variables</i>							
Article	Theory	N, industry	Y (DV)	X ₁ , etc. (IV)	Controls	Method	Main findings
Boeker, Karichali 2002 (AMJ)	Life cycle theory: human development, the role of power and influence, demographic arguments	78 semiconductor firms	<i>Team Change:</i> Founder departures (431 founders at risk of departure)	Firm size, age, firm growth, founder ownership, ownership concentration (top four owners), board insiders (employees on board), founder's R&D responsibility and industry experience, whether CEO is founder	Public ownership, team size, team growth industry growth (change in sales of the market), board size	Continuous-time event history analysis, Transition data analysis	Support for firm size (+), U-shaped relationship between Y and growth, founder ownership (-), board insiders (-), founders in R&D (-), CEO-founder (-). No support for firm age (+), industry ownership concentration (+), industry experience (-).
Boeker, Wilbank 2005 (Organization Science)	Life cycle, organisational adaptation literature	86 semiconductor firms founded in 1983-1995, Silicon Valley	<i>TMT change</i> (additions and departures)	Firm growth, strategic diversification (increase in number of product groups), team industry experience, functional diversity. Inside, CEO and VC ownership. Outside and VC directors.	Firm size, age, team size, industry growth, public ownership	Annual observations, first 7 years. Ordered probit estimation	Support: Firm growth (U-shaped relationship), industry experience (-), functional diversity (-), inside ownership (-), CEO ownership (-), VC ownership (+), VC directors (+). No support: Strategic diversification (+), outsiders (+).
Chandler, Honig, Wiklund 2005 (JBV)	TMT literature, environmental dynamism, firm stage of development	I. 408 Swedish nascent entrepreneurs II. 5-year-old 79 US ventures	<i>A. Team turnover</i> (additions and departures); <i>B. New venture performance</i>	A. Industry dynamism, Stage of development, Initial team size, Demographic and functional team heterogeneity. B. Team departures, team additions. Task environment dynamism and stage moderate the relationship between additions, departures, and performance.	I. Industry: service, trading, manufacturing. II. Four groups: manufacturing, retail, business services, others.	I. Binary logistic regression II. Hierarchical regression. Moderating relationships were tested by moderated regression analysis	I. A. Support for: Team size influence additions (+) (not departures). B. Additions influence performance (-). II. Support. Teams are likely to add members in unstable environments (not to remove); Team size influences departures (not entries); Heterogeneity (education, industry tenure, functional specialization) is positively related to additions. Industry tenure - to departures (+). Dynamism and stage moderate the link between additions/departures and performance.

<i>(v) Team studies with team structure and processes as dependent variables</i>							
Article	Theory	N, industry	Y (DV)	X _p etc. (IV)	Controls	Method	Main findings
Clarysse, Moray 2004 (JBV)	Spin-off and TMT literature	One academic spin-off case	Entrepreneurial <i>Team formation</i>	Sequence of events: idea, pre start-up, start-up, post start-up phases. Team-related issues: the venture champion, role development, work time flexibility, project management and techn. evolutions	n/a	Single longitudinal case study	One should enable experiential team learning. Entrepreneurial team formation may be seen as a process of self-organized punctuated equilibrium: start-up is a revolution, then equilibrium period comes, capital increase is a new shock, new equilibrium comes etc.
Ensley, Carland, Carland, Banks 1999 (International Journal of Management)	Entrepreneurial team literature	8 entrepreneurial teams	<i>Team structure and functioning</i>	n/a	n/a	In-depth interviews	The authors argue for the lead entrepreneur who shapes and maintains the organization's collective vision and that entrepreneurial teams act as management teams in entrepreneurial organizations
Ensley, Hmieleski 2005 (Research Policy)	Institutional isomorphism. TMT members' education, industry and functional expertise, skills. Team shared strategic cognition, potency, cohesion, conflict	102 high-tech USOs, 154 independent high-tech new ventures	<i>Team composition and dynamics</i> in two groups. <i>New venture performance</i> comparison.	Cohesion, conflict, potency, shared strategic cognition. Team Heterogeneity (skill, functional, educational speciality, educational level).	Firm age, firm size, TMT size	Discriminant analysis with criterion group membership. New venture performance comparisons. Multiple regressions.	Support: USO have less heterogeneous teams than independent ventures. Independent TMTs develop higher levels of group potency, cohesion, idea conflict, shared str. cognition, and lower levels of relationship conflict than USOs. Team composition and group dynamics account for a significantly lower portion of variance in firm performance in USOs. USOs perform lower than ind. start-ups.

<i>(vi) Team studies with team structure and processes as dependent variables</i>							
Article	Theory	N, industry	Y (DV)	X _i , etc. (IV)	Controls	Method	Main findings
Forbes, Borchert, Zellmer-Bruhn et al. 2006 (ETP)	Human, social capital, RDV; attraction theory, social networks	3 university spin-offs	<i>Turnover</i> : Team member addition	Identification and timing and sequence of addition	Conflicting explanations for new member addition	Case studies	Several explanations for new member addition based on resource-based theories, social network theories, timing theories.
Hellmann, Puri 2002 (The Journal of Finance)	The impact of venture capital on the development of new firms	173 start-ups in Silicon Valley	<i>Turnover</i> (1 if hired outside CEO, 0; not one of the original founders). Time-to-Turnover (from birth to turnover).	VC funding. Time-to-VC. Firm industry, age. Model V. Firm states: IPO, product on the market, nothing-to-show.	Model IV. DV: Accommodating turnover (founder becomes board chair), Separating turnover (founder leaves the firm).	Probit regression (Turnover), Cox Regression (Time-to-turnover)	Obtaining VC is associated with a higher likelihood of appointing an outsider to the position of CEO. The effect of VC is strongest in the nothing-to-show phase, still strong in the product phase, insignificant for IPO firms.
Ruef, Aldrich, Carter 2003 (American Sociological Review)	Sociological literature on group composition, based on homophily, functionality, status expectations, network and ecological constraint	816 US founding teams, panel study of PSED	Number of founding teams conforming to a particular combination of socio-demographic and relational characteristics	Team size, industry, gender of member, gender composition of multimember team, ethnic composition, occupational and relational composition.	n/a	Structural event analysis	Homophily and network constraints based on strong ties have the most pronounced effect on group composition of the teams in US. Social isolation (i.e. exclusion from a group) is more likely to occur as a result of ecological constraints on the availability of similar alterations in a locality than as a result of status-varying membership choices.
Ucbasaran, Lockett, Wright, Westhead 2003 (ETP)	Human capital	Small and medium sized private firms	<i>Turnover</i> : Team member entry (1/0, founding-1990/91-2000), Exit	Team size, Team age, Family firm, Functional experience, Entrepreneurial experience	Firm size, Age, Industry, External environment (hostility)	Logistic regression analysis	Support for team size and team member entry (-), family firm team and team member exit (-), entrepreneurial experience and exit (+).

<i>(vii) Team studies with team structure and processes as dependent variables</i>							
Article	Theory	N, industry	Y (DV)	X _i , etc. (IV)	Controls	Method	Main findings
Vanaelst, Clarysse, Wright, Lockett et al. 2006 (ETP)	Team structure and performance. Cognitive and affective conflict. Shared cognition: support, rules, goal, and innovation oriented teams	10 USOs in Belgium. The level of analysis is a spin-out process. Unit of analysis – entrepreneurial team.	Entrepreneurial team development / evolution. Team heterogeneity: experiential, entrepreneurial and cognitive	n/a	n/a	Case studies	New members do not introduce another perspective on how to do business. Newcomers reinforce the cognitive homogeneity (support and innovation oriented people) and they are not business developers with different goal orientation (similar strategic orientation). Conflicts are the reason for departure. Resources are the reason for team addition.
Wiersema, Bantel 1993 (SMJ)	Organizational adaptation framework, the role of environment	85 manufacturing firms, 380 individuals within TMT	TMT turnover (the proportion of team members in 1980 who were no longer with the firm in 1983)	Environmental munificence, instability, and complexity – all influence firm performance (ROA), strategic change, and demographic heterogeneity (tenure, education curriculum)	Mean age, mean firm tenure, mean team tenure	Path analysis	Strategic change, environmental instability and complexity have significant effects on turnover (not heterogeneity). Indirect effects of environmental factors through firm performance were not supported. Firm performance was not significantly associated with turnover.
<i>Board studies with board structure and processes as independent variables (and firm performance as dependent variable)</i>							
Daily, Dalton 1992 (JBV)	Boards in small and entrepreneurial firms	100 firms in UK	Firm performance: Investor and accounting returns	Founder-CEO, CEO duality, CEO-chair, percentage of outside directors, total number of directors	n/a	MANOVA, Canonical correlations	There are benefits of having outside directors. Modest performance advantages were found with greater numbers and proportions of outside directors.

<i>(viii) Board studies with board structure and processes as independent variables (and firm performance as dependent variable)</i>							
Article	Theory	N, industry	Y (DV)	X _p , etc. (IV)	Controls	Method	Main findings
Fredriksen, Klofsten 1999 (Babson Proceedings)	Board literature, board typologies	68 managers of VC-backed companies and 68 venture capitalists	<i>Firm performance</i> . Sales, profits, financial resources, market share, R&D activity, organization development, etc. "according to plan".	Formal power of the CEO and the board. Insiders/outside. Lack of director independence. Start year for the portfolio companies, Number of employees, Share owned by VC, R&D activity in %, portion that is seed or start-up phase, VC or outside chairman.	n/a	ANOVA	There are two different types of governance structures: formal board related and informal trust and openness related. Firms where a power over decision-making is equally distributed between the CEO and the board have better performance. Caretaker board type has the best performance.
George, Wood, Khan 2001 (E&RD)	Linkages with external environment, board interlocks	Banking industry in the USA, 70 responses	<i>Firm performance</i> : ROA and ROE	Board various activities, networking strategy, interlock, board size, environmental hostility, entrepreneurial orientation	n/a	Simple linear regression model	Firms with a networking strategy performed better than those firms that did not actively pursue the development of networks
<i>Board studies with board structure and processes as dependent variables</i>							
Borch, Huse 1993 (ETP)	Informal strategic networks and boards	104 responses from hotels in Norway and Sweden	<i>Board's networking involvement</i>	Board composition (size, family, friendship and business relationships, employees, executives, stakeholders), trust and processes (role integration etc.), incentive (motivation)	Company size, performance, industry, localization	Correlation and multiple regression analyses	The study revealed the importance of the directors' incentives in taking care of the networking functions of contacting and lobbying.
Clarysse, Knockaert, Lockett 2007 (SBE)	Agency, resource dependency, social networks	140 Belgian high-tech startups	<i>Board's human capital complementarity</i> and substitution (R&D, commercial and financial experience)	Academic origin, VC financing, human capital of the founding team (R&D, financial, commercial experience)	Founding year, industry sector, sector experience in founding team, team heterogeneity	Binary logistic regression, regression model	Founding teams add outside directors with similar experience. Academic start-ups add outside directors with complementary human capital. VC directors are complementary if the founding team has R&D experience, and are substitutes if team has finance experience

(ix) *Board studies with board structure and processes as dependent variables*

Article	Theory	N, industry	Y (DV)	X _p , etc. (IV)	Controls	Method	Main findings
Deakins, O'Neill, Mileham 2000 (E & Innov Mgmt Stud)	The role of outsiders	23 small companies in Scotland	The <i>relationship</i> between CEO and non-executive director	n/a	n/a	46 interviews with CEOs and outside directors	An input-output model of the relationship between CEO and non-executive director in the role as consultant, counsellor, advisor, and mentor in the short and long term.
Deakins, O'Neill, Mileham 2000 (VC)	Role of VC and non-VC appointed external directors	46 interviews with founding entrepreneurs in 23 small firms in Scotland	The <i>relationship</i> between entrepreneur and external director	n/a	n/a	Qualitative and quantitative evidence	Both VC and non-VC appointed outside directors brought value-adding benefits. VC directors performed more than mere monitoring functions, they were used as a valuable resource by the founding entrepreneurs.
Fiet, Busenitz, Moesel, Barney 1997 (JBV)	Agency theory, Power theory, Board diversity, Procedural Justice theory	205 firms who had received at least one round of VC funding. Average age is 4.9 years. Average number of employees is 145.	<i>Dismissal</i> (involuntary departure) of new venture team members. 43 cases of dismissal reported.	Limits on managers' salaries, dismissal covenants to force a management change, earn-out arrangements, sales, board size, VC-controlled seats, etc.		Logistic regression	Contractual covenants limiting salaries paid to the venture managers are related to fewer dismissals. There is a negative relationship between sales improvement per employee since first-round funding and dismissal. Number of seats on the board (-). VCs on the board (+). Procedural justice (-).
Filatovchev, Toms, Wright 2006 (Int J of Mgmt Fin)	Corporate governance life-cycle, resource and strategy roles	27 university spin-offs, IPO, maturity firms, listed corporations in UK	Corporate <i>governance characteristics</i>	n/a	n/a	Qualitative (interviews) and quantitative analysis of primary and secondary data	Corporate governance parameters may be linked to strategic thresholds in the firm's life-cycle. Successful transition over a threshold is accompanied by a re-balancing in the structure and roles of corporate governance compared with each previous stage in the cycle.
Gabrielsson, Huse 2002 (VC)	Boards in VC-backed technology-based firms	n/a	Board <i>role</i>	n/a	n/a	The paper reports results from 4 studies	Boards in VC-backed firms are more active than boards in other firms. CEO and VC have diverging expectations to board roles.

<i>(x) Board studies with board structure and processes as dependent variables</i>							
Article	Theory	N, industry	Y (DV)	X ₁ , etc. (IV)	Controls	Method	Main findings
Harrison, Torres, Kukulis 1988 (ASQ)	Upper-echelon theories, power, external dependency	671 manufacturing firms COMPUS TAT	CEO, board chair <i>turnover</i> for the period 1978 to 1980, 111 CEO and 112 chair changes	Firm performance (ROA, ROE), size, risk, board insiders, structure of the top positions (CEO - chair), industry concentration, CEO and chair's age		Log-linear models, continuous-time stochastic models	Support: CEO turnover: ROA (-), firm size (+), age reached 65 (+). Board turnover: separated positions (+). The authors examined turnover for CEO - chair who remained as CEO, otherwise (in case of separated positions) left the firm.
Lynall, Golden, Hillman 2003 (AMR)	Agency, resource dependence, institutional and social network theories. Firm's life cycle stages.	n/a	<i>Board</i> composition	n/a	n/a	Conceptual paper, theoretical development	The authors show that board composition and firm performance are a reflection of both the firm's life cycle stage and the relative power of the CEO and external financiers at the time of founding. Boards are subject to path dependency, and, thus, board composition is likely to persist over time.
Pye 2004 (International Studies of Management and Organization)	The lens of social capital	UK organizations	<i>Board behaviour</i>	The impact of external relations on the internal working of boards		46 interviews in 1987-89 and interviews in 1998-2000	Chairman, CEO and their relationship affect board effectiveness/culture. Financial directors play a greater role in 2000 than in 1989, interacting with institutional investors who are also more active in 2000 than in 1989.
Rosenstein, Brune, Bygrave, Taylor 1993 (JBV)	Value-added contributions of outside board members	162 VC-backed high-tech firms in USA	<i>Value-added contributions</i> of the outside directors; <i>Firm performance</i>	Board size and composition, Contribution of VC board members	n/a	Ranked activities where external directors have been of greatest help were ranked	Outside directors' role – sounding board, interfacing with the investor group, monitoring financial performance, recruiting/replacing CEO, and assistance with short-term crisis. This help was rated higher for early-stage than later-stage companies. VC board members do not contribute more “value-added” than other outside directors in terms of firm performance.

<i>(xi) Board conceptual and review studies</i>							
Article	Theory	N, industry	Y (DV)	X _p , etc. (IV)	Controls	Method	Main findings
Forbes, Milliken 1999 (AMR)	Board processes, effectiveness and demography	n/a	n/a	n/a	n/a	Review, theoretical development	The authors have developed a model of board processes and their impact on firm performance through board effectiveness, which they integrate with demography in different types of firms.
Huse 2000 (E&RD)	Boards in SMEs	n/a	n/a	n/a	n/a	n/a	Review and research agenda
Sapienza, Korsgaard, Goulet, Hoogendam 2000 (E&RD)	Agency risks and procedural justice in boards	n/a	n/a	n/a	n/a	Conceptual paper, model development	Agency risks are proposed to increase the tendency of outside directors to focus on monitoring activities. Trust and positive attribution and the perception of fair procedures and interactions are proposed to reduce these tendencies.
Uhlener, Wright, Huse 2007 (SBE)	Private firms and corporate governance	n/a	n/a	n/a	n/a	Introduction / review article	Suggest a need to develop governance codes for privately-held firms that are flexible enough to take account of the different types of governance needs of firms at different stages in their life-cycle.

Abbreviations (journals): **AMJ** Academy of Management Journal; **AMR** Academy of Management Review; **ASQ** Administrative Science Quarterly; **E&RD** Entrepreneurship & Regional Development; **AIJ** International Journal of Entrepreneurship Research; **ENTP** Entrepreneurship Theory and Practice; **JBV** Journal of Business Venturing; **JOB** Journal of Organizational Behaviour; **SBE** Small Business Economics; **SMJ** Strategic Management Journal; **VC** Venture Capital: An International Journal of Entrepreneurial Finance.

Abbreviations (other): (+) positive relationship between independent and dependent variables; (-) negative relationship between independent and dependent variables; **TMT** top management team; **RDV** resource dependency view; **X₁, etc. (IV)** independent variables; **Y (DV)** dependent variable(s).

Vanaelst et al. (2006) attempts to clarify the ambiguity of team definition by investigating ASO cases. The authors illustrate how an entrepreneurial team evolves from the pre-founding team, consisting mainly of the researchers, to the founding team, which may include a surrogate (external) entrepreneur and is ready to legally incorporate the ASO venture. Once the new venture is legally established, the founding team divides into two major teams: the top management team and the board of directors (ibid), as depicted in Fig. 1.

Similar to ASO studies, studies on board in new entrepreneurial firms appear to be a-theoretical (see Table 2 pages vii-x) examining board typologies, the role and contributions of outside directors, the relationships between outside directors and leading entrepreneur etc. (Fredriksen and Klofsten 1999; Borch and Huse 1993; Pye 2004; Deakins et al. 2000 a, b; Rosenstein et al. 1993). One might say that these studies implicitly consider board as a means by which firms can manage external dependency (Selznick 1949; Pfeffer and Salancik 1978; Borch and Huse 1993; George et al. 2001). In small firms, due to a lack of basic resources, the various service tasks of the board will be more highly valued than in large firms (Huse 2007). The boards are shown to have an active involvement by e.g. offering legitimacy in the business community or helping with networking rather than merely performing monitoring and control (e.g. Deakins et al. 2000a, b; Borch and Huse 1993; Huse 2007). The board members are often seen as a pool of helpers, playing roles such as providing a sounding board, a shoulder to cry on or a source of advice in decision-making (Johannisson and Huse 2000). Studies on board in new high-tech firms have indicated that venture capitalists are often a key stakeholder group (Rosenstein 1988; Fried et al. 1998). Venture capitalists and other external directors may provide managerial competence and other valuable resources, all of which can be of great help for young start-ups (Deakins et al. 2000a).

Prior governance studies mainly employed agency theory and cross-sectional data on boards in large organizations (Lynall et al. 2003; Huse 2007). The research on board in new high-tech ventures, which is in its infancy, along with agency perspective, also attempts to incorporate social networks and resource dependency theories to improve our understanding of corporate governance in privately-held firms. The studies that link various board characteristics to new venture performance are quantitative and draw on frameworks, which were applied to large publicly-listed corporations. The studies that treat board composition and processes as dependent variables are both quantitative and qualitative. Few studies have sought to address the board gap in ASO research and looked explicitly at the boards in ASOs (e.g. Filatotchev et al. 2006; Clarysse et al. 2007).

