

The Transformation of Network Ties to Develop Entrepreneurial Competencies for University Spin-offs

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Abstract

Social networks are integral to the emergence and development of new ventures but the temporal utility of networks is poorly understood. We consider the initial development of four university spin-offs and examine the formation and development of network ties to construct valuable entrepreneurial competencies. We develop a conceptual framework that explains how strong and weak network ties are strategically transformed in terms of strength and purpose depending on the type of competency sought and the business development need. We conclude that theoretical explanations of the new venture formation process need to incorporate not only network formation but also the role of network tie transformations.

1. Introduction

A growing body of literature has considered the importance of networks for the initiation and growth of new entrepreneurial ventures (Elfring and Hulsink, 2007; Hite, 2005; Hite and Hesterly, 2001; Sullivan and Ford, 2013). Start-ups can enhance early performance by establishing broad networks to overcome liabilities of newness at a reduced cost (De Carolis et al., 2009; Greve and Salaff, 2003; Jack, 2005). Network relations act as a bridge to access information and resources that supplements the existing assets of the entrepreneurs or nascent firms (Newbert et al., 2013; Semrau and Werner, 2013). Networks are also central to how emerging ventures understand and enact their environment (Jack et al., 2008). There is general support for the notion that entrepreneurs with a more developed network, in terms of the quality and number of ties, are more likely to succeed than those having a less developed

network (Burt, 2000; De Carolis et al., 2009). However, less is known about how entrepreneurs can build on their current ties and strategically develop networks that can be used for different purposes (Hallen and Eisenhardt, 2012). Hence, this article addresses the need for more fine grained research into network formation and development (Grossman et al., 2012; Jack, 2010; Slotte-Kock and Coviello, 2010).

Networks can serve many different purposes, and, in the context of new venture creation, one of the most significant is providing access to entrepreneurial competencies. Nascent ventures need access to a set of entrepreneurial competencies to be able to proceed from idea to value creating firm (Man et al., 2002). A competence is defined as an ‘ability to accomplish something by using a set of material and immaterial resources’ (Danneels, 2002: 1102). Competencies have material as well as cognitive components. As proposed by Hayton and Kelley (2006: 410) ‘situationally specific individual competencies involve identifiable sets or combinations of individual characteristics, specifically knowledge, skills, and personality characteristics’. For most nascent ventures the required competencies are not readily available, but have to be constructed during the early phases of venture development. Consequently, we analyze the formation and development of networks to build entrepreneurial competencies within nascent university spin-off ventures based on academic research.

Nascent high-technology ventures provide an excellent setting to study network theory in action due to their technological complexity, fast moving market dynamics, growth struggles, and re-directions (Elfring and Hulsink, 2007). Moreover, university spin-offs are situated within an institutional context where their development may be inhibited by a lack of business experience and commercial skills amongst academics (Vohora et al., 2004), possible conflicts of interest with other university tasks (Mustar et al., 2006), and high distance to market as they tend to emanate from internationally renowned research (Hewitt-Dundas,

2012). Academics are often novice entrepreneurs lacking entrepreneurial competencies and are therefore a highly suitable context to study the process of developing competencies through networks (Zahra et al., 2007).

We focus upon the early stages of venture formation, arguably the most influential in terms of the path upon which the venture evolves (Clarysse and Moray, 2004). The earliest stages comprise the period from the research stage, when ideas about commercial applications are relatively opaque, through to when an independent spin-off venture is established (Rasmussen, 2011). Within this early stage, we can observe the