In brief, the research streams studying new ASO firm creation and team/board in new ventures seem all to be in their infancy. The majority of spin-off and new venture board studies

are a-theoretical. The research on team/board not only in the context of ASOs, but also high-tech new firms is limited. Many of the theory-driven papers draw on the theories or frameworks used in neighbouring well-established disciplines and/or applied to large corporations.

4. Discussion

Currently, no literature review exists that specifically focuses on spin-off studies on group level and provides an overarching framework to encompass the different pieces making up group-level studies, e.g. team and board studies. The development of such a framework is a worthwhile attempt because it is quite hard to advance the field without an agreed-upon categorization scheme (cf. Rothaermel et al. 2007). The framework may serve as a useful tool, which makes the existing body of knowledge more accessible and easier to understand for novice researchers, which in turn should enhance the diffusion of the research topic and its impact. Therefore, in this section, I will first present the framework used to discuss team and board studies. Then, I discuss the findings within this framework.

Aranda et al. (1998) suggest a broad categorization for all types of teams including team structure (essentials like size, membership criteria, skill mix), process (group rules, participation, decision-making), culture (values, rituals, learning), and politics (conflicts, relationships with external agents). Thus, their framework accounts for team structure and processes occurring internally in the team. Although, Aranda et al (1998) touch on the subject of new member entry and team member exit as a part of team culture, they do not explicitly consider processes that cross the boundaries of the team such as team formation and change. In the reviewed studies, these processes are exemplified as crucial parts of team development which may influence an ASO's transition from academia to a commercial environment. Hence, they should be included.

In their review Cooper and Daily (1997) suggest the following three categories when considering entrepreneurial teams in growth-oriented new firms: process of team formation (recruiting, prior relationships, contributions and benefits), team functioning (roles, heterogeneity, consensus and other psychological variables), and influences of team composition (stability, size) on firm performance. Thus, they explicitly address team formation and intra-team processes. They discuss the reasons for and consequences of team member exits and their effect on firm performance; yet, they leave out new member additions during the firm's development and their influence on firm performance. The major problem is that their framework lacks an independent discussion of the team's observable structure consisting of essentials like size, membership criteria and composition. For instance, heterogeneity, which is an element of team composition, is treated under the team functioning category, and team size -

under the last category, but it is important to have a proper understanding of team essentials before proceeding to how they are related to the team processes and firm development.

The reviewed articles can basically be classified according to two dimensions: those considering team structure and those considering processes. Hence, I suggest that two main dimensions of the team should be discussed: structure and processes. Team structure includes size, membership criteria and composition (Aranda et al. 1998). Team processes include the processes across and within the team boundaries, i.e. external and internal processes. External processes are about team member addition or exit and would cross the circle of the team, which is depicted in Fig. 1. Internal processes are about e.g. conflict, cohesion and would occur within the team circle depicted in Fig. 1. Since the board is a management unit, which can be considered a team (group) and may overlap the TMT in an ASO (see Fig. 1), I propose that similar dimensions, i.e. board structure and processes, should be discussed for this unit. Thus, the framework includes the basic elements of the team/board, i.e. structure and external/internal processes. Such framework reflects that the team and board in ASOs are dynamic concepts since both units undergo changes during ASO firm development.

4.1 Structure

Forming a new team offers a unique opportunity to design a team with preferred features to increase the likelihood of team and hence firm's success (Aranda et al. 1998). Essential elements of team structure are team size, membership criteria and composition (ibid).

4.1.1 Team size, membership criteria and composition

As for the team size, large teams have been associated with success in high-tech ventures. In the study by Eisenhardt and Schoonhoven (1990) team size is linked to firm growth. Weinzimmer (1997) has tested the applicability of the “upper-echelon” TMT variables on small-firm growth and found support for positive linkages between team size and average age of team members and firm growth. Chandler et al. (2005) demonstrate that larger initial team size provides an advantage for new organizations (not more than 5 years old). In the case-based study by Vanaelst et al. (2006) the number of persons in ASO teams ranged from two to eight, depending on the venture's phase. Most studies have an “optimistic” approach implying that larger teams bring more and diverse resources to the firm, which is positive for firm's development (Beckman et al. 2007). “Entrepreneurial TMTs are often deeply involved in the choice of prospective team members”, and achieving consensus and personal chemistry is therefore assumed to be less problematic in entrepreneurial firms than in established firms

(Beckman et al. 2007: 150). These arguments need to be empirically tested in the context of ASOs.

An important aspect of deciding team composition is to look for contribution to the team and start-up rather than the proximity of team members (Aranda et al. 1998). In terms of human capital, scientist-entrepreneurs usually contribute the tacit knowledge, which is an innovative research idea or technological solution to a problem (Cooper and Daily 1997; Franklin et al. 2001). However, there is also an element of proximity. ASO founding teams are shown to be homogeneous with concentrated R&D human capital and networks limited to academia, which they utilize when trying to find potential team members during legal incorporation (Ensley and Hmieleski 2005; Mosey and Wright 2007).

When the ASO is legally established, members with commercial and industry-specific knowledge should be recruited to the TMT to enable further development (Franklin et al. 2001; Shane 2004; Wright et al. 2007). In new venture team studies greater team member heterogeneity of functional backgrounds (e.g. in terms of the functions of marketing, finance, operations, and engineering) is found to be associated with new venture success (Weinzimmer 1997; Zimmerman 2008). Other types of heterogeneity are also found to be beneficial in entrepreneurial firms. For instance, Beckman et al. (2007) find that broad access to information by virtue of having TMT members, who have worked for many different employers (affiliation diversity) and have diverse prior experience (functional diversity), tend to be associated with positive outcomes, e.g. attracting venture capital (VC) and going public. Zimmerman (2008) finds that heterogeneity in the TMT's functional background and educational background is associated with greater capital raised through an initial public offering. Eisenhardt and Schoonhoven (1990) have linked heterogeneity in industrial experience to venture growth.

Compared to independent start-ups, ASO top management teams are found to have more homogeneous teams in terms of background mix, i.e. education, functional expertise, industry experience, and skills, and have lower performance in terms of net cash flow and revenues (Ensley and Hmieleski 2005). It is recognized that obtaining VC financing is crucial for ASO development, yet, it is one of the main obstacles that ASO ventures face due to the underdeveloped TMTs and the reduced venture's credibility (Chiesa and Piccaluga 2000; Shane and Stuart 2002; Wright et al. 2006). The existing ASO research fails to identify more specifically which structural characteristics, including team size and heterogeneity, are associated with VC acquisitions successfully made by ASO ventures. Although it is known that for venture capitalists TMT quality is one of the most important funding criteria (MacMillan et al. 1985; Zacharakis and Meyer 1998), the existing studies do not give us an answer to what kind of background mix and, hence, diversity of knowledge and skills among team members is

associated with successful ASO development and positively related to achieving main entrepreneurial milestones like obtaining VC financing or going public.

Spin-off studies demonstrate that a number of public and private financing initiatives have been developed aiming to support early stage ASOs and to fill the financing gap (Lerner 2002; Leleux and Surlemont 2003; De Clercq et al. 2006; Wright et al. 2006). Type and amount of prior financing may serve as important markers of the ASO's team quality for potential external financiers, that is, the ASO team has passed through some screening (De Clercq et al. 2006; Wright et al. 2006). However, there has been surprisingly little research regarding the extent to which these public and private financing initiatives have actually improved the development of ASO firms and helped ASOs in obtaining VC financing. Also, considering that the VC acquisition is one of the main thresholds that ASO firms face due to the reduced TMT quality, there is surprisingly little knowledge regarding TMT characteristics including size and composition that are associated with successful VC acquisitions in ASOs.

Wright et al. (2004) suggest that the forming of an ASO as a joint venture may be an effective route, because the industrial partner is potentially a rich source of surrogate entrepreneurs and can supply managerial and marketing capabilities. Through cooperative strategies universities can partner with established firms in industry to pool resources, co-opt legitimacy and build credibility in order to start and develop the new venture (ibid). However, their study is based on four U. K. cases. Future studies could further test empirically and in other contexts as to what extent a joint venture commercialization route actually facilitates the ASO development and growth.

4.1.2 Board size, membership criteria and composition

Boards help firms to establish links with the external environment in order to secure resources, and a large board will handle this task better than a small board (Pfeffer and Salancik 1978). The greater the need for external linkages the larger the board should be. According to Jensen (1993), the ideal size is between seven and eight board members (cf. Huse 2007). In Scandinavian countries, the number of board members tends to be small (Huse 2007). Also, research on threshold (VC-backed) firms suggests that the board is likely to be small, with significant activity and influence shared among all members (e.g. Sapienza et al. 2000). The questions of how boards look like at different stages of an ASO's life cycle and to what extent and how the board size affects ASO development are unexplored.

During spin-off creation the intellectual property (IP) needs to be formally transferred from the university to the ASO. In return for transferring the IP to the ASO the university will commonly take an equity stake in the ASO (Clarysse et al. 2007). Hence, a parent organization

controls a strategically important resource and thus may require the presence of outside board members. The external stakeholders in ASOs are often linked to the firm by the provision of finance (ibid). Equity providers may be venture capitalists who make financial investments due to the firm's potential for significant economic returns (ibid). VC investors demand the presence of outside board members to monitor their interests (Lynall et al. 2003). Venture capitalists are considered investors who contribute value to the start-ups in excess of their monetary investments (Baum and Silverman 2004; Deakins et al. 2000a). VC investors improve the performance of the firm by shaping their strategies (Fried et al. 1998), increasing the firm's reputation (Busenitz et al. 2003) and facilitating the firm's professionalization (Hellman and Puri 2002).

New venture board studies highlight that the main benefits of having outside directors on the board are networking (Deakins et al. 2000a) and specialized commercial or marketing expertise (Rosenstein 1988). External directors may also contribute to small firm development by bringing additional informal networks, providing contacts in new markets and assisting in acquisition of resources (Borch and Huse 1993). Other roles of outside directors include counselling and advisory (Daily and Dalton 1993), impact on strategic planning processes, involvement in recruitment, training and staff development (cf. Deakins et al. 2000a).

Similar to ASO team studies, little is known about the size and composition of the board in ASOs and whether the larger and more diverse boards are advantageous for ASO development or not. The boards with more diverse experience and background mix may be more likely to have larger networks and hence provide ASOs with more connections to potential VC providers. In terms of board contribution, ASOs are demonstrated to attract outside members with backgrounds and skills which are complementary to those of the founding team (Clarysse et al. 2007). Previous governance studies theorize which competences board members should have to be effective and thus contribute to the firm's success (Forbes and Milliken, 1999; Huse 2007). For instance, board members in high-tech firms should preferably have the functional area knowledge and skills (finance, marketing etc.) and firm-specific knowledge and skills (Forbes and Milliken, 1999; Kotz 1998). Nevertheless, the research provides limited knowledge about what kind of background mix and diversity among board members actually contributes to ASO development.

Prior spin-off research demonstrates that it may be easier for scientist-entrepreneurs from higher quality institutions to attract necessary human and financial capital (Di Gregorio and Shane 2003). Yet, the knowledge about the role of the board in accessing critical resources necessary for ASO growth is limited. The researchers argue that having board members who are able to contribute to the development of the firm resources may considerably increase the ASO's

growth and survival (Filatotchev et al. 2006; Huse 2007). For instance, the qualitative evidence shows that the networking that outside directors do is experienced by small firm CEOs as beneficial (Rosenstein et al. 1993; Deakins et al. 2000a). However, there is still little evidence regarding the extent to which e.g. board networking and advising actually contribute to assembling necessary resources that would move the ASO forward.

4.2 Processes

“Teams need to be structured in a way that allows for the benefits of stability and the vitality of change” (Aranda et al. 1998: 2). Little systematic research has been conducted on the process by which teams are formed (Cooper and Daily 1997; Forbes et al. 2006) and how teams evolve from the research environments (Clarysse and Moray 2004). Despite the notion that the team is the most important factor that makes professional investors decide to enter a company (e.g. Cyr et al. 2000; Wright et al. 2006), as the VC literature points to, there is a lack of theoretical development as well as presentation of data or empirical analysis.

4.2.1 Team external and internal processes

A key element of team formation is recruitment of key persons, which depends on the competences needed and existing networks (Clarysse and Moray 2004; Forbes et al. 2006; Vanaelst et al. 2006). As spin-off studies point out, the team formation process involves interaction with external agents such as TTO officers and industry, learning to run a team and articulation of roles (Vanaelst et al. 2006; Clarysse and Moray 2004; Grandi and Grimaldi 2003). For scientist-entrepreneurs located in universities recruiting may be a particularly challenging task. There may be few opportunities to find potential co-founders who combine industry and technical expertise with the functional experience needed to form a balanced team. Such support-organizations, facilitating spin-off creation as incubators and TTOs, may play the role of intermediaries who connect researchers with such people and build a network of contacts who may be interested in investing in, and managing, technology-based spin-offs (Nicolaou and Birley 2003b).

ASO studies show that an ASO team changes over time and people added to the team have different experience than original members, but do not introduce another perspective on how to do business (Vanaelst et al. 2006). General high-tech firm research demonstrates that both fast growth and a lack of firm growth are associated with team change (Boeker and Karichalil 2002; Boeker and Wiltbank 2005). Current spin-off research provides case-based evidence on the drivers (or motives) and consequences of team member additions and departures in ASOs (Vanaelst et al. 2006; Forbes et al. 2006; Francis and Sandberg 2000). For instance,

new team members bring necessary resources or they may be recruited because of personal chemistry or readily available networks. More research could be done to explore what drives team member additions and departures, under which conditions team membership changes occur and how these changes affect ASO development. In new ventures, the consequences of team changes seem to differ depending on how far the new venture has developed (Chandler et al. 2005) and on whom leaves the team, founder or other TMT members (Beckman et al. 2007). For example, Beckman et al. (2007) find that the founder departures from the TMT and additions of TMT members increase the likelihood that a firm will achieve an initial public offering. TMT member departures, in turn, reduce the likelihood that the firm will go public.

As for internal processes, Ensley and Hmieleski (2005) find that the ASOs teams are more homogeneous in terms of internal team dynamics (i.e. shared strategic cognition, potency, cohesion and conflict) compared to independent start-ups, which may be the reason that ASOs have lower performance than other start-ups. The link between internal processes and firm performance could be better examined. Ensley et al. (2002), for example, provide evidence that TMT cohesion is positively related to new venture growth. More studies on intra-team processes (e.g. conflict, cohesion) in ASOs are welcomed additions to ASO literature. Intra-team dynamics may also be an entry point for researchers on micro level trained in psychology, a group currently obviously absent from spin-off research stream (cf. Rothaermel et al. 2007).

4.2.2 Board external and internal processes

The existing spin-off studies provide some knowledge about which board members ASO firms attract to the board during legal start-up. For example, a scientist-entrepreneur may become a board member and TTO and VC organizations may place their representatives on the board of the ASO (Vanaelst et al. 2006; Clarysse et al. 2007). Filatotchev et al. (2006) have provided evidence of 27 ASOs from UK universities as ventures facing a founder-manager/IPO (initial public offering) threshold, which requires access to external resources and expertise that may be obtained through initial board members. However, their focus was on the life-cycle of the governance and strategic dynamics in both young and established companies. Considering the facts that it may be challenging for scientist-entrepreneurs to recruit new members due to limited (academic) networks and that the board may make a considerable contribution to the ASO development (Ensley and Hmieleski 2005; Mosey and Wright 2007; Filatotchev et al. 2006; Huse 2007), additional research on how and why ASOs find and attract people to the board should be helpful.

Identified current ASO research does not provide knowledge on how a board develops through different stages of ASO development, what drives changes in board composition and

what consequences these changes have for ASO development. There is also little research on how and to what extent the board contributes to and influences team member additions and departures in ASOs. New venture board studies provide some evidence. For example, drawing on agency and power perspectives, usually applied to large corporations, researchers demonstrate that in high-tech firms greater CEO and VC ownership and increasing VC representation on the board is likely to lead to more TMT changes in terms of replacing TMT members rather than adding new members (Boeker and Wiltbank 2005; Hellman and Puri 2002; Fiet et al. 1997).

The research conducted on the board as a group (team) in ASOs was not identified. According to Huse (2007), it is not common to consider the board as a team. One reason for this is that the board meets infrequently. However, a board consists of people who have a psychological dependence on each other. Board members will thus have to relate to group norms rather than to individual norms (ibid). Forbes and Milliken (1999) integrate the demographic literature on boards with the literature on group dynamics and discuss criteria that may distinguish effective boards from ineffective ones. For boards to become more effective, i.e. meet the task expectations, researchers should focus on board socio-psychological processes, and in particular those related to group participation and interaction, the exchange of information, and critical decisions (e.g. cohesiveness, openness). There is a need to open the “black box” between board composition and firm performance (Huse 2007) to better understand how the processes within the board impact firm development.

5. Conclusion

This literature review has sought to ascertain the significance of team and board in academic spin-off companies. Team and board in high-tech new ventures is a promising, yet unexplored, research stream, and ASOs represent an interesting dynamic context for studying team and board. For researchers wishing to contribute to the spin-off studies on group level, there is an opportunity to address the existing gaps related to the TMT and board structure and processes and their relationships to firm performance. It is also an opportunity to respond to recent calls of the team and board researchers to treat both groups as dynamic entities and use other theories than those traditionally applied to TMT and board in large organizations, e.g. upper-echelon and agency theory. For instance, the resource and stage-based perspectives widely used in ASO research can fruitfully be applied in the studies on team and board in ASOs. ASO research could go beyond identifying resource endowments or scarcity at the university, TTO and individual level and focus on how TMT and board can contribute to sustained ASO development. How can team and board be important resources that add value to the ASO firm?

Team dynamics is shown to be related to ASO dynamics. Is there dynamics in board? If so, can it be related to the stages an ASO goes through?

Although the ASO research has become quite international, most published studies to date are from the U.S. and selected European countries. There are many studies on teams in ASOs from single universities. Few studies are conducted across countries. The majority of the reviewed new venture team studies are U.S. centric. Reviewed new venture board studies are primarily from selected European countries. Hence, the scholars should be careful when interpreting past results and take into consideration cultural specifics, e.g. U.S. team culture or board culture and internal processes in Great Britain. In terms of research methods, most of new venture team studies rely on survey designs. Quantitative studies on team in ASO firms could be a useful addition to existing qualitative ASO team studies, which allow the testing of generalizability of the findings. The neglected area of boards in ASOs can benefit from using inductive qualitative methods that enable generating new insights into phenomenon. Quantitative methods (e.g. regression models) applied in new venture board studies can also be drawn on when studying boards in ASOs, which may strengthen the validity of prior findings.

Overall, there is much about teams and boards in ASOs as new high-tech firms that has not been studied systematically (Cooper and Daily 1997; Davidsson et al. 2001; Shane 2004; Huse 2007), and this presents numerous opportunities for future research. One of the opportunities for research is, for instance, to investigate which structural team and board characteristics are associated with successful ASO development, and how these structural characteristics of management units together with various public and private financing options may contribute to attracting essential external financing such as venture capital. Another promising research avenue is to explore external processes that cross the boundaries of the team and board. For instance, recent studies on the formation and evolution processes in ASO teams are characterized by a limited number of cases from one region. Also, very little research has been done on the processes by which boards are formed and how they evolve. Few studies have explicitly addressed boards in ASOs and most of the literature is primarily conceptual. Hence, there is a need for more empirical investigation as well as theory development. For example, what factors influence board formation, and how the board changes over time? What is the board's contribution to TMT development? How do boards in ASOs function?

Understanding team and board has important implications for practitioners. For instance, if teams with certain structural attributes are more likely to function effectively, this has implications for lead entrepreneurs and TTOs as they work to form teams. This also has implications for venture capitalists who prior to investing are often concerned with the quality of the ASO team (Wright et al. 2006). For universities, a better understanding of teams may bring a

new knowledge of how to develop more mature teams (Ensley and Hmieleski 2005) and thus make them more attractive for investors (Wright et al. 2006). In a similar vein, if boards with certain structural attributes are more likely to be add value and function effectively and thus contribute to ASOs, this has implications for lead entrepreneurs as they look for board members. University TTOs that have a better understanding of boards are more likely to search for and network with potential board members that add value to their ASO projects.

This paper is certainly not without limitations. First, since the nature of most ASO studies is empirical, and there are still few studies on team and board in ASOs, I tried to provide some directions for future research which could develop this area. Therefore, the relationships between some variables have received greater attention, depending on whether or not they have been addressed by previous spin-off research. Future researchers may try to identify and focus on the relationships between certain variables, which have been extensively studied in other contexts or disciplines, and theorize about, or even test the applicability of, these relationships in an ASO context. Second, both the TMT and board have been quite extensively studied in other contexts (e.g. large corporations) and disciplines (e.g. social psychology), and, thus, each of them represent a broad stream of research. Arguing that team and board in ASOs as early stage firms are intertwined entities which should both be considered, I reviewed both TMT and board studies. This should not be a problem since the research on team in ASOs is in its infancy, and the research on board in ASOs is almost absent. Future research could explore the extent of the interaction between team and board and their joint influence on ASO performance. Finally, research on both team and board as groups of individuals entails several methodological issues, which are not discussed in this paper. More studies are needed to examine how academic entrepreneurship researchers can tackle the methodological issues and measurements when investigating various group characteristics and their effect on firm growth.

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PAPER 2

Exploring board formation and evolution of board composition in academic spin-offs

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Abstract

An in-depth analysis of eleven cases is used to provide insight into the neglected area of the dynamics of boards in academic spin-offs. Drawing on stage-based, resource dependence and social network theories, we explore board formation and changes in board composition occurring in Norwegian and US spin-offs. We find that these theories are important complements to earlier research on boards in technology-based new ventures. The process of board formation is mainly driven by social networks of the founders. Although we find differences in the initial board compositions in Norwegian and US spin-offs, there is convergence over time in subsequent board changes, which are mainly driven by the social networks of the board chair. Additions of key board members are associated with the progress of a spin-off developing from one stage to another. Several avenues for future research and implications are discussed.

Keywords Boards of directors, Academic Spin-offs, Stages, Resources, Social Networks

JEL Classification M13 M10

1. Introduction

Earlier board studies have mainly investigated mature firms, using samples from large US firms, agency theory and multivariate analyses of secondary data (Lynall et al. 2003; Huse 2007). Research into boards in small and entrepreneurial firms has focused on boards as a means by which new firms can manage external dependency (Selznick 1949; Pfeffer and Salancik 1978; Borch and Huse 1993; George et al. 2001). Venture capital (VC) involvement in boards of small firms has also been studied (Rosenstein 1988; Fried et al. 1998; Deakins et al. 2000; Sapienza et al. 2000). More recent research incorporates social exchange, identity, social networks, organizational justice, game and other theories to improve our understanding of corporate governance in private firms (Uhlener et al. 2007).

Still, little attention has been devoted to the board of directors in academic spin-off companies (ASOs). ASOs are usually based on technology formally transferred from the parent organization, which is a public research organization such as a university or research institute. Boards in ASOs are particularly interesting to study since ASOs are new ventures in

transition, which go through a number of stages of activity and need to develop resources and capabilities (Vohora et al. 2004) and board structure and processes (Filatotchev et al. 2006) to enable their transition from a non-commercial environment to the market.

Once resource needs have been determined and a team has been selected, it will usually be necessary to obtain additional resources from outside the venture in the startup stage (Timmons and Spinelli 2004). Scientist-entrepreneurs may attract experienced and well-connected directors to their boards who can play an important role in accessing critical external resources (Lynall et al. 2003). However, finding appropriate board members is a challenge for scientist-entrepreneurs with networks limited to peers within academia (Cooper and Daily 1997; Ensley and Hmieleski 2005; Mosey and Wright 2007). In addition, to move an ASO forward to the next development stage, the new configurations of resources and capabilities should be obtained. This can be done by attracting new external directors providing access to new resources. Thus, one might expect that different board members are needed on the board in different stages. The board composition may thus change reflecting the firm's life cycle (Lynall et al. 2003).

Few studies, however, look explicitly at the boards in ASOs. Clarysse et al. (2007) have provided quantitative evidence on board composition in ASOs. They found that high-tech start-ups, with a public research organization as an external equity stakeholder, are more likely to include outside board members with complementary skills to the founding team than ASOs with venture capitalists or founders as the main stakeholders. Filatotchev et al. (2006) have provided evidence of 27 ASOs from UK universities as ventures facing a founder-manager/IPO (initial public offering) threshold, which requires access to external resources and expertise. Vanaelst et al. (2006) studied the entrepreneurial team development in ten Belgian ASOs. They showed that after legal establishment of the venture the founding team evolves into two other teams: the management team and the board. However, their focus was on the founding and management team. Showing that the boards in ASOs may change, these studies emphasize the need for more in-depth research on changes in board composition in the firm's lifecycle. Yet, the majority of board studies has taken a snapshot of the board composition at a certain point, and linked it to performance.

Responding to these calls for a closer investigation into board dynamics, the purpose of this study is, therefore, to explore how boards are formed and how boards evolve through various stages of a spin-off process. We address this research gap by investigating (1) Which board members do ASOs add, and why, in the start-up stage? (2) When, why and how do the main changes in board composition occur during subsequent stages?

Thus, our paper extends previous research and makes a number of contributions. First, it studies boards in early stage Norwegian and US spin-offs, rarely addressed by governance studies which mainly focused on mature firms employing cross-sectional data and treating the board as a static concept (Gabrielsson and Huse 2004). Given limited prior research on board evolution we use inductive logic and in-depth cases (Glaser and Strauss 1967; Eisenhardt 1989). Second, it responds to recent suggestions in governance literature to use other theories than agency theory (Huse 2007). Specifically, we combine life cycle, resource dependence and social network theories and find that these theories are important complements to research on boards in new ventures. Third, it focuses explicitly on changes in the boards of ASOs. Accordingly, the paper adds to academic entrepreneurship research by linking board changes to development stages (Vohora et al. 2004; Vanaelst et al. 2006) and dominant tasks (Kazanjian 1988) and suggesting that board changes are associated with the progress to the next stage with outside directors contributing to overcoming critical junctures.

Below, we start by outlining our framework based on stage-based, resource dependence, and social networks theories. Next, we discuss the research design and data collection methods, followed by a presentation of the findings and a development of propositions. Finally, we conclude and discuss future research directions and policy implications.

2. Theory

To introduce a dynamic component in spin-off boards we incorporate literature on stages in new firm development. In particular, we use stage-of-growth models specifically developed for ASOs as high-tech new ventures (Kazanjian 1988; Vohora et al. 2004; Clarysse and Moray 2004; Vanaelst et al. 2006). Employing a stage-based and resource-based framework, Vohora et al. (2004) identify five stages that ASOs encounter in their development: (1) research stage, (2) opportunity framing stage, (3) pre-organization stage, (4) reorientation stage, and (5) sustainable returns stage. Furthermore, Vohora et al. (2004) argue that while the different stages are important it is the difficulties in moving from stage to stage that create critical junctures, which are the key challenges an ASO faces in its development. Critical junctures arise because the venture requires new configurations of resources, capabilities and networks if it is to progress to the next stage of development. If the critical junctures remain unresolved for a prolonged period of time, the venture will eventually fail. Four key critical junctures that spin-off companies need to overcome if they are to succeed are (1) opportunity

recognition, (2) entrepreneurial commitment by a venture champion, (3) attaining credibility in the business environment, and (4) achieving sustainable returns within their respective markets.

Other researchers (e.g. Kazanjian 1998; Clarysse and Moray, 2004; Vanaelst et al. 2006) came to a similar classification of stages: a research stage, during which the project prepares itself to formally turn into a spin-off, and a post-startup stage, during which external capitalization takes place. Each venture must pass through the previous stage in order to progress to the next one, but each stage involves an iterative, nonlinear process of development in which there may be a need to revisit some of the earlier decisions and activities. In addition, ventures face different problems that dominate during different stages. Kazanjian (1998) examined the relationship between stages of growth and the dominant tasks and found that in earlier stages the dominant tasks are product and technology development, securing finance and strategic positioning in a new product-market segment. In later stages acquisition of additional resources, sales and marketing, and organization and administration are the dominant tasks.

The legal incorporation of the company is an important entrepreneurial event marking that the company moves from the pre-startup to the post-startup era (Clarysse and Moray 2004). At this point in time the founding team evolves into the management team and a board of directors (Vanaelst et al. 2006). As shown in the study by Vanaelst et al. (2006) both the management team and the board may evolve. However, their focus was on examining changes in the founding and management team. We address this gap by focusing on changes in board accommodating stage-based aspects while seeking to understand when, why and how the changes in board composition occur in the trajectory of an ASO's development.

ASOs aim at finding appropriate board members to fill the gaps discovered in the process of forming the management team in the start-up stage (Timmons and Spinelli 2004; Ucbasaran et al. 2003). During subsequent growth stages the gaps are discovered when difficulties arise and ASOs face critical junctures. Such gaps can represent the absence of relevant experience, know-how, networks, and other current needs that can be provided by outsiders. We thus draw on the resource dependence perspective (Pfeffer 1972; Johnson et al. 1996; Pfeffer and Salancik 1978). In this view, the evolution of the board is a response to the changing resource needs in the firms. New board members are seen as resource providers playing value-adding roles in the ASO's development (Selznick 1949; Boeker and Goodstein 1991; Deakins et al. 2000; Pfeffer and Salancik 1978). Given the limited resource base of a start-up, a board of directors is an excellent vehicle for accessing scarce and/or strategic

resources (Lynall et al. 2003). Following the logic of resource dependency, new members will be selected so that they bring necessary complementary resources to the firm. The resource dependence theory is concerned with reducing uncertainty regarding the flow of capital, information and other resources at the lowest cost. Hence, the scientist-entrepreneurs who have best access to critical resources that will move the firm forward will not attract new members to the board of directors. Instead, they take a place on the board themselves.

In addition, most ventures typically look to personal acquaintances of the lead entrepreneur or team for their first outside directors (Timmons and Spinelli 2004). Scientist-entrepreneurs, considering starting their own businesses, were shown to develop social networks with TTOs and more experienced academic entrepreneurs (Mosey and Wright 2007). Social network literature is thus also relevant to our study (e.g. Granovetter 1985; Gulati and Gargiulo 1999), dealing with the influence of social networks on board formation and composition. In this view, the member addition process is driven by the actors' social relations and interpersonal attraction (Forbes et al. 2006). The implication of social network theory for new member addition is that scientist-entrepreneurs are likely to recruit board members from their existing social networks (Birley 1985; Larson 1992; Westphal 1999) so that the likelihood of adding an outside director similar to the lead entrepreneur or the team is high (McPherson et al. 2001; Zahra and Pearce 1989; Ruef et al. 2003). New members will reflect the original founders' social networks with ascribed and achieved characteristics similar to the founders.

Our integrated theoretical framework is depicted in Figure 1.

We expect that during the legal incorporation of the company the board members will reflect the existing personal networks of the founding team with characteristics similar to those of the founders, but bringing in resources that the founding team does not have. After legal incorporation the board may undergo changes as the venture needs to acquire outside resources to overcome critical junctures, solving various problems that arise in different development stages. The new members recruited in the post-startup stage will to a greater extent reflect the social networks of the existing members on board. That is, if the company has external stakeholders on the board, the composition of the board will also reflect the social networks of the principal stakeholders, such as the CEO and external financiers (Lynall et al. 2003). These new members are expected to bring critical resources that the top management team lacks, helping ASO to solve current dominant tasks and move it forward.

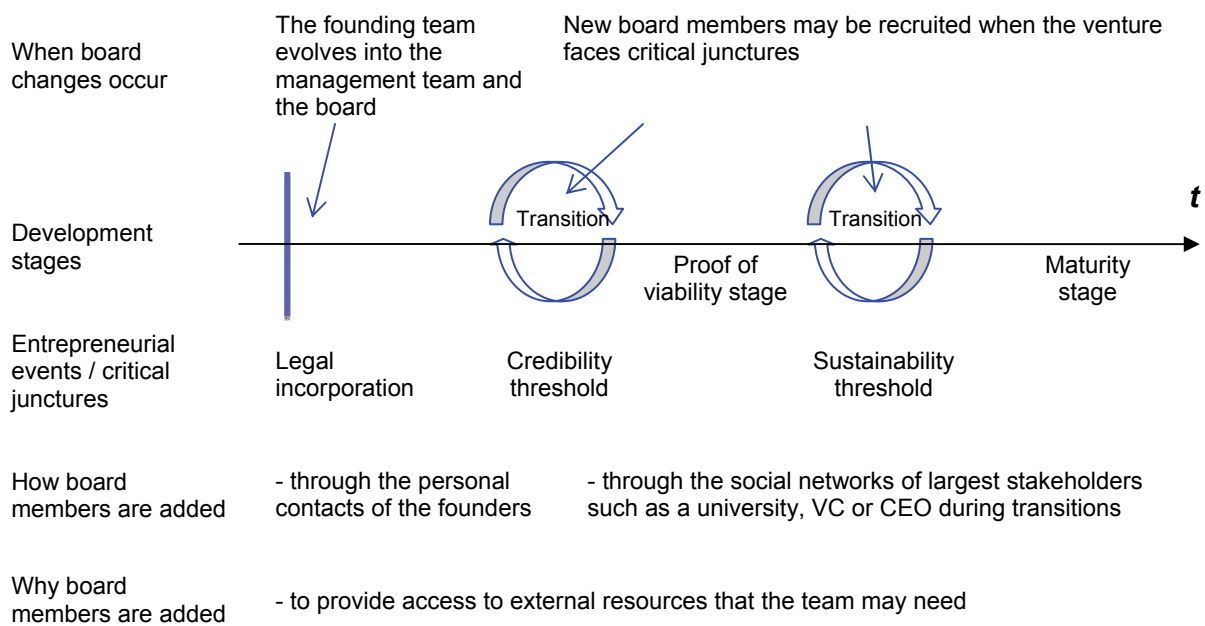


Fig. 1 Integrated theoretical framework

3. Methods and empirical context

Given limited prior research on the evolution of boards, especially for young ASOs, our research design is a multiple case, inductive study (Glaser and Strauss 1967; Eisenhardt 1989). Multiple cases allow replication. In contrast to pooled logic where each observation is part of a larger sample, replication logic views multiple cases as a series of experiments, with each case confirming or not confirming the inferences drawn from the others (Yin 1994). Single-case studies offer insight into one particular example; multiple cases provide us with empirical richness and may also generate generalizable and accurate theoretical insights (Eisenhardt 1989).

Following Eisenhardt (1989), our sample of ASOs was selected to give a substantial degree of variance regarding the stage of development, technological focus and institutional environments like university origin and VC industry support. This degree of variance is important to obtain insights into the process of how board composition changes over time and facilitates the investigation of replication across cases.

We have sampled eleven academic spin-off companies that were created to commercialize intellectual property (IP) initially generated within parent institutions. In all these companies at least one board change occurred. In all cases at least one of the scientist-entrepreneurs was still involved as a top manager (CEO, CTO, R&D director, board chair or member) – a person who had taken the venture through the founding process and who was aware of the current operations of the company. The ASOs come from five different Norwegian research institutions and three US universities. All institutions are actively pursuing technology transfer through licensing and ASOs. However, these institutions are located in different areas, and have a different orientation towards the commercialization of research. This is reflected in their cultures, values and institutional norms, seen not least in varying levels of public and VC support.

Norway has had a long history of ASOs for over a century. In international investigations, Norwegian universities and research institutes report a high number of spin-offs compared to many other countries (OECD 2003). However, until recently research results were the property of the individual professors. A substantial publicly funded support structure of technology transfer offices (TTOs), seed capital funds etc. has been built up following legislation in 2003 which was closely modelled after the US Bayh-Dole Act of 1980. Many earlier spin-offs have become support companies for large national industries like oil, gas and metal processing, while the VC industry has traditionally been weak. The recent legislative changes and strong public role in the commercialization of research may make Norway representative of smaller western European countries.

Silicon Valley, where four US cases in our sample come from, has had a strong VC industry and close informal networks between entrepreneurs (e.g. Saxenian 1994). The difference in venture capital between Silicon Valley and Michigan, where two other US cases come from, is that over a billion dollars of investments happens in the former region and about 10-20 millions in Michigan (interview with the founder of Semicon4). Some studies have found that US TTOs are relatively more oriented toward patenting and licensing than spin-offs when compared to other countries (Arundel and Bordoy 2007; OECD 2003). Thus, ASOs may be seen as fairly common in the US and Norway, but the surrounding networks and support structure vary widely.

The cases represent different technology platforms covering engineering, biology, chemistry, physics, and computer sciences. Each of the ASOs' core technology (or medicine, drug) is characterized as internationally new. All ASOs except spin-off Software have patented their core technology in and outside their country. There has been a steady growth in

employees in all cases. Finally, each case is at a different stage of development, allowing greater insights into the evolutionary aspects of board composition. Table 1 gives an overview of the sample used in our study.

Biotech spin-offs tend to develop both a board of directors and a scientific advisory board (SAB) which is beyond the focus of this study. Only one Norwegian case in our sample had a SAB, the four others did not (including another biotech company). All US cases, even the four semiconductor companies, had a scientific or technical advisory board. We asked whether members of these advisory boards had contributed by helping to find and select new board members, and this was not the case.

Data were collected through in-depth face-to-face interviews, followed by telephone interviews with representatives from the eleven ASOs from March 2006 to December 2006 in Norway and from January 2007 to May 2007 in the US. We collected background material on each of the institutions about how they organized their technology transfer activities. From this, a list of interviewees was compiled. In most cases we interviewed the current CEO who was usually one of the founders, a scientist-entrepreneur or an externally introduced “surrogate” entrepreneur (Franklin et al. 2001). In two cases we interviewed two members of the founding team on different occasions. As for Norwegian cases we could trace all board changes through the database. This limitation is thus addressed by checking the responses against the database and, if needed, asking additional questions after interviews. The original founder was an important respondent who knew the inside story of the venture throughout its entire life. The founders were targeted because they possessed the most comprehensive knowledge about the venture’s history, strategy, processes, and performance (Carter et al. 1994). Our interviews focused on different founding team and board members, their background and expertise, how they got involved in the venture etc. Additional data on the venture’s resources, strategies, and industry environment were also gathered during the semi-structured interviews and follow-up calls.

The eleven companies were between two and nine years old when the interviews were conducted. The young age of the companies and the involvement of the original founder in strategic decisions like board changes improve the likelihood of informants accurately recalling events. All interviews lasted from one to two hours and were recorded and transcribed.

Table 1 Cases overview

Firm and Board characteristics	Academic spin-offs Norway				Academic spin-offs US						
	Biomedical	Nutrimet	Optical	Chemical	Software	Biotech 2	SemiCon	SemiCon 2	Biotech	SemiCon	SemiCon 4
Establishment year	1998	1999	2001	2001	2004	1998	2000	2001	2003	2004	2004
Parent organization	The Norwegian Forest and Landskape Institute	The Foundation for Scientific and Industrial Research	Norwegian Defence Research Establishment	Norwegian University of Life Sciences	Norwegian University of Science and Technology	Stanford university	Stanford university	University of Michigan	UC Berkeley	UC Berkeley	University of Michigan
Number of full-time employees in 2007	15	7 Norway, 16 abroad	5	0	3	10	25	25	69	25	20
Degree of innovation	New technology (drug, medicine), patented internationally	Proof of viability (drug, medicine), patented internationally	Proof of viability	Proof of viability	Not patented	New technology (drug, medicine), patented internationally	In transition to Maturity	Maturity	Maturity	In transition to Maturity	In transition to Maturity
Stage of development	Maturity	Proof of viability	Proof of viability	Proof of viability	Proof of viability	Maturity	In transition to Maturity	Maturity	Maturity	In transition to Maturity	In transition to Maturity
Founding team size*	3	3	4	5	7	3	2	3	3	4	4
Positions of academic inventors held in the company (current and previous)	Product development dir., R&D dir., CEO, board members	Short period CEO, board chairman, board members	CEO, CTO, board chairman, board members	Board chairman, board members	VP technology development, VP R&D, board members	CEO, board members	CTO, President	CTO, Chief Science Officer, R&D Director, board member	VPs R&D, President, board members	President and CTO, founder / board member	CTO, board member
Board size in 2007	6	7	4	4	4	8	9	7	8	7	6
Number of board membership changes	6	6	4	2	2	8	7	7	6	3	3

* Founding team size is the number of founding team members during legal incorporation of the company, including academic founders (inventors) and surrogate entrepreneurs (entrepreneurs recruited from outside)

Besides interviews, we used several databases that contain accounting data and information on the board and top management. For the Norwegian cases we used the national registers, Brønnøysundregistrene, the official export and trade directory Nortrade, and the business search engine Purehelp. For the US cases we used the Link Silicon Valley directory supplemented by other sources, e.g. The San Jose Mercury News and extensive web searches. Such triangulation of data improved reliability by providing a check against the inaccuracy of informant responses (Yin 1994; Jick 1979). Triangulation was especially helpful in the cases where the informants in the older ASOs had difficulties recalling the date of events or names. In addition, we assured anonymity for companies and informants. Collectively, this combination improved the likelihood that the methods yield rich, detailed, and accurate accounts.

Responses from the interviews and additional information were used to develop a case study database, which included table shells to record data (Miles and Huberman 1994). These table outlines ensured that data collection focused on the research questions and verified that the same information was collected for all cases. The individual case histories ranged between 10 and 20 pages, including interview quotes, summary tables, and charts of key facts. For each case we also used a retrospective reconstruction of the early growth stage. Within-case analysis concentrated on developing generalizable and unique patterns that emerged for each firm, and proceeded in an iterative fashion with data collection to provide better grounding and improve the conceptual insights. Once the individual case studies were complete, we used cross-case analysis, relying on methods suggested by Miles and Huberman (1994) and Eisenhardt (1989) to develop common and differential factors. Conceptual insights concerning boards in ASOs were drawn out and refined during an iterative process as the case studies progressed. This iteration between theory and data helped to sharpen constructs, strengthen the internal validity of findings, and raise the generalizability of results.

4. Findings and development of propositions

As suggested by Vanaelst et al. (2006) pre-startup teams (before legal incorporation) differ from post-startup teams. This difference may have consequences for who is added to the board of directors. Pre-startup founding teams choose their first top management team (TMT) and board members during legal incorporation relying on their personal networks and estimates of additional resources they need to obtain from outside members. After legal incorporation, both post-startup team and board of directors may be involved in decisions

about board additions. Hence, in the discussion we differentiate between initial board composition, which is the result of board formation process in the start-up stage, and changes in board composition in the post-startup stages (depicted in Figure 1). A detailed description of the initial board composition, first change in board and other findings can be found in Table 2.

4.1 Who is added and why in the start-up stage

During the legal startup of the companies the founding teams consisted either solely of scientists or scientists and “privileged witnesses” (Vanaelst et al. 2006). Privileged witnesses are the advisors that guide the researchers in the pre-startup stages and with whom the researchers develop close relationships (ibid.). In our sample most of the privileged witnesses were part of the university community, e.g. TTO and incubator representatives, current and former MBA students, and industrial partners who carried out the research together with scientist-entrepreneurs. Our small data set indicates a difference between the US and the Norwegian cases. In the latter, the privileged witnesses came mainly from the TTOs, while in the US cases the privileged witnesses represented local seed funds at the university incubators and small VCs. Similar to the findings of Vanaelst et al. (2006) for Belgium, our results seem to confirm the universities’ active role as stakeholders in the development of ASOs in Norway. For the US, our data support other studies (e.g. Arundel and Bordoy 2007; OECD 2003) indicating that TTO assistance seems to be concentrated on developing patenting and licence agreements. However, further investigations are needed to compare countries, a task, which is complicated further by large differences between universities.

The advisory role of the privileged witnesses became formalized with the establishment of the board. Privileged witnesses took a seat on the board and together with scientist-entrepreneurs formally committed to the spin-off in almost all cases. In the case of Nutriment the TTO director appointed two members from his personal network, instead of taking a seat on the board himself. Only one ASO SemiCon1 formed a board which included outside members with whom the founders neither had previous relationships nor knew through personal acquaintances. This may be due to winning the first prize in the business plan competition at Stanford. As the founder stated, “After we won the business plan competition there we a lot of interest from the investors... we could pick those with experience in semiconductors...and network relevant to what we were trying to do”.

Table 2 Board composition during legal incorporation and first change in board

	Initial board composition	Board chair	Theories	1st board change: Who added / removed	How and why board members were added / removed	Board chair	Theories
Biomedical	The same as the team: 2 scientists, TTO representative	Privileged witness	Social networks (of scientists)	+ 2 outsiders	Investor through PW (TTO); industry member through new investor	New investor became chair and stayed with the company till 2007	Social networks (of PW & new investor) and RDV
Chemical	The same as the team: 4 scientists, TTO representative	Scientist	Social networks (of scientists)	- 2 inventors + 1 outsider	TTO representative was replaced	New TTO representative who stayed with the company till 2007	None
Nutritment	2 scientists, 2 TTO's acquainted	Scientist	Social networks (of PW)	+ 1 outsider	Industrial investor through new CEO	New industrial investor who stayed with the company till 2007	Social networks (of PW & new CEO) and RDV
Optical	Scientist, TTO member, 2 industrial partners (from the same research group)	Privileged witness	Social networks (of scientists)	+ 2 outsiders	Two privileged witnesses were replaced	The same person	None
Software	2 scientists, surrogate entrepreneur	Privileged witness	Social networks (of scientists)	+ 2 outsiders	Investors through PW (TTO)	New investor who stayed with the company till 2007	Social networks (of PW) and RDV
Biotech 1	The same as the team: 4 scientists	Scientist	Social networks (of scientists)	- 1 inventor + 1 outsider	Legal advisor through scientist	The same person	Social networks (of scientist) and RDV
Biotech 2	The same as the team: 2 scientists, 1 small VC	Scientist	Social networks (of scientists)	+ 3 outsiders	Investors through money raising, 1 member from industry through new investor	New member from industry who stayed with the company till 2007	Social networks (of new investor) and RDV
SemiCon 1	2 scientists, scientist's relative, 2 VCs, industrial outsider	Lead VC	Social networks (of scientists) and RDV	+ 3 outsiders	Investors and CEO through chair	The same person who stayed with the company till 2007	Social networks (of board chair) and RDV
SemiCon 2	2 scientists, 2 local seed fund members	Privileged witness	Social networks (of scientists & PW)	- privileged witness + 1 outsider	New CEO through PW	New CEO who stayed with the company till 2007	Social networks (of PW) and RDV
SemiCon 3	scientist and surrogate entrepreneur/PW	Scientist	Social networks (of scientists)	+ 1 outsider	From industry through privileged witness	New member from industry , stayed with the company till 2007	Social networks (of PW) and RDV
SemiCon 4	The same as the team: 2 scientists, 2 local seed fund members	Scientist	Social networks (of scientists & PW)	+ 3 outsiders	Investors through money raising, member from industry through PW	The same person	Social networks (of PW) and RDV

Abbreviations: “+”: addition of the member, “-”: removal of the member, *PW*: privileged witness, *RDV*: resource-dependence view

These findings spur reflections on social networks and resource dependency. Entrepreneurs do look to personal acquaintances of the lead entrepreneur or team for their first board members. The process of board formation is mainly driven by the social networks of the founders. Putting it another way, during the pre-startup stages the founders have developed professional relationships with privileged witnesses who guided the founders from the research stage until the venture was legally incorporated. Interaction with privileged witnesses turned them into “trusted informants” (Gulati and Gargiulo 1999). These social relations between the scientists and privileged witnesses were thus primary predictors of initial board composition, as social network theory implies. Hence,

Proposition 1: The board at founding will most likely consist of the scientist-entrepreneurs and people from the scientist-entrepreneurs’ networks.

4.2 When do the main board changes occur during subsequent growth stages?

Nine out of eleven cases in our sample have overcome the *credibility threshold* around and during *first change* in the board thus reaching the next Re-orientation or Proof of Viability stage. Following Vanaelst et al. (2006) *Proof of Viability* post-startup stage was characterized by proving the viability of the newly established venture and by the team bringing together necessary resources to develop it. Entrepreneurs in this stage had gained access to and acquired an initial stock of financial, human and physical resources, which were required for the business to begin to function. The credibility threshold refers to a lack of credibility that constrains the entrepreneur’s ability to access and acquire key resources: seed finance and human capital to form the entrepreneurial team (Vohora et al. 2004). Two cases that did not overcome the credibility threshold during first change were the ones that had experienced the influence of external factors - restructuring of the TTO and partner’s organizations involved in these ASOs through the board. This suggests that well-advised and deliberate board changes - as opposed to externally induced changes due to outside or unforeseen events - contribute to overcoming the threshold of credibility and taking the venture to the next stage.

The only spin-off that seemed to have become *sustainable* and reached Sustainable returns or *Maturity stage* during the second change in board composition was Biotech1. This is most probably due to extremely large investments since the firm’s inception. Maturity stage means that the venture had proven viability, and founders had built up credibility outside the

scientific community and attracted additional resources. SemiCon2 seems to have reached the Maturity stage around the third change in board composition after the second round of fund raising and selection of a manufacturing partner. Biomedical and Biotech2, the oldest cases in the sample, seem to have reached Maturity stage during the fourth change in board. For them overcoming the sustainability threshold meant going public.

SemiCon1, SemiCon3 and SemiCon4 reported to be in the *transition* stage of overcoming the sustainability threshold and reaching the Maturity stage. These respondents emphasized the iterative, nonlinear nature of the development process. For instance, the founders in SemiCon1 were close to reaching the Maturity stage, but realized that the deficiency in management hindered them “to raise revenues and develop technology as fast as we [founders] could”. So, SemiCon1 decided to replace the old CEO with a new one.

An interesting aspect of development stages in our cases is that many of the Norwegian ASOs mentioned that the first change in board was associated with “the actual start-up” of the company and overcoming the credibility threshold. Before this critical point, the companies had spent more time than planned on attracting investors, and the interviewees were disappointed with the TTOs in not being able to speed up the process. “Actual start-up” was in all cases related to finding “the right individual with the right [investor] contacts and large [industrial] networks”. None of the US spinoffs described the first change in board composition in terms of an actual start-up.

It may be added that we have observed nine founder and four outside member departures from the board during the first three changes compared to 20 outside member additions during just the first change. The effect of these departures on ASO development was unclear. The scientist-entrepreneurs left their firms for several reasons: they saw a better opportunity to pursue or they wanted to return to university. The reason for founder departure was often related to board representation when venture capitalists or independent outsiders came on board. In this case, the scientist-entrepreneur took a senior management position on the TMT or moved to the SAB.

Overall, our findings indicate that after legal incorporation the additions of the key board members (e.g. board chair, investor) are associated with the progress of a spin-off from one stage to another or at least they make the venture approach closer to the next stage. That is, the additions were associated with reaching entrepreneurial milestones, e.g. getting external capital, proving or sampling the product, finalizing deals with collaboration partners, finding new distributors, expanding to other markets, which all moved the venture forward. Hence,

Proposition 2a: The board composition will change as the academic spin-off grows.

Proposition 2b: The first change in board composition will most likely be positively related to gaining credibility and moving to the Proof of Viability stage.

Proposition 2c: Subsequent changes in board composition will most likely move the academic spin-off closer towards the Maturity stage.

4.3 Why does the board change after the company's legal incorporation?

After legal incorporation and formation of the initial TMT and board, the scientist-entrepreneurs in our cases tried to recruit key individuals outside the academic community. The initial resources of ASOs were limited to intangible resources, comprising of mainly technological assets and related know-how within a set of patents. The first boards had a limited set of complementary resources they could provide. However, the further ASO development required some initial financial investments or the co-optation of resources (Starr and MacMillan 1990) through existing relationships and external networks (Aldrich and Zimmer 1986). Hence, ASOs searched for new board members who would procure critical resources like seed or VC finance, market and industry knowledge, and management skills. Achieving this commitment relied heavily upon the level of social capital the scientist-entrepreneurs were able to leverage through their personal contacts or those of initial board members.

For all cases raising sufficient seed or venture capital was a key activity along with technology/drug development, like as in earlier investigations (Kazanjian 1988; Vohora et al. 2004; Vanaelst et al. 2006). This was critical for acquiring other necessary resources to develop an embryonic ASO venture into a fully operational business to be able to engage in productive activities. Hence, finance was the main resource obtained through new board members who were all outsiders and mostly investors (see Table 2 column 6). Prior industry experience, including networks and specific knowledge, were the second most reported resources obtained through new members. Finally, the competence “around the company” such as IP issues, legal advice and executive experience, which does not reside in the post-startup TMT was the third main resource obtained.

TTOs in Norway emphasize the importance of having people with start-up experience on the board. Surprisingly, prior start-up experience of board members was not among the first resources the board members were valued for, although several new members had started

companies before. This may be due to VC funding being more likely for high quality teams (Baum and Silverman 2004; Florin 2005). This suggests that the ability to acquire financial resources or industry-specific knowledge, developed during a previous start-up attempt, may be more valuable than the prior start-up experience itself.

During the *second* change there were fifteen member additions in nine cases. In seven cases the new members were outsiders: either VCs or from industry. During next *third change* the new members added were again outsiders: seven investors, two from industry, and two CEOs. Few, the oldest cases, have had the fourth board change. There were strategic, resource-related, considerations in the decisions to add members to the board in all cases except for spin-offs Chemical and Optical. Here, the reason for the board changes was the restructuring of other companies that were represented on the board of Optical and Chemical. These members were simply replaced by new representatives.

Thus, the board members added in the first rounds (during first and second changes) were mostly investors and people who could contribute with industry-specific networks and knowledge. The resources and capabilities obtained through these members were complementary to those of the TMT, which concentrated on mainly solving the development of technology/product task.

During the third and subsequent board changes the new members were investors, professional executives and those who “knew the markets” in which customers and potential collaboration partners operated. However, people responsible for the company’s financial system and sales and marketing were appointed to the TMT indicating a shift in the TMT’s focus from product/technology development to internal efficiencies (Kazanjian 1988). Thus, new board members helped the TMT with such tasks as acquisition of other resources, organization and administration, and sales and marketing. In eight cases the CEO was replaced by a new one with much executive experience indicating the need for more formalized organizational and administrative skills and routines. In seven of these cases the external professional CEO was hired to replace scientist-entrepreneurs, TTO and university seed fund representatives who were functioning as CEOs in the firm. Hence, as the resource dependence theory predicts, the boards increasingly consisted of members who could add value to the firm by bringing in different resources that the TMT needed depending on the current dominant task the ASO worked on. Thus,

Proposition 3a: New board members will most likely bring critical resources that the top management team lacks, depending on the current dominant tasks.

Proposition 3b: New board members' resources will most likely range from finance and industry experience in earlier stages to executive and market/sales experience in later stages.

4.4 How are board members added?

While attempting reaching the Proof of Viability stage the new board members were brought to the board through personal contacts of privileged witnesses, scientist-entrepreneurs and board chair in eight cases and of new CEO and investors in three cases (see Table 2 column 6 and 8). Surprisingly, in seven cases an outsider who entered during first board change became chair and stayed with the ASO until the time we finished all our interviews (Table 2 column 7). This had consequences for subsequent changes: the common denominator for these cases was that the new members were added to the board primarily through the networks of this *board chair*. As the new chair was an investor and/or person with 15 to 40 years of working experience in industry, the new members attracted to the board in subsequent rounds had similar backgrounds, comprising finance, executive and/or industry experience. Hence, the board composition from the second change reflected to a greater extent the social networks of the board chair as social network theory predicts.

During the *second* change in six out of seven cases the new members were also added through the new chair. Nine cases in our sample had experienced a *third change* in board with the same pattern in terms of social networks as previous change. Again, outsiders were added through the chair's network in eight cases. Few of our cases have experienced a *fourth change* so it is hard to infer firm conclusions from this; but the pattern was similar to the second and third board changes in terms of social networks.

Besides, we expected that if the company had external stakeholders on the board, the composition of the board after legal start-up would also reflect the social networks of the principal stakeholders, such as the public research organization and external financiers (see Figure 1). These new members were expected to bring critical external resources. Our findings show mixed results. The initial boards in all Norwegian spin-off cases included a TTO member who represented the public research organization as the main external stakeholder. In half of the US cases the initial board included early stage VCs as external stakeholders. Contrary to our expectations, there seems to be a convergence over time in the sense that later board members are mainly selected from the network of the professional board chair. This board chair came from outside the venture during the first change in board composition and tended to remain in the company during all stages of growth influencing

subsequent board additions. Therefore, we separate the first change in board from the subsequent changes, termed board evolution process. In five cases the chair is indeed the largest external stakeholder and financier: either VC or industrial partner. In the remaining six cases the board chair is not the largest stakeholder. The process of board evolution can thus be characterized as driven mainly by the social networks of the board chair. Hence,

Proposition 4: In the post-startup stages the new board members will most likely be recruited from the board chair's network.

5. Discussion and conclusions

This paper has sought to explore the process of board formation and board evolution in young academic spin-off companies (ASOs) in Norway and the US drawing on stage-based, resource dependence and social network theories. Our research questions are: (1) Which board members do ASOs add and why in the start-up stage? (2) When, why and how do changes in board composition occur in the subsequent stages of growth?

Due to the limited number of cases, the conclusions and policy implications should be treated with care. However, since little is known about board dynamics in ASOs, our investigation represents a useful addition to the governance and spin-off literature and may provide a foundation for later empirical studies. We contribute by providing greater insight into dynamic aspects of board formation and evolution in new technology-based entrepreneurial firms (Vanaelst et al. 2006; Filatotchev et al. 2006; Clarysse et al. 2007), a relatively unstudied area in entrepreneurship and governance research (Huse 2007; Uhlaner et al. 2007). Overall, our findings indicate that stage-based, resource dependence and social network theories are important complements, which all provide partial explanations for board change processes, but have to be employed in combination to better understand the phenomenon.

We have shown that the process of board formation is mainly driven by the social networks of the founders as social network theory predicts. During the pre-startup stages the founders develop professional relationships with "privileged witnesses" (Vanaelst et al. 2006), i.e. coaches and trusted informants, who guide the founders from the research stage to legal incorporation. As a result, the board at founding consists of the scientist-entrepreneurs and people from the scientist-entrepreneurs' networks.

Furthermore, our study has shown that the board undergoes changes as the ASO grows, and that these changes are closely related to overcoming critical junctures and reaching the next development stage. Particularly, the first change in board composition is positively related to gaining credibility and moving to the Proof of Viability stage, while subsequent changes most likely move the ASO closer to the next, Maturity stage. New outside directors bring critical resources that the top management team lacks. They may thus be considered to play a value-adding role as resource dependence theory predicts.

The very first board members were found mainly through the networks of founders, privileged witnesses, but also the chair and investors. Contrary to our expectations, the new board members in post-startup stages were not recruited from the social networks of the largest stakeholders such as universities and venture capitalists. There seemed to be a convergence over time in the sense that later board members were mainly selected from the network of the professional board chair. This chair came from outside the venture during the first board change and tended to remain in the company during all stages of growth influencing subsequent board additions. In less than half of the cases the chair represented the largest external stakeholder: VC or industry partner. Thus, regardless of whether the chair represented a principal stakeholder or not, the process of board evolution was mainly driven by the social networks of the chair. The role of the board chair in ASO development may, therefore, be more central than what is commonly assumed and requires further investigation, e.g. a large-scale quantitative study that tests the generalizability of this proposition.

Our study adds to academic entrepreneurship research by relating changes in boards to stages and dominant tasks in spin-off development (Vohora et al. 2004; Vanaelst et al. 2006; Kazanjian 1988). We suggest that changes in board composition reflect the changing resource needs of the company during stages of growth. In each stage the top management team works on certain dominant tasks and acquires necessary additional resources through new board members. The members added in the first rounds are mostly investors and industry representatives helping to solve tasks related to securing financing and strategic positioning. The members added in later rounds are investors, professional executives and those with market-specific knowledge aiding with the acquisition of other resources, organization and administration, and sales and marketing.

Finally, we contribute to research on boards by showing that the board is a dynamic concept (Uhlener et al. 2007). As mentioned, board member additions seem to be associated with the venture's progress from one stage to another. This may imply that tenure heterogeneity which arises from additions to the board may be beneficial to the firm.

Borrowing a categorization of stages of development from earlier ASO studies (Vohora et al. 2004; Vanaelst et al. 2006), we find that board member additions are closely related to events such as external capital increase. Future research may attempt to use a more refined categorization of stages and milestones borrowing e.g. from finance and governance literature. For example, one could trace to what extent and how the changes in board composition are related to achieving important entrepreneurial milestones like going public (Shane and Stuart 2002; Filatotchev et al. 2006). More research remains to be done examining in detail to what extent and how board member departures influence the firm's development.

Our research has a number of implications. Changes in the board may be seen both as an effect of ASOs' development and progress to a new stage, and as a driving force in this development. More longitudinal research is needed, but our data point to the latter effect and the role of key outside directors in overcoming critical junctures. An important policy message is therefore to include the perspective of board dynamics in mechanisms intended to support ASO development. For instance, certain types of public funding seeking to stimulate academic entrepreneurship could be made contingent on the ability to attract professional outside directors to the board of an ASO.

The next important policy message stems from our evidence regarding the TTOs' involvement in and contribution to ASOs. Compared to well-established US TTOs whose involvement was basically limited to developing patenting and licensing agreements, we found that young TTOs in Norway played a much more active role in ASOs. They were represented on the ASO board and in some cases the management team, picking new board members and participating in other strategic decisions. Despite this active involvement during the legal incorporation and early post-startup period, the Norwegian spin-offs seemed to have a slower rate of development in post-startup stages.

The reason for the Norwegian TTOs' active participation may be due to their aims to secure a future income for themselves and their universities and to demonstrate the legitimacy and importance of technology transfer and ASOs – following recent legislative changes that some academics did not welcome. There may thus be a conflict of interest for the TTO staff as representatives of the university (Mosey and Wright 2007), since involving outsiders may reduce their role and potential income. Public ASO support programs and seed capital funds, which exist in Norway and most other countries interested in stimulating academic entrepreneurship, should be aware of this and moderate the financial expectations to TTOs.

Until recently, the legal establishment of a spin-off company was regarded as a significant event for Norwegian TTOs, and they received extra funding for this. The pitfall here is

therefore also related to premature formal establishment of an ASO before all necessary resources and capabilities have been acquired and developed. Public support mechanisms should be tailored so that they could prevent the premature formal establishment of an ASO. As shown in our data, after such early legal start-up some scientist-entrepreneurs were frustrated by a lack of progress. So, attracting the first key outside directors who were also the main resource providers was experienced as an “actual” start-up enabling the ASO to develop the business further. The challenge for TTOs is, in other words, to find a balance between acting as a representative of the university and as a wider societal institution.

For policy-makers and practitioners we suggest that there may be a need to develop policies that meet the needs of ASOs in finding outside directors. Efforts to develop networks and relationships with professional board members – investors, industrial members, and executives – may be an important additional component in general and specific assistance programs. This may imply that TTOs should recruit staff with working experience in private high-tech sectors in established companies, not only in start-ups. Such actions may help address the concerns that academic spin-offs are being created without the necessary resources to move the business forward.

Our study has a number of limitations which will hopefully be addressed by future research. One limitation is methodological. We have conducted one or two interviews per firm using a limited number of cases. Overall, we attempted to address this limitation by studying cases that are in different stages of development, to better capture the evolutionary aspects of board composition. Future research might undertake longitudinal studies of a greater number of cases to trace the board evolution of firms through development stages. Next, additions and departures raise important governance issues in terms of how changes in the equity holdings are negotiated. We have been able to observe the effects of additions on firm development. Further research may explore departures, negotiation and tension issues, and examine whether the changes are conflict-loaded or resolved by the power that may come from the size of an individual’s equity holding.

In spite of these limitations, we have attempted in this study to shed light on an unstudied topic, namely board formation and evolution of board composition in new technology-based firms, going beyond agency perspective. Our results indicate that the process of board formation is driven by the social networks of the founders, while the process of board evolution is mainly driven by social networks of the board chair with external board members adding value by bringing the additional resources that the management team lacks and, thus, contributing to the development of the venture.

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PAPER 3

Board features associated with new team member addition in academic spin-offs

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Board features associated with new team member addition in academic spin-offs

Abstract

We examine board features associated with new team member addition in academic spin-offs (ASOs) providing additional insights into the underexplored area of the dynamics of the top management team (TMT) in high tech new ventures. In particular, we draw on resource dependence perspective and investigate the role of board composition and networking in the new member addition process. The findings suggest that the board plays an important role in the new team member addition process. In particular, we find that board size and board networking activity facilitate team member addition. The hypothesis about the number of outside board members (who are neither TMT members nor TTO representative) and team member addition did not receive support. Implications are discussed.

Keywords: top management teams, addition, board, academic spin-offs

1. Introduction

The strategic management and organizational behaviour literature contains an extensive body of work that has examined the relationship between management change characteristics and the need for organizational change. Managerial turnover as a form of organizational adaptation has been widely studied in the context of large established organizations (Wiersema and Bantel 1993; Romanelli and Tushman 1988), in which the replacement of top executives provides an important mechanism for the organization to overcome inertia (Tushman and Romanelli 1985) and adapt strategically to changing contexts (Helmich 1977; Pfeffer and Salancik 1978). However, studies focusing on top management teams (TMT) in large established firms have failed to distinguish between the factors associated with team member entry and those associated with team member exit (Ucbasaran et al. 2003).

In sharp contrast to large established firms, management turnover in the context of new ventures has almost been neglected. Few studies have attempted to address this gap (e.g. Forbes et al. 2006; Erikson and Berg-Utby 2009). Yet, entrepreneurship scholars and theorists have begun to acknowledge that the teams that lead entrepreneurial firms change over time,

and that new team members need to be brought in and founders, whose skills may become outdated, need to be replaced (Rubenson and Gupta 1996; Boeker and Wiltbank 2005). Overall, the studies of team dynamics demonstrate that the managerial transitions in new ventures may not always go smoothly and even be detrimental to the firm (e.g. Chandler et al. 2005; Beckman et al. 2007). Still, these managerial transitions have not been studied extensively, and more research remains to be done examining the reasons for and skills of those entering and leaving the firm (Beckman et al. 2007). The range of issues associated with managerial transitions is wide, including the dismissal and replacement of team members (e.g. Fiet et al. 1997; Boeker and Karichalil 2002) and team member entry (Forbes et al. 2006). Some studies have attempted to address both additions and departures (e.g. Ucbasaran et al. 2003; Chandler et al. 2005). In this paper we focus on team member addition, which allows us to examine issues more thoroughly.

In evolving team-based ventures, the addition of the new member is a critical and common development (Forbes et al. 2006). The decision about choosing and adding a new member is important because it may considerably change the existing human capital, which in terms of achieved attributes such as experience, is linked to increased levels of productivity (Becker 1975). Academic spin-off firm (ASO) founders need to fill skill gaps to facilitate the development of resources and capabilities, which enable the firm's transition from a non-commercial environment to the market (Vohora et al. 2004). Entrepreneurship scholars have demonstrated the positive linkages between the quality of the team's past experience and firm performance (Burton et al. 2002; Chandler and Hanks 1998). Therefore, adding a new member to the team may potentially affect ASO firm growth and survival.

Although the idea of increasing team diversity by adding a new member is not new, we have little knowledge of the factors associated with team member addition (Ucbasaran et al. 2003; Vanaelst 2006). Vanaelst et al. (2006) have studied the entrepreneurial team development in ten Belgian spin-off cases. They examined the heterogeneity of the team members, which evolved through the firm's life cycle, suggesting that people enter the team due the firm's resource needs. Forbes et al. (2006) have explored team formation and elaborated on strategic choice perspective, e.g. resource seeking, and interpersonal attraction / social motives of team member addition. Drawing on resource dependence theory, Huse (2007) identified the importance of the board's role of using a network when recruiting new top management team (TMT) members in privately-held threshold firms.

The purpose of this study is to increase our understanding of the factors associated with team member entry. We address this research gap by exploring the factors associated with the

new member addition to the team in ASO companies, which are usually based on technology formally transferred from the university or research institute. Since many ASOs, as high-tech firms, operate in industry niches characterized by high levels of growth and require highly skilled board members, the boards in these firms may play a greater role and have stronger influence on firm activities compared to other types of companies (Hambrick and Abrahamson 1995; Forbes and Milliken 1999). Several entrepreneurial firm studies have demonstrated an active involvement of board members in the firm's strategic decisions playing roles such as providing a sounding board and a source of advice in decision-making rather than merely performing monitoring and control (e.g. Johannisson and Huse 2000; Deakins et al. 2000; Rosenstein 1988). Furthermore, ASOs usually have a significant demand for finance and human capital, e.g. industry-specific knowledge and commercial expertise (Clarysse et al. 2007; Wright et al. 2007). ASOs may attract experienced and well-connected directors to their boards who can aid in accessing critical external resources (Lynall et al. 2003). Consequently, in this study we attempt to examine the role of the board as a "pool of helpers" as an important predictor of new team member addition. In other words, we consider board size, number of outsiders (board members who are not part of TMT and the university community), and board contribution of networking.

Thus, our paper extends previous research and makes a number of contributions. First, it studies managerial transitions in high-tech new ventures, rarely addressed by TMT studies, which mainly focused on mature firms (Ensley et al. 2002). Second, it responds to suggestions in the entrepreneurial team literature to use a broader definition of team turnover considering team member entry and exit (Ucbasaran et al. 2003). Specifically, we gather additional insights into team member additions in ASOs by considering board features associated with team member addition. Moreover, we contribute to the governance research on privately-held firms, which emphasizes the need to go beyond agency theory (Uhlener et al. 2007). We draw on the resource dependence perspective on the board's role in TMT dynamics. Finally, we focus explicitly on the board in ASOs. Thus, we add to academic entrepreneurship where the number of studies on team and board level is still limited (Rothaermel et al. 2007; Djokovic and Souitaris 2008).

Below we start by outlining the development of our hypotheses. Thereafter, we present the research design and data collection methods. Then we present the results. Finally, we discuss findings, implications, limitations and future research directions.

2. Hypotheses development

2.1 Board resources and size

The resource role of board members in start-ups is particularly important for increasing strategic flexibility and enabling firm growth and survival (Filatochev et al. 2006). Resource theories have been used to argue for a positive relationship between board size and corporate financial performance (Huse 2007). Resource dependency view holds that boards help firms to establish links with an external environment in order to secure resources, and a large board will fulfil this task better than a small board. The argument is that the greater the need for external linkages the larger the board should be (Pfeffer and Salancik 1978).

Larger boards have more contacts in or connections with stakeholder groups, other boards and other organizations, which increase their chance of receiving new information and gaining new insights to help to solve non-routine challenges (George et al. 2003). Thus, each director may bring different linkages and resources to a board. Larger boards may therefore be better at identifying the appropriate member, which the TMT might need. This leads to the following hypothesis:

***Hypothesis 1:** Board size is positively associated with subsequent team member addition in academic spin-offs.*

2.2 Board resources and outsiders

Research also suggests that the proportion of inside versus outside members will affect the board's involvement and influence (Sapienza et al. 2000). The proportion of outside board members has been found to be positively related to board involvement in strategic decisions (e.g. Johnson et al 1993). Outside directors are classified as non-management members of the board (Rosenstein et al. 1993). Outside directors bring in new resources and diversity of perspectives (Pfeffer and Salancik 1978). They also bring their networks into the company. It is generally noted that firms with a higher proportion of outside board members who have greater number of interlocks (i.e. sit on two or more boards), will have a superior performance (Johnson et al. 1996). Also, the service role of directors, i.e. providing advice and counsel to the Chief Executive Officer (CEO), may impact new venture performance (Daily and Dalton 1992; cf. George et al. 2003; Deakins et al. 2000).

The study by Vanaelst et al. (2006) illustrates how the entrepreneurial team evolves from the pre-founding team, consisting mainly of the researchers, to the founding team, which may include surrogate (external) entrepreneur and is ready to legally incorporate the ASO venture. Once the new venture is legally established, the founding team divides into two major teams: the management team and the board of directors (ibid.). The management team and the board of directors may represent separate entities or they may overlap. For instance, the scientist-entrepreneur may be a member of both the management team and the board, while a university technology transfer office (TTO) may place its representative on the board of the ASO. In this study, we term management, such as scientist-entrepreneurs, as board insiders. We also consider TTO members involved in ASOs as insiders since they are a part of university environment, and in the academic entrepreneurship literature they were shown to still need to develop networking and commercial skills if spin-offs are to be successful (Lockett et al. 2005). Other external board members who are not part of the TMT and do not belong to the university community are conceived of as outsiders. Outside board members may be, for instance, VC investors and industrial partners (Clarysse et al. 2007; Wright et al. 2004). The larger the number of outsiders on the board, the more external and diverse connections and interlocks the board will have. This increases the probability of finding an appropriate team member candidate from outside the academic environment. Thus, we propose the existence of a relationship as follows:

***Hypothesis 2:** The number of outsiders on the board is positively associated with subsequent team member addition in academic spin-offs.*

2.3 Board networking role

In threshold firms, as ASO ventures, the outside directors develop the contributions of the boards by using their networks (Huse 2007). An active networking strategy entails an increased board involvement and a greater number of interlocks (George et al. 2003). Informal strategic networks are of great importance to small firms, and directorates play a central role in creating, maintaining, and influencing important external contacts of the firm (Borch and Huse 1993). The board's networking involvement is connected to the creation of personal contacts, with representatives of its exchange partners or other people involved, and the board members' involvement in environment-influencing activities as, for example, legitimizing, door-opening, and lobbying (ibid).

In this respect, the outside directors are found to be mainly active in using their networks to find and recruit key personnel, and in receiving additional financial resources during the stages of external capitalization (Rosenstein 1988; Borch and Huse 1993; Deakins et al. 2000). Finding appropriate team members can be challenging for scientist-entrepreneurs with networks limited to peers within academia (Cooper and Daily 1997; Ensley and Hmieleski 2005; Mosey and Wright 2007), and the board members can aid them in finding and recruiting appropriate top management candidates using their connections. Previous studies also show that the outside directors aid entrepreneurs in the decision-making process within the firm through contacts, experience and other expertise they bring to the firm (Rosenstein 1988; Deakins et al. 2000). Board members with well-developed networks have information that may improve their skills and competence to fulfil their strategic function (George et al. 2003), and thus enabling them to give better advice to entrepreneurs. Therefore, ASOs may benefit from boards that actively use their networks. Thus, we propose the existence of a relationship as follows:

***Hypothesis 3:** Board contribution of networking is positively associated with subsequent team member addition.*

3. Data and methods

The data set originates from a survey given to the CEO of 353 companies considered as originated from Norwegian universities and public research institutes in autumn 2008. This sample constitutes the 318 companies, which are registered as having used the university TTO or technology licensing-like organization in the FORNY database. FORNY is a government program (under the Research Council of Norway) designed to increase the creation of wealth in Norway by supporting the commercialization of R&D results. The rest of the companies were found from other sources. Anonymity for all companies and informants was assured. 53 firms reported that they are not academic spin-offs or they are no longer active. 135 academic spin-off companies returned their questionnaires resulting in a response rate of 45 %. Due to missing values, 95 cases were included in the analysis. We registered 64 firms with new team member addition.

3.1 Dependent variable

Our dependent variable is new team member addition. We asked the respondents to consider the most important/critical membership change. Then we asked them whether it was the person who entered (not left) the TMT. The firm was allocated a value of 1 if the new team member addition occurred, and a value of 0, otherwise.

3.2 Independent variables

Board size was measured with the question: How many persons are on the board? The number of outsiders was measured as the number of external board members who are neither TMT members nor TTO representatives. With regard to board contribution of networking, we asked a respondent to indicate to what extent s/he agrees with the following statement on the board networking role (Huse 2007a), i.e. to which degree on the Likert 7 point scale ranging from 1 (to a very small degree) to 7 (to a very large degree) the board contributes to networking (i.e. network building).

3.3 Control variables

We controlled for firm stage since ASO companies that are in later development stages may have more resources, experience, more information and more relationships (Finkle 1998), and the skills required by a team may vary between early stage and late stage firms (Hambrick and Mason 1984). We used five categories of development stages from research, product development and growth stages to maturity and declining stages (Kazanjian 1988; Vohora et al. 2004).

We also controlled for firm performance since firms with very poor and very high performance are shown to experience TMT change more often (e.g. Boeker and Karichalil 2002; Boeker and Wiltbank 2005). The firm performance is often measured by sales revenues and profits for the past three years. Our sample ranges from early start-ups to more mature ASOs. Many of these firms have no sales or profit. Hence, the traditional measures are not appropriate. As suggested by Fredriksen and Klofsten (1999), a way to deal with this problem is by using an all-subjective measure of how the companies are developing according to a business plan. Therefore, we measure firm performance by asking the firms to estimate various performance variables and give 1 (much worse) through 7 (much better) to these variables since the firm's foundation (Fredriksen and Klofsten 1999). We chose 7 variables, which we considered as most applicable for ASOs. After the factor analysis we received 2 factors: growth (Cronbach's alpha = .859) and product (Cronbach's alpha = .711). The growth measure

consists of the following items: growth in sales, growth in market share, profitability and financing since the firm's foundation. The product measure includes the quality of the firm's product/service, the innovation in the form of new products/services, and customer satisfaction since the firm's foundation. The traditional performance measures were incorporated in the question to what degree the firm is satisfied with its market share, profit, sales and ROA (Likert 7 point scale), which measures the satisfaction with the firm's performance (Cronbach's alpha = .937); the items were inspired by Chen (2009).

We also controlled for team size, tenure and team heterogeneity in functional and industry backgrounds as they, in previous studies, have been hypothesized and tested to moderate team member addition (e.g. Ucbasaran et al. 2003; Chandler et al. 2005). Team size is the number of persons who are in the management team (not included in the board). Heterogeneity in functional (sales, finance, etc.) and industry backgrounds was measured on the Likert 7 point scale ranging from 1 (to a very small degree) to 7 (to a very large degree), adapted from the survey carried out by Huse (2007a). This measure was composed by summated scales (Cronbach's alpha = .660). Team tenure indicates the total sum of years the members have been on the TMT.

4. Results

We assessed common method bias by means of the Harman one-factor test (Aulakh & Gencturk, 2000; Podsakoff & Organ, 1986) where the largest factor accounts for 24,2 % of the variance. This indicates that common method bias is not a major issue. A multi-collinearity assessment using the Variance Inflation Factors also indicates values within acceptable ranges. The test of the overall model fit and examination of residuals can be found in the appendix to the dissertation. Measures of correlation and descriptive statistics are reported in Table 1.

Logistic regression analysis is an appropriate technique to use when assessing independent variables against a binary dependent variable. To test the significance in predicting the new team member addition of the independent variables over the control variables, we used a two-step logistic regression. All control variables were entered in the first step (Model 1) whereas all the focal variables were entered in the second step (Model 2).

Table 1 Pearson correlation matrix with all the variables and descriptive statistics

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
Addition (1)	.57	.50	1.000										
Firm growth (2)	4.27	1.36	-.100	1.000									
Firm product (3)	5.00	.97	-.114	.451**	1.000								
Satisfaction with firm performance (4)	3.38	1.63	-.061	.568**	.168	1.000							
Development stage (5)	2.14	.99	-.044	.267**	.041	.260**	1.000						
Team size (6)	2.62	1.70	.241**	.280**	.157	.248**	.076	1.000					
Team tenure (7)	12.13	10.71	.051	.249**	.125	.282**	.267**	.513**	1.000				
TMT functional and industry heterogeneity (8)	4.65	1.79	.222*	-.036	.139	-.093	-.198*	.063	-.057	1.000			
Board size (9)	3.80	1.16	.272**	.073	.214*	.005	-.156	.384*	.124	.379**	1.000		
Board outsiders (10)	2.05	1.66	.262**	-.017	.094	-.118	-.195*	.125	-.096	.378**	.535**	1.000	
Board networking (11)	4.83	1.74	.260**	.026	-.029	.037	-.287**	.008	-.135	.169	.003	.152	1.000

N = 95; * p < .05; ** p < .01; **SD** Standard Deviation; **TMT** Top Management Team

Table 2 presents the results of our two-step regression. Model 1 representing only the control variables (i.e. firm growth, product, satisfaction with performance, development stage, team size, team tenure, team heterogeneity) is significant at the .01 level. One control variable, team functional and industrial heterogeneity, is positively and significantly related to subsequent team member addition at the .01 level.

The focal variables (i.e. board size, outsiders, board networking) were entered as a block in Model 2. The addition of the board variables to the equation with the control variables resulted in an improved model. This block is significant at the .001 level, and the overall model is significant at the .000 level. Two control variables, firm growth and team functional and industrial diversity, are significantly related to the subsequent team member entry at the .1 and .05 levels respectively. Board size is positively and marginally significantly related to the subsequent new team member addition ($p < .1$). Hence, Hypothesis 1 is marginally supported. The number of outsiders is positively, but not significantly related to the new member addition. Thus, Hypothesis 2 is not supported. Hypothesis 3 regarding the positive relationship between board contribution of networking and subsequent new member addition, is supported. The level of board networking activity is positively and significantly associated with adding new members to the TMT ($p < .01$).

In summary, ASO companies that have heterogeneous teams with regard to functional and industry backgrounds, larger and more active networking boards are more likely to add new members to their TMTs. As to firm growth, our findings seem to indicate that the better the firm's growth is, the less need there is for adding new members to the team.

Table 2 Results of the logistic regression on team member addition

Levels	Variables	Model 1	Model 2
Firm controls	Firm growth performance	.70 (-.37)	.60 [†] (-.50)
	Firm product performance	.92* (-.08)	.88 (-.13)
	Satisfaction with firm performance	1.10 (.09)	1.09 (.08)
	Life cycle stage	.98 (- .02)	1.34 (.30)
Team controls	Team size	1.40 (.34)	1.33 (.29)
	Team tenure	1.01 (.01)	1.03 (.03)
	Functional and industrial heterogeneity	1.67** (.52)	1.60* (.47)
Board	Board size (H1)		1.91 [†] (.65)
	Board outsiders (H2)		1.06 (.06)
	Board networking (H3)		1.76** (.56)
	Constant	.45	.00*
	Model χ^2	18,580	34,448
	Model χ^2 significance	.01**	.00***
	-2 log likelihood	101,412	85,544
	Overall predictive accuracy	70.5 %	80.0 %
	Cox & Snell R ²	.178	.304
	Nagelkerke R ²	.248	.424
	Number of firms	95	95

*** p < .001, ** p < .01, * p < .05, † p < .10

5. Discussion

In this paper, we sought to explore board factors associated with new team member addition in academic spin-offs. Drawing on the resource dependence perspective of active boards in small companies (Borch and Huse 2003; George et al. 2003; Huse 2007), we examined the role of the board, including composition and networking contribution, as drivers of new team member entry. Our findings suggest that the board plays an important role in the team member addition process. In particular, we find that board size and networking activity level facilitate the team member addition process in ASOs, while the number of outsiders – people who do not belong to either the TMT or university community – was not significant with regard to adding a new member to the TMT.

Our investigation represents a useful addition to the team literature and governance literature, since little is known about the role of the board in TMT dynamics in ASOs as high-tech new ventures (Ucbasaran et al. 2003; Ensley et al. 2002; Clarysse et al. 2007). We contribute by drawing on the resource dependence perspective on the board's role as an important predictor of team member entry in ASO companies (Lynall et al. 2003; Uhlaner et al. 2007). An empirical contribution of our study to academic entrepreneurship is identifying factors associated with team member addition in ASOs (Rothaermel et al. 2007; Djokovic and Souitaris 2008). ASO companies which have larger active networking boards are more likely to add new members to the team. However, a firm's growth (which includes growth in sales, market share, profitability and financing) seems to lessen the likelihood of adding a new member. In other words, lack of growth increases the likelihood of new team member additions. This is consistent with open answers from the survey, in which the respondents mentioned "improved growth" and "increase in sales" as consequences of team member entry.

A positive relationship between the functional and industry background diversity among TMT members and additions is similar to the findings demonstrated by previous studies (e.g. Chandler et al. 2005). In contrast to Ucbasaran et al. (2003) study of family firms, and Chandler et al. (2005) study of five year old emerging ventures, we do not find that team size is associated with subsequent team member addition. This may be due to the origin of ASOs from a non-commercial academic environment and that the firms we studied represented all development stages.

For academic entrepreneurship and research on governance in privately-held firms, our study adds board composition and networking measures as variables that should be considered. The exploration of the factors at the board level shows that board size and board networking

contribution are positively related to new team member entry. This is in line with previous studies on boards that demonstrate the active role of the board recruiting key personnel and engaging in network building activities in VC-backed small and medium sized enterprises (e.g. Borch and Huse 1993; Deakins et al. 2000; Huse 2007). Also, we have been able to account for the firm's development stage, which is important since various studies show that ASOs are threshold companies, which go through several stages of activity, and this influences TMT development (e.g. Vohora et al. 2004; Vanaelst et al. 2006). The number of outsiders - board members who are neither TMT members nor TTO representatives - was not found to be significantly associated with the additions of new team members in ASOs. This may suggest that what matters is the joint engagement in the networking activities by both internal and external board members and whom these board members know when it comes to finding new members to the TMT.

5.1 Implications

This study has several implications. First, the study indicates that the diversity in functional and industrial backgrounds of the team members is positively related to new member addition. Early stage technology-based firms were shown to overcome various thresholds (e.g. receiving VC funding, going public) when they had teams that were complete in terms of the functions of marketing, finance, operations, and engineering (Roure and Maidique 1986; Zimmerman 2008; Beckman et al. 2007) and heterogeneous in industry experience (Chandler et al. 2005; Vohora et al. 2004). For managers seeking further ASO development, this implies that they should adjust the team's functional and industrial diversity as early as possible by adding members with relevant expertise in order to enable growth and overcome the thresholds that an ASO faces.

Second, additional analyses do not uncover any significant interactions between the studied variables and firm's development stage. Neither could we find significant interactions between the studied variables and firm performance except from the interaction between the board size and firm growth, which was marginally significant ($p < .1$) and positively related to subsequent team member entry. This suggests that the larger the board and the better the growth is, the more likely there will be added a new team member. The additional analyses also support our suggestion about the importance of the joint networking effort of both internal and external board members in the new team member addition process. Although it is not significant, our third performance variable, which measures the satisfaction with firm performance regarding market share, profit, sales and ROA, is positively related to subsequent

team member addition. Most of the survey respondents are CEOs and original founders in CEO, board chair and other positions. Thus, this positive relationship may indicate that when the CEO/founder is satisfied with firm performance s/he will most probably have a positive attitude to the addition of new TMT members. Our results are only indicative. Hence, future research is needed to explore in-depth the role of team and board in various stages of firm development and under which conditions these factors become more pronounced. For instance, previous high-tech start-up studies have demonstrated the U-shaped relationship between TMT change (including founder departure and general additions and departures) and firm growth (e.g. Boeker and Karichalil 2002; Boeker and Wiltbank 2005). Both fast growth and a lack of start-up growth create the need for different top managers, but in the latter case “to help turn the new venture around” (Boeker and Wiltbank 2005: 125).

Finally, our study suggests that ASOs with larger boards and greater levels of networking activity are more likely to add new members to their management teams. For academic founders, this means that when forming a board or negotiating board seats with e.g. powerful investors, they should pay attention to the records of potential board members with respect to previous networking and recruiting activities in other companies.

5.2 Limitations and future research opportunities

Our study has a number of limitations which will hopefully be addressed by future research. First, we considered only the strategic choice perspective in this paper, which implies the addition of the member according to the wishes of the existing team members. An institutional perspective, according to which the addition may be imposed by external institutional forces, e.g. influential owners, is outside the scope of this study. Second, our study is cross-sectional which means that we could not capture the underlying processes behind the relationships assessed. Third, this is a study of Norwegian ASOs, and there is obviously a need for more studies in other comparable countries and contexts. Fourth, we have only focused on team member addition, while the other side of team turnover - team member exit – could also be investigated as these events are apparently related, although they may have different drivers. Future research should investigate what drives team member exits. Consequences of TMT member addition are important as well. For instance, Beckman et al. (2007) show that high-tech venture teams that add members obtain IPO faster. The results of our survey seem to indicate that most important additions to the team were usually positive with a new/better competence brought by the new member on the team as a result, which opens for new growth

opportunities or even increased sales. However, future research should address the question of the consequences of team member entry for the new venture.

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PAPER 4

Design characteristics associated with venture capital acquisitions in academic spin-offs

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Design characteristics associated with venture capital acquisitions in academic spin-offs

Abstract

This study explores design characteristics associated with venture capital financed academic spin-off firms (ASO). In particular, we address the role of prior finance as well as management team and board design features. We analyze 106 firms using hierarchical logistic regression. We find that prior finance and management team characteristics are important predictors of receiving venture capital funding. Particularly, portfolio seed funding, capital from industrial partners, team size and cognitive diversity among management team members are design features associated with venture capital acquisition.

Keywords: venture capital, financing, team, board, diversity

1. Introduction

The formation of high-growth academic spin-off companies (ASO) is one of the main policy goals of governments and universities (Rothaermel et al. 2007; Wright et al. 2007). ASOs are usually based on technology formally transferred from the parent organization, which is a university or research institute. Finance conduces to the creation of wealth through ASO formation; however, access to venture capital (VC) is a major barrier that ASOs face (Wright et al. 2006). According to Wright et al. (2006), potential VC investors perceive the risk of having to build management teams as greater in ASOs than in other high-tech companies. Their concerns are related to the quality of the management team and that scientist-entrepreneurs may not have the credibility to recruit management with commercial expertise or to attract customers (ibid).

The importance of the topic of ASO creation is also reflected by the increasing literature related to academic spin-offs (see O'Shea et al. 2004; Rothaermel et al. 2007; Djokovic and Souitaris 2008 for reviews). ASO researchers have primarily tried to explain the variation in spin-off activity and suggest policies that would increase this activity in the universities. Previous ASO studies have mainly focused on the following factors that affect the spin-off creation process (O'Shea et al. 2005): the personal characteristics of the

entrepreneurs (motivation, research quality etc.); the institutional factors like universities' policies, procedures, practices on commercialization; incentive structures and rewards for researchers and technology transfer office (TTO) staff; and various external factors (e.g. knowledge infrastructure of the region, enactment of Bayh-Dole Act etc.).

Few studies have investigated to what extent these stimulating university policies and activities have actually improved the performance of the new ventures. The study by Ensley and Hmieleski (2005) shows that ASOs are more immature with regard to their top management team (TMT) development and perform significantly lower in terms of net cash flow and revenue growth than independent new ventures. Although TMT is recognized as one of the most critical factors related to new venture performance, as Ensley and Hmieleski (2005) state, TMT role in ASO development is still not well investigated in the literature and university support still tends to focus primarily on technology and marketing. Even fewer studies have addressed the role of boards in ASOs (Clarysse et al. 2007). This is surprising because to enable their transition from a non-commercial environment to the market ASO companies, along with resources and capabilities (Vohora et al. 2004), including the management team's human capital, need to develop board (Filatotchev et al. 2006). Having board members who are able to contribute to the development of the firm resources may considerably increase the ASO's growth and survival (Huse 2007).

In this study we seek to assess ASO design characteristics associated with venture capital acquisition. VC acquisition is indicative of venture success because ties to VC investors increase a firm's chances of survival (Shane and Stuart 2002). Further, in entrepreneurship research, VC investors are typically considered to be value-adding investors, contributing value to the companies in excess of their monetary investments (Baum and Silverman 2004). Apart from being established in the literature, VC acquisition suits our context and allows us to examine characteristics across multiple high-tech industries, e.g. oil and gas, energy and environment, ICT and biotech-related industries, that have different profiles on traditional financial metrics such as turnover and ROI (cf. Beckman et al. 2007).

The existence of and the need to fill a gap between the demand for finance from scientist-entrepreneurs involved in ASOs and the willingness of suppliers to provide this finance has been widely recognized in policy initiatives in the US (Shane 2004) and Europe (Wright et al. 2006). A VC firm's supply of risk capital has been considered a major solution to bridge the equity gap for ASOs and a primary source of funds for new firms based on new technologies usually originated from universities, like biotechnology (Zucker et al. 1998). However, as the study by Wright et al. (2006) demonstrates, there is a mismatch between the

expectations of ASOs and VC providers, which results in the so-called equity gap. While TTOs and ASOs consider venture capital as more important in the early seed stage, the venture capitalists prefer to invest after the seed stage. The ASO may also face problems in attracting investments due to its origin from a non-commercial environment. For example, there has been growing recognition of the notion that ventures need to be in a pre-prepared state that enables VC firms to evaluate them more easily (e.g. Zacharakis et al. 1999). The ASO's understanding of the requirements of potential external funders may be quite low. Venture capitalists often mention TMT quality as an important funding criterion (MacMillan et al. 1985; Zacharakis and Meyer 1998). Therefore, the TMTs that have an essential diversity of knowledge and skills may be more likely to capture the interest and attention of investors. In the same vein, the boards with diverse experiences and backgrounds are more likely to cope well with a task of networking, connecting ASOs to potential finance providers.

The purpose of this study is, thus, to examine the role of prior finance and management team and board design features associated with VC financed ASOs. In line with Cohen and Bailey (1997: 243), the design features are defined as characteristics of “the task, group, and organization that can be directly manipulated by managers to create the conditions for effective performance” (cf. Stewart 2006). Particularly, we seek to examine the role of different types of early stage finance such as finance from the portfolio seed funds, informal and industrial investors as important predictors of VC acquisition in ASOs. Moreover, we are concerned with the trade-offs affiliated with team size and diversity in management teams and company boards.

This paper extends previous research and makes a number of contributions. First, we contribute to academic entrepreneurship and VC literature by linking several types of early stage finance - from the seed funds to the informal investors and industry - to the ASO ability to acquire VC capital. We find that portfolio seed funding and capital from industrial partners, but not the support from informal investors, are design features associated with successful VC acquisitions. Second, the paper extends our understanding of the role of the TMT (Ensley and Hmieleski 2005) and boards (Clarysse et al. 2007) in ASOs by linking their design characteristics to VC financing. We find that only team size and cognitive diversity among management team members are design features associated with VC acquisitions. Thus, the paper contributes to high-tech entrepreneurship studies, in which the role of teams has recently made a re-emergence as a critical component (Ensley et al. 2006; Wright et al. 2007a), and adds to research on boards in privately-held firms (Uhlaner et al. 2007).

Below, we start by outlining the development of our hypotheses. Next, we discuss the research design and data collection methods. Then we provide definitions of the selected dependent, independent, and control variables, followed by a discussion of the findings. Finally, we conclude and discuss implications, future research directions and limitations of the study.

2. Hypotheses development

2.1. Prior finance characteristics and venture capital acquisition

Dasgupta and David (1994) argue that there are no economic forces that operate automatically to maintain dynamic efficiency in the interactions between university-based open science and commercial R&D. There is considerable uncertainty associated with commercialization of research results because university innovations are often embryonic in nature (Colyvas et al. 2002; Jensen and Thursby 2001). Thus, there are few economic incentives for single firms to invest in developing early-stage projects with high uncertainty and long payback time. This leads to the general situation that private actors are reluctant to invest in early-stage technologies. Lockett et al. (2002) found that although the UK venture capital firms have become more willing to invest in new technology-based firms, there was still a reluctance to invest in the earliest stages of technology development, such as seed and start-up funding. Business angel funding could be an alternative, but these investors will often invest smaller amounts and are often not a main source for ASOs (Wright et al. 2007). This implies that some kind of governmental financial support is needed in order to facilitate the formation of ASOs.

The gap between the demand for finance from scientist-entrepreneurs and the willingness of financiers to supply this funding is recognized by policy makers in many countries and considerable amounts of resources have been allocated to promote the creation of ASOs from public funded research (Feldman et al. 2002; Wright et al. 2006). The recognition of this “market failure” or “financing gap” for high-growth ventures has led governments around the world to increasingly channel public financing to research and early-stage ventures (Jaaskelainen et al. 2007; Leleux and Surlemont 2003; Lerner 2002; Wright et al. 2006). However, the rationales and effects associated with these programs are controversial (Armour and Cumming 2004; Jaaskelainen et al. 2007; Leleux and Surlemont 2003; Lerner 2002). In addition to the apprehension that the private sector provides

insufficient capital to new firms, Lerner (2002) argues that all government efforts in this arena are predicated on the assumption that the government either can identify investments which will ultimately yield high social and/or private returns or can encourage financial intermediaries to do so. A consensus on both these claims remains elusive, and the design of government programs is still a highly experimental activity. Furthermore, especially in Europe, seed capital funds are usually set up as an intermediary in order to reduce uncertainty related to technical and commercial issues (Murray 2007). Thus, one should expect that some of the ASOs financed with governmental and seed capital funds will be capable of securing venture capital funding as they become more mature and uncertainty related to technical and commercial issues is reduced.

A traditional view on external financing of high-tech new ventures, including ASOs, implies that ASOs may first attract start-up support from a university and/or government seed funds, then the capital from informal investors (so-called business angels) and in some cases from industry until the VC investors become interested in the venture (Benjamin and Margulis 1996). However, the assumption that there is a relay race between informal investors and VCs has been questioned in several studies (Freear et al. 1997; Sørheim 2005). The most prominent reason for this seems to be differences in investment strategies as informal investors are more concerned about avoiding bad investments rather than “hitting a home run” (Mason and Harrison 2002).

ASOs face the challenge of making the venture “investor ready” (Douglas and Shepherd 2002) to acquire venture capital by, for example, developing successful prototypes, assembling an experienced TMT, customer testing and early sales, and thorough intellectual property (IP) due diligence. The support of the industrial partner in the ASO may make it easier to access resources, exchange information and establish legitimacy (Pfeffer and Salancik 1978). The decision to invest and the level of investment committed to a venture is contingent upon external investors perception of the credibility of the venture in terms of whether the risks involved are acceptable (Wright et al. 2004). Collaboration with an industrial partner generates the credibility of an ASO early on and may facilitate greater commitment by VC investors (ibid).

This means that financial choices made in the very early stages of an ASO are expected to heavily influence the capital acquisition process in later stages. Thus, we propose the following hypothesis:

***Hypothesis 1:** Prior finance design characteristics will make an independent contribution to the venture capital acquisition function in academic spin-offs.*

2.2 Management team design characteristics and venture capital acquisition

Team size is an important measure in TMT research. In the meta-analyses of team and performance, management and project teams are shown to benefit more when having larger team size (Stewart 2006). Larger teams have been found to be linked to better performance and growth in high-tech ventures (Eisenhardt and Schoonhoven 1990; Cooper and Daily 1997). Chandler et al. (2005) demonstrate that larger initial team size provides an advantage for organizations that are not more than 5-years old.

Another important measure is diversity or member heterogeneity (Stewart 2006). Diversity in entrepreneurial teams that brings together people with different skills, experiences and backgrounds is usually seen as advantageous in new ventures, and the positive linkages between the quality of the team's past experience and firm performance were demonstrated by entrepreneurship scholars (e.g. Burton et al. 2002; Chandler and Hanks 1998; Beckman et al. 2007). Other scholars doubt the positive consequences of diversity, claiming that it leads to more conflict, but often failing to find support for this in entrepreneurial settings (e.g. Ensley et al. 2002; Chandler et al. 2005). These contradicting views call for a more nuanced debate of the heterogeneity puzzle, and the question arises as to what type of diversity in ASO teams is beneficial.

The diversity dimensions that have systematically been studied in the TMT research are different demographic diversity characteristics like gender, age etc., personality diversity and more directly task-related cognitive (or background) diversity characteristics like educational or functional background (Stewart 1996; Kearney et al. 2009). Following this distinction, we focus on demographic, personality and cognitive diversity respectively. The personality diversity characteristic varies across settings and needs to be additionally studied on a team-level (Stewart 2006). For ASO teams having personality diversity may be advantageous because it can be helpful in creating innovative and new insights with respect to e.g. technology development, product improvement and marketing tasks. Similar to Kearney et al. (2009), we argue that age diversity is a more appropriate indicator of demographic diversity than gender, ethnicity, or nationality in entrepreneurial setting. Among the positive consequences of age diversity are greater firm performance and better ability to address

strategic issues (Wiersema and Bantel 1992; Richard and Shelor 2002). Age diversity in management teams reflects a varied set of experiences, views and social ties that may ultimately appear attractive to external financiers.

When tasks are complex and non-routine - as with ASO development - cognitive diversity should have a beneficial effect on firm performance (Stewart 1996; Beckman et al. 2007). Educational and functional backgrounds, as mentioned, belong to the cognitive diversity dimension. A diverse set of educational backgrounds in the TMT reflects diversity in its cognitive base, which positively influence strategic decision making (Hambrick and Mason 1984; Wiersema and Bantel 1992). Zimmerman (2008) found that diversity in the TMT's educational background is associated with greater capital raised through an IPO. The positive relationship between functional heterogeneity and firm performance has been widely supported in several new venture studies (e.g. Roure and Maidique 1986; Zimmerman 2008; Beckman et al. 2007; Ensley and Hmieleski 2005).

In addition to educational and functional backgrounds, TMTs may vary in background characteristics such as industry, start-up experience, management and international experience, which are all important cognitive features associated with entrepreneurial success (Packalen 2007). Investors view industry experience as one of the main predictors of new venture success (Hall and Hofer 1993). Greater diversity in industry backgrounds reflects a varied set of different points of view on technology, competitive tactics, knowledge of how industry operates, which all may produce innovative solutions, give competitive advantage to the new venture and enhance understanding of customer demands (Eisenhardt and Schoonhoven 1990; Boeker and Karichalil 2002). The positive consequences of diversity in start-up (or entrepreneurial, founding) experience are that they may enhance a team member's human capital (Ucbasaran et al. 2003; Packalen 2007) since many tasks in new ventures are unique and tacit in nature and can only be learned by doing (Shepherd et al. 2000). Diversity in management experience may indicate quality of the management team in an ASO, which is one of the major concerns of the VC investors (Wright et al. 2006). Heterogeneity in industry background, prior start-up and management experience were all shown to be associated with improved performance (e.g Eisenhardt and Schoonhoven 1990; Colombo and Grilli 2005; Roure and Maidique 1986). Hence, variation along all these characteristics makes a new venture more attractive to external stakeholders and to investors.

A final characteristic, which we argue to be an important element of the cognitive diversity dimension in the context of ASOs, is heterogeneity in prior international experience (e.g. experience of having worked abroad). ASOs are often based on completely new

technologies that give significant technical advances in the scientific field (Del Campo et al., 1999) and they develop new products with significant value to customer (Shane 2004), which sometimes makes them enter or even create new markets and industries for their technologies and products, e.g. biotech industry (Jong 2006). Such newness necessitates interaction with e.g. industrial partners and customers across borders, and the presence of varied international experience on the TMT should facilitate such interactions. Team members with international experience are better equipped to deal with the uncertainties and ambiguities associated with international operations and are more confident and effective in foreign environments (Sambharya 1996). International background diversity may, thus, be a positive signal to potential investors. In summary, we therefore hypothesize:

Hypothesis 2: Management team design characteristics will make an independent contribution to the venture capital acquisition function in academic spin-offs

2.3 Board design characteristics and venture capital acquisition

Boards help firms to establish links with external environment in order to secure resources, including finance, and a large board will fulfil this task better than a small board. The argument is that the greater the need for external linkages the larger the board should be (Pfeffer and Salancik 1978). A positive relationship can also be assumed between the existence of knowledge and competence among board members and the board's advisory contributions (Huse 2007). Gabrielsson and Huse (2002) found that the board size was larger in Swedish VC-backed industrial firms compared to non-VC backed firms. Hence, we expect a positive relationship between a large board and company's ability to attract VC.

Zahra and Pearce (1989) suggest that the board attributes, composition and contingencies (e.g. firm size) determine strategic outcome and, in turn, the performance of the company. The resource role of board members in start-ups is particularly important for increasing strategic flexibility and enabling firm growth and survival (Filatotchev et al. 2006). Diverse board members differ in their educational and social background, business and professional experience, age, gender, personality and so on (Milliken and Martins 1996). As with the TMT, we distinguish between demographic (age), personality and cognitive diversity characteristics.

The most relevant knowledge and skills of the board are the functional area knowledge and skills that include the accounting, finance, marketing, and law, and the firm-specific knowledge and skills, including the knowledge of how the firm operates, how technology works, how to develop the product and set it into production (Forbes and Milliken, 1999). We assume that the board members who represent a broader range of work experience in related industries will make better use of the firm-specific knowledge and skills than the members with almost no or single industry experience. Hence, among cognitive diversity characteristics we emphasize diversity in industry and functional backgrounds as more appropriate design features. With respect to board's networking and resource roles we also consider diversity in education and international backgrounds as important components of board cognitive diversity. Board members with varied industry, education, functional and international backgrounds may have alternative networks with several representatives of the firm's exchange partners and other informants, e.g. potential VC investors (Huse 2007). Hence, having diverse and well-experienced board members may make a new venture more attractive to VC investors. Therefore, we hypothesize that:

***Hypothesis 3:** Board design characteristics will make an independent contribution to the venture capital acquisition function in academic spin-offs.*

3. Data and methods

The data set originates from a survey given to the CEO of 353 companies considered as originated from Norwegian universities and public research institutes in autumn 2008. This sample constitutes the 318 companies, which are registered as having used the university technology transfer office or technology licensing-like organization in the FORNY database. FORNY is a government program designed to increase creation of wealth in Norway by supporting the commercialization of R&D results. The rest of the companies were found in other sources. Anonymity for all companies and informants was assured. 53 firms reported that they are not academic spin-offs or they are no longer active. 135 academic spin-off companies returned their questionnaires resulting in a response rate of 45 %. Due to missing values, 106 cases were included in the analysis.

We registered 28 firms with VC financing. The firms represent a broad range of industries such as ICT, health, oil and gas, energy and environment, medical and

biotechnology, maritime and offshore, and others. As for the innovation degree and scope, most of the firms were highly innovative. That is, most of the firms have reported that the product/service or technology they develop or the markets they aim at are completely new. Thirteen firms answered that a similar product/service, technology or market exists. And most of the firms had a new product/service, technology or market internationally. Only eight firms had a new product/service, technology or market in the firm country, locally.

3.1 Dependent variable

Our dependent variable is whether or not the ASO received funding from a venture capitalist coded as a dummy variable, i.e. the firm was allocated a value of 1 if a respondent reported that the firm has received external capital from VC investors, and the firm was allocated a value of 0 if the firm had never received external capital from VCs. We have two separate markers for VC finance, the first a direct question, the second question addresses how many rounds with VC finance the company has received. When the latter is dichotomously coded, they exhibit a perfect correlation with the employed measure (1.000, $p < .001$).

3.2 Independent variables

3.2.1 Prior finance measures

Type of prior finance. We asked the firms to check a set of alternatives with regard to prior finance. These measures were coded dichotomously into seed capital, industrial capital and private (informal) capital.

3.2.2 Management team measures

Team member heterogeneity. We asked a respondent to which degree the TMT members represented a variety in the Functional background (sales, finance, etc.) on the Likert 7 point scale ranging from 1 (to very small degree) to 7 (to very large degree). The index was inspired by Huse's (2007a). Similar questions were posed with regard to personality, age, education background, industry background, start-up experience, management and international experience.

Team size. Team size was measured by the following question: How many persons are in the **management team** (not included in the board)?

3.2.3 *Board measures*

Board member heterogeneity. We asked a respondent to which degree the board members represented a variety in the Functional background (sales, finance, etc.) on the Likert 7 point scale ranging from 1 (to very small degree) to 7 (to very large degree). Similar questions were posed with regard to personality, age, education background, industry background, and international experience. The index was inspired by Huse's (2007a) comprehensive study of value creating boards.

Board size. Board size was measured with the question: How many persons are on the **board?**

3.3 *Control variables*

We control for firm stage, age and size as larger and older ASOs may have more resources, experience, more information and more relationships (Finkle 1998). The skills required by a team may vary between younger and older firms (Hambrick and Mason 1984). We used five categories of cycle stages from product development to maturity and declining stages (Kazanjian 1988). Firm age is the number of years since the business was formally incorporated. Firm size is measured as full time employment equivalents.

3.4 *Common method bias*

Harman's one-factor test was used to test for common source bias (Aulakh and Gencturk 2000; Podsakoff and Organ 1986). A principal component analysis (PCA) was conducted on all 23 items used in this study, and if the study has a common method variance bias, a single factor should emerge or one general factor would account for most of the covariance in the independent and criterion variables. The standard algorithm extracted seven components with Eigenvalues > 1, and the largest component accounts for 25.6 % of the total variance. This post hoc analysis indicates that common source bias is not an issue.

4. Results

Measures of correlation are reported in Table 1.

Table 1 Pearson correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
VC acquisition	1.00																							
Firm																								
(1)																								
Size (2)	-.31	1.00																						
Age (3)	-.43	.39**	1.00																					
Stage (4)	-.03	.26**	.34**	1.00																				
Seed (5)	.32**	-.05	.08	-.07	1.00																			
Informal investors (6)	.10	-.13	.11	-.15	.17	1.00																		
Industry (7)	.25**	.01	.16	.17	.09	.29**	1.00																	
Size (8)	.17	.54**	.30**	.20*	.03	.06	.15	1.00																
Functional background (9)	.24*	.17	.05	-.18	.08	.08	.04	.21*	1.00															
Industry (10)	.23*	-.01	-.04	-.24*	.25**	.17	.11	-.11	.48**	1.00														
Education (11)	.02	-.01	-.12	-.15	.03	-.01	.02	-.03	.38**	.45**	1.00													
Startup experience (12)	-.16	-.09	-.01	-	.14	.15	.15	-.06	.31**	.28**	.18	1.00												
Management experience (13)	.14	.01	-.11	-	.27**	.16	-.03	-.13	.41**	.48**	.39**	.56**	1.00											
International experience (14)	.09	.03	-.04	-.22*	.09	.05	.10	-.08	.35**	.38**	.29**	.42**	.48**	1.00										
Personality (15)	-.10	.11	-.08	-.10	-.02	.41	-.02	.03	.17	.16	.20*	.10	.14	.25**	1.00									
Age (16)	-.03	-.06	.04	-.04	-.03	-.02	.06	.11	.20*	.29**	.45**	.43**	.30**	.23*	.08	1.00								
Size (17)	.15	.30**	.10	-.07	.15	.20*	.19	.40**	.36**	.34**	.26**	.09	.30**	.22*	.21*	-.01	1.00							
Functional background (18)	.17	.10	-.03	-.17	.26**	.27**	.13	.16	.57**	.39**	.30**	.43**	.44**	.24*	.20*	.24*	1.00							
Industry (19)	.11	-.05	-.08	-	.22*	.25**	.05	-.05	.38**	.58**	.34**	.30**	.50**	.38**	.11	.13	.16	.53**	1.00					
Education (20)	-.03	-.04	-.16	-.19	.21*	.02	.05	-.11	.36**	.42**	.51**	.28**	.48**	.23*	.30**	.25**	.23*	.43**	.52**	1.00				
International experience (21)	.20*	-.05	-.07	-.18	.27**	.16	.15	.02	.32**	.33**	.24*	.50**	.41**	.46**	.15	.21*	.36**	.50**	.54**	.35**	1.00			
Personality (22)	.10	.12	-.07	-.12	.25*	.13	.13	.15	.21*	.32**	.30**	.22*	.38**	.23*	.36**	.10	-.06	.43**	.44**	.57**	.49**	1.00		
Age (23)	.01	-.18	-.07	-.02	.18	.03	.13	.15	.04	.26**	.39**	.28**	.16	.21*	.19	.30**	.15	.22*	.34**	.43**	.35**	.24*	1.00	

* p < .05; ** p < .01

Hierarchical logistic regression analysis is an appropriate technique when assessing multiple themes against a binary dependent variable. Since we hypothesized on the overall theme level, we present, and assess, four blocks: the first block includes the control variables firm stage, size, and age, in the second block we add the prior financing measures, in the third - management team variables, and the fourth - the board measures. Thus, three models beyond the control variables are presented in order to assess ASO design characteristics associated with VC acquisitions. The test of the overall model fit can be found in the appendix to the dissertation.

Our four step model is shown in Table 2.

Model 1 contains the control variables. Model 2 demonstrates support for hypothesis H1. This model is significant at the .001 level. Prior seed and industry funding are both found to be significant at the 0.05 level. Financing by informal investors has apparently no effect on subsequent VC acquisition. In fact, the data indicate that the presence of informal investors may have a negative effect on subsequent VC financing.

Model 3 demonstrates support for H2. This model includes management team member heterogeneity and team size variables. It appears that team size and functional and industry backgrounds representing cognitive diversity are positively associated with attracting VC financing ($p < .05$ and $p < .1$). Personality diversity is negatively associated with receiving VC financing ($p < .1$). Model 4 does not exhibit support for H3, although educational diversity in boards, which is negatively related to VC acquisition, is found to be significant at the 0.05 level.

In summary, prior portfolio seed and industry financing appear to be the predominant predictors of subsequent VC funding. However, cognitive diversity in terms of variation in functional and industry backgrounds and management team size are both associated with VC financing, although team personality diversity and board educational diversity are negatively associated. The presence of the positive relationship for functional background and team size in our findings seems to be in line with the literature on diversity and performance. Meta-analytical studies of teams and performance provide support for that cognitive diversity (e.g. functional heterogeneity, etc.) is desirable in the creative settings, like in ASO context, which require the teams' engagement in applying knowledge and expertise in non-routine tasks (Stewart 2006). The similar support is provided for the team size, and is consistent with the notion that additional members are desirable when the team (like in ASO context) is required to interact with, and obtain, resources such as supplies and expertise from a complex environment. A negative relationship of personality diversity may be rooted in the conflict.

Table 2 Hierarchical logistic regression model results

	<i>Variables</i>	<i>Block 1</i>	<i>Block 2</i>	<i>Block 3</i>	<i>Block 4</i>
Controls	Firm size	1,00	1,00	,99	,99
	Firm age	,98	,94	,88	,84
	Cycle stage	,97	,86	1,53	1,64
Finance level	Seed financing		4,63**	3,89*	5,30*
	Informal investors		,84	,79	,75
	Industrial investors		3,33*	3,40 [†]	5,14*
TMT Level	Team size			1,51*	1,54*
	Functional background diversity			1,78*	2,29**
	Industry background diversity			1,40	1,59 [†]
	Educational diversity			,90	,94
	Diversity in startup experience			1,45	1,44
	Diversity in management experience			,82	1,01
	Diversity in international experience			,86	,73
	Personality diversity			,68 [†]	,73
	Age diversity			,80	,79
Board level	Board size				,89
	Board functional diversity				,86
	Board industry background diversity				,89
	Board educational diversity				,56*
	Board international experience diversity				1,31
	Board personality diversity				1,00
	Board age diversity				,96
	Constant				,02
	Model χ^2	,248	16,296	34,810	42,762
	Model χ^2 significance	ns	,012	,003	,005
	Δ Model χ^2	,248	16,048	18,514	7,952
	Δ Model χ^2 significance	ns	,001	,030	ns
	-2 log likelihood	122,151	106,103	87,589	79,64
	Overall predictive accuracy	73,6%	75,5%	79,2%	82,1%
	Cox & Snell R ²	,002	,143	,280	,332
	Nagelkerke R ²	,003	,208	,409	,485
	Number of firms	106	106	106	106

[†] p < .1; * p < .05; ** p < .01; *** p < .001

When negative sides of the conflict prevail upon positive (task) conflict on the team it may result in poor performance (Ensley et al. 2002).

While knowledge and skills of the board members are about doing, other characteristics including age and education or school attended may rather be about being (Huse 2007). Board members may have a good reputation providing ASOs with prestige and helping with networking and resource tasks, but they do not necessarily need to have relevant education or competence with respect to key issues that ASOs face (e.g. technology development). This may be reflected in the negative relationship of educational diversity. Alternatively, the negative relationship may be due to that educational diversity among board members in our context resembles an ascribed (demographic) rather than more directly task-related (cognitive) characteristic. As shown in meta-analytical group studies demographic diversity typically has a slightly negative effect (Stewart 2006).

5. Discussion with conclusions

This paper has sought to explore characteristics such as the role of prior finance, management team and board design features associated with venture capital-financed academic spin-off companies. Our study brings a novel contribution to academic entrepreneurship research by relating early stage finance and team and board design characteristics to ASO performance. Our investigation also represents a useful addition to the team and governance literature, since little is known about the TMT and board's role in venture capital acquisition in high-tech new ventures (Ensley and Hmieleski 2005; Wright et al. 2007a; Clarysse et al. 2007; Uhlaner et al. 2007). Overall, we find that prior portfolio seed and industry financing are the predominant predictors of subsequent VC funding. We find that ASOs with larger teams and higher cognitive diversity previously financed by seed funds and industry are more likely to attract VC funding than ASOs with board educational diversity and with support from informal investors.

Empirically, we contribute in several ways. First, we consider early types of financing from the seed funds, informal investors, and industry as important predictors of VC acquisition by ASOs. Second, we find that management teams with higher cognitive diversity in terms functional and industry background are more likely to receive VC funding. These findings extend and refine previous research, confirming that the human capital of the management team may usefully predict entrepreneurial success (Ucbasaran et al. 2003;

Beckman et al. 2007; Zimmerman 2008). Third, as boards in high-tech ventures exhibit greater levels of influence on firm development compared to other types of firms (Forbes and Milliken 1999; Huse 2007), we tried to integrate board design features associated with receiving VC financing into our model.

Further, our findings indicate that previous funding by informal investors does not assure obtaining VC financing. It is often claimed that informal investors do seed stage deals that they hope will develop into ventures that attract start-up financing from venture capitalists or they invest in ventures whose growth prospects are too small to be of interest to a venture capitalist (De Clercq et al. 2006). Additional analysis shows that there are no significant differences in perceptually-measured growth variables (e.g. firm's satisfaction with performance in terms of market share and firm sales) between the groups of ASOs financed by informal and VC investors. This could be explained by the nature of the informal investors. They are often interlinked with other informal investors (and not to VCs) (Sørheim and Landström 2001; Sørheim 2003). This means that informal investors probably will be the main source of finance in future financing rounds. Another explanation to this could be that informal investors and entrepreneurs respond negatively to VC terms (which could be considered as negative treatment of current owners). Moreover, the reader should also bear in mind that in total VCs make very few investments compared to the total of investments from informal investors. This means that only a small fraction of investments from informal investors would be of interest to VCs.

This study has several implications and offers several future research avenues. First, this study suggests that the combination of seed funding and alliances with industrial partners is positively related to an ASO's ability to attract VC. For policy makers, this means that different types of public support schemes should be designed in order to facilitate involvement from strategic industrial partners. Second, when forming a team, TTOs and entrepreneurs should pay attention to the cognitive diversity. Like in other high-tech ventures the cognitive diversity expressed in functional and industry background variation is positively associated with the ASO's ability to attract VC funding. Yet, our results demonstrate that prior portfolio seed and industry financing appear to be the more important predictors of receiving VC financing than a management team's cognitive diversity. This may imply that the management team's ability to accumulate seed and industrial financing prior to seeking VC support plays a greater role than the team's cognitive diversity per se. Future investigations may test this hypothesis. Third, board design characteristics do not appear to be as important as prior finance and TMT design features, yet the overall model, which accounts

for all these three levels, remains strong. For future research on boards in high-tech firms, this means that the board's role and, particularly, the extent to which the human aspects of the board (not mere control function) contribute to entrepreneurial success is an attractive research path, which needs more systematical investigation. Finally, our findings indicate that there is no relay race between VCs and an informal investor. Hence, future research studies on entrepreneurial financing should focus on this issue more explicitly. The question is whether there is a "lock in" effect, meaning that funding from informal investors in early stages is a negative signal to potential VC investors and, thus, an obstacle for obtaining future financing from VCs. Or is it the other way around, meaning that finance from informal investors is a part of a deliberate strategy. Such a strategy could be rooted in skepticism about the terms introduced by venture capitalists, which is demonstrated by the founders of ASOs who deliberately choose this route of finance because they want to have "total control" (both related to cash flow and control rights).

Our study has a number of limitations which will hopefully be addressed by future research. First, our study is cross-sectional, and some of the team and board characteristics found may be attributed to the teams and boards after they have received VC funding. We could partially control for this issue. We performed an additional analysis with the variable that accounts for whether there were changes in the management team after the investment was made and we received the similar results as in our main analysis. Yet, future researchers need to attempt to conduct a longitudinal study to ensure the proper sequence of events and characteristics measured. Second, even if this study indicate that cooperation between informal investors and VCs is limited when it comes to investments in ASOs we still have limited knowledge about this phenomena. There is a need for future studies addressing the issues of finance, TMT and board in ASOs in more detail. Third, this is a study of Norwegian ASOs, and there is need for more studies in other comparable countries and contexts. For example, risk capital markets in the US are far more developed compared to Norway. A market place with more professional actors might influence the interplay between investors focusing on different stages of the lifecycle of an ASO.

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APPENDIX

Questionnaire: Question selection for papers 3 and 4

What role do you have in the firm? (Check in **all** boxes that are relevant) Are you:

- 1 Founder of the firm 2 CEO 3 If other, please specify

A1 Organization identification number or firm name:

A2a What university/research institute do(es) the technology/founders come from?

A2b Which TTO or other Commercialization Unit did your firm deal with?

A4 How many full-time equivalents are there in the firm:

2004 2005 2006 2007 2008 Estimation for 2009

Total number of FTEs

A7 In which phase of the firm's life cycle is your firm now? (Tick one box)

- ₀ *Early phase*: We evaluate the commercial potential and strengthen intellectual rights; we apply for a patent or try to protect technology which will be at the core of our product/service.
- ₁ *Development phase*: We are developing a product/service, which to limited degree is introduced in the market. Revenues are very low.
- ₂ *Start-up-/introduction phase*: Our product/service is gradually being introduced in the market.
- ₃ *Growth phase*: Our firm grows fast and investments may be necessary for further development. Our product/service can be introduced in several markets, and the sales are increasing.
- ₄ *Maturity phase*: The sales are flattening out. Our firm has reached all potential customers in the targeted markets.

A10a Since the firm's foundation, how is:

Much worse

Much better

the firm's growth in sales

₁ ₂ ₃ ₄ ₅ ₆ ₇

the growth in market share

₁ ₂ ₃ ₄ ₅ ₆ ₇

the quality of the firm's product/service

₁ ₂ ₃ ₄ ₅ ₆ ₇

the innovation in the form of new products/services

₁ ₂ ₃ ₄ ₅ ₆ ₇

the customer satisfaction

₁ ₂ ₃ ₄ ₅ ₆ ₇

the firm's profitability

₁ ₂ ₃ ₄ ₅ ₆ ₇

the firm's financing

₁ ₂ ₃ ₄ ₅ ₆ ₇

A10b Our firm is satisfied with:

Completely disagree

Completely agree

• market share

₁ ₂ ₃ ₄ ₅ ₆ ₇

• profit

₁ ₂ ₃ ₄ ₅ ₆ ₇

• sales

₁ ₂ ₃ ₄ ₅ ₆ ₇

• return on assets

₁ ₂ ₃ ₄ ₅ ₆ ₇

B3 How many members are in your **top management team (TMT)**? _____ members

B4 How many members are in your **board of directors**? _____ members

B5 How many members are in both the TMT and board? _____ members

B6 Please name the total number of years all members served on the TMT? _____ years

Consider the most **important/critical membership change** in the TMT or board:

- B8 Was it:
- ₁ the person who left the TMT or board
 - ₂ the person who entered the TMT or board

B13b What was (were) the **reason(s)** that the member **has entered** management?

Rank the reasons to why the member has entered the TMT (1 – most important reason, etc.)

- We wanted this member on the team because of his/her competence
- The member was going to replace a person who left the firm
- Our firm grew and we needed an additional manager to lead our new departments
- Largest stakeholder(s) wished the member to join the TMT
- Other reasons, please specify

B14 Which positive and/or negative consequences did membership change have for the firm's growth/performance?

- in case of member's entrance:
- in case of member's departure:.....

B18a Our TMT members represent a variety in the:	To a small degree				To a large degree		
Functional background (sales, finance etc.)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Industrial background	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Education background	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Personality	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Age	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Previous experience of starting up ventures	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Management experience	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
International experience (worked abroad, of foreign origin)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇

C1 Has the firm contacted and possibly received the financial capital from the following:	No, has not tried	Has tried, but did not receive capital	Has received capital
Family	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃
Seed fund	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃
Incubator	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃
Industrial or public R&D grant	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃
Other support from the Research Council of Norway	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃
Other, specify _____	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃

C2 When was the first external capital from private investors (not family) received? Year: _____ ₂ Never

C3 When was the first external capital from industrial partners received? Year: _____ ₂ Never

C4 When was the first external capital from venture capital investors received? Year: _____ ₂ Never

C5 How many times did your firm receive the capital from venture capital investors? _____ times

D5 Please indicate to what extent you agree with the following statements on the contribution made by the board:

	Totally disagree						Totally agree
• Board members contribute to networking, network building	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
• Firm and board often use board members' network to get advice	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇

D6 Our board members represent a variety of

	Totally disagree						Totally agree
Functional backgrounds (e.g. sales, finance)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Industrial backgrounds	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Educational backgrounds	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Personalities	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Ages	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
International experience	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇

D8 How many board members have the following background: ___ Venture capital investors
 ___ TTO / commercialization unit representatives ___ External members (not employees)

Table 1 Means, standard deviations and tests for differences in means between the responding firms and those not responding to the survey

Characteristics	Respondents	Non-respondents	T-statistic
Sample size	82	137	n/a
Number of employees	3.38 (s.d. 5.16)	4.31 (s.d. 21.36)	.390
Firm age	5.71 (s.d. 3.23)	5.92 (s.d. 3.43)	.448
Operating revenues	2 939 047 (s.d. 4 507 240)	5 366 294 (s.d. 2.740E7)	.795

Notes: **s.d.** standard deviation

Table 2 Hosmer and Lemeshow measure of overall model fit for paper 3

Hosmer and Lemeshow Test

Step	Chi-square	Df	Sig.
1	13.015	8	.111

Contingency Table for Hosmer and Lemeshow Test (Model 2)

		Add = ,00		Add = 1,00		Total
		Observed	Expected	Observed	Expected	
Step 1	1	9	8.298	1	1.702	10
	2	6	6.682	4	3.318	10
	3	7	5.263	3	4.737	10
	4	4	3.840	6	6.160	10
	5	2	2.701	8	7.299	10
	6	0	1.899	10	8.101	10
	7	0	1.183	10	8.817	10
	8	1	.696	9	9.304	10
	9	2	.383	8	9.617	10
	10	0	.054	5	4.946	5

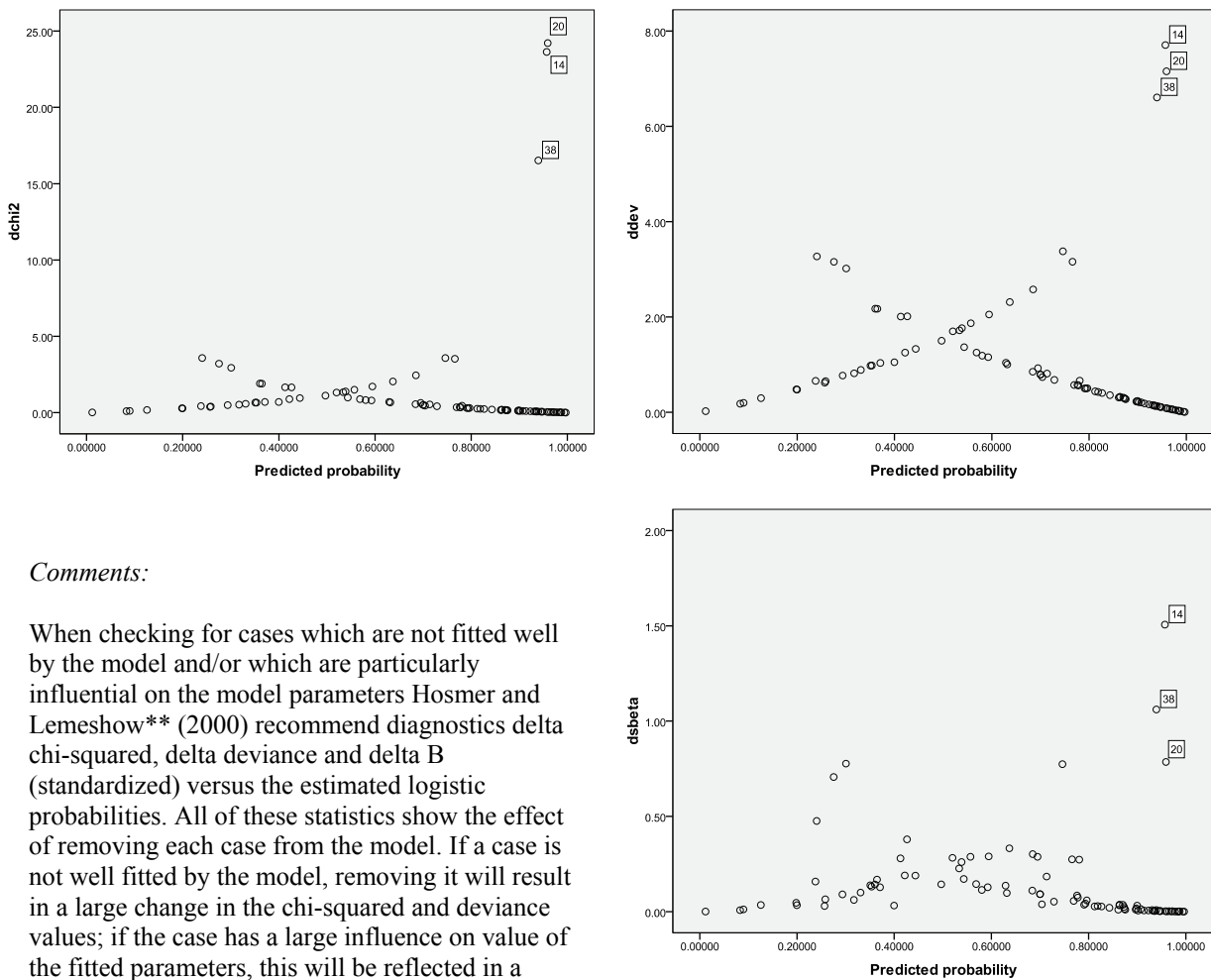
Comment:

Hosmer and Lemeshow's test provides a comprehensive statistical measure of predictive accuracy that is based on the actual prediction of the dependent variable (Hair et al. 2006*). This statistical test measures the correspondence of the actual and predicted values of the dependent variable. In this case, better model fit is indicated by a smaller difference in the observed and predicted classification.

The test indicates that there are no significant differences between actual and expected values. This means that the model fit is acceptable.

*Hair, J. F. Jr., W. C. Black, B. J. Babin and R. E. Anderson (2006), *Multivariate data analysis*, Upper Saddle River, N.J.: Prentice Hall.

Figure 1 Examining residuals: plots of $\Delta\chi^2$, ΔD and $\Delta\beta$ (standardized) versus the estimated probability (paper 3)



Comments:

When checking for cases which are not fitted well by the model and/or which are particularly influential on the model parameters Hosmer and Lemeshow** (2000) recommend diagnostics delta chi-squared, delta deviance and delta B (standardized) versus the estimated logistic probabilities. All of these statistics show the effect of removing each case from the model. If a case is not well fitted by the model, removing it will result in a large change in the chi-squared and deviance values; if the case has a large influence on value of the fitted parameters, this will be reflected in a large value of delta B.

We will investigate the most extreme points at the top right of the $\Delta\chi^2$ and ΔD graphs. The cases whom the model does not fit are 14, 20 and 38. What is common for these cases is that they have diverse teams with regard to functional and industrial backgrounds, large and networking boards, however, they did not add a new member on the team. This may be attributed to the early stages of firm development (early stage for cases 14 and 20 and development stage for case 38), which may imply that the need for adding external members with necessary competence to the team of researchers is somewhat reduced. Overall, these cases go against our general finding.

According to Hosmer and Lemeshow (2000), we use four as an approximation to the ninety-fifth percentile of the distribution of delta chi-squared and delta deviance values. That is the values of delta chi-squared and delta deviance greater than four should be considered significant. It can be seen from $\Delta\chi^2$ and ΔD graphs that none of the values (except for the extreme points) are greater than four, which indicates that the model fits well.

Plot of $\Delta\beta$ vs. predicted probability shows how influential each case is in determining the model parameters. Case 14, and perhaps case 38, stand out. The main reason for this is that firm 14 has very much higher team tenure, 30 years, compared to others (mean team tenure is 12 years). Firms 14 and 38 also go against the general finding that firms with larger and more networking boards are more likely to add new member to the top management team. Removing these cases had very little effect on the results. Therefore, the presence of the influential cases is not an issue.

** Hosmer, D. W. and S. Lemeshow (2000), *Applied logistic regression*, New York: Wiley, 2nd ed.

Table 3 Examining residuals: outliers (paper 3)

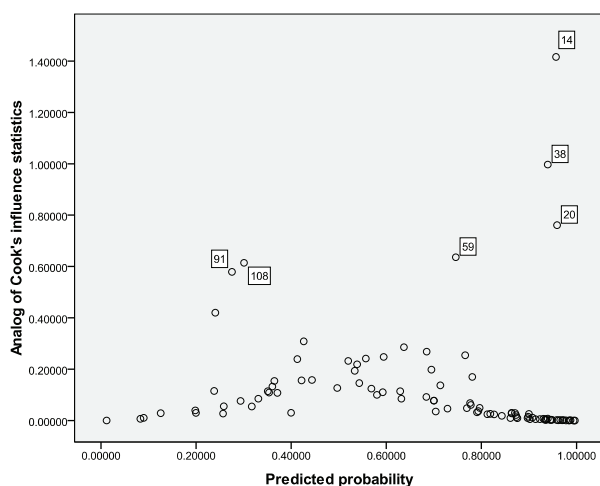
Casewise List ^b						
Case	Selected Status ^a	Observed	Predicted	Predicted Group	Temporary Variable	
		Add			Resid	ZResid
14	S	0**	.957	1	-.957	-4.713
20	S	0**	.959	1	-.959	-4.842
38	S	0**	.939	1	-.939	-3.940

a. S = Selected, U = Unselected cases, and ** = Misclassified cases.

b. Cases with studentized residuals greater than 2,000 are listed.

Comment: Only three cases have been misclassified. Given the low levels of misclassification and based on the analysis of these cases presented above no further analysis of misclassification is necessary.

Figure 2 Examining residuals: plot of Cook's D versus the estimated probability (paper 3)



Comments:

Cook's D measures the total effect of the case on the model as a whole, i.e. how much deleting a given case affects residuals for all cases.

According to Hamilton*** (1992) the cases, which are especially influential will have Cook's D value larger than $4/n$ (cf. Eikemo and Clausen 2007****), i.e. $4/95$ in our case. Hence, **Cook's D** value is about .04. Six cases that have Cook's D values above the calculated one are 14, 20, 38, 59, 91 and 108.

Conclusion based on the residual analysis (paper 3):

The possible remedy is to filter out influential cases identified from the plots and using calculated critical Cook's D value, and run logistic regression. After using filter, the Cox & Shell R2 and Nagelkerke R2 are increased to .588 and .859 correspondingly in the new model. The overall predictive accuracy is increased from 80 % (in original model) to 93.1 % in the new model. B-coefficients have slightly changed, but not significantly. Hence, the coefficients do not change the interpretation of the results. Overall, the new logistic regression model without influential cases produces similar results. This confirms that the presence of the influential cases is not a major issue.

***Hamilton, L. C. (1992), *Regression with graphics*, Belmont: Duxbury.

**** Eikemo, T.A. and Clausen, T. H. (2007), *Kvantitativ analyse med SPSS: en praktisk innføring i kvantitative analyseteknikker*, (Quantitative analysis in SPSS: a practical introduction into quantitative analysis techniques) Trondheim: Tapir akademisk forlaget.

Table 4 Hosmer and Lemeshow measure of overall model fit for paper 4

Hosmer and Lemeshow Test (H&L)

Step	Chi-square	df	Sig.
1	6,260	8	,618

Contingency Table for Hosmer and Lemeshow Test

		VC = ,00		VC = 1,00		Total
		Observed	Expected	Observed	Expected	
Step 1	1	11	10,975	0	,025	11
	2	11	10,837	0	,163	11
	3	10	10,554	1	,446	11
	4	11	10,168	0	,832	11
	5	10	9,452	1	1,548	11
	6	7	8,570	4	2,430	11
	7	9	7,063	2	3,937	11
	8	4	5,915	7	5,085	11
	9	4	3,526	7	7,474	11
	10	1	,940	6	6,060	7

Comment: The test indicates that the model fit is acceptable.

Similar *diagnostics* was conducted for paper 4 as it was presented above for paper 3. The results indicate no problems with residuals or cases with unusual impacts. The diagnostics for paper 4 is not appended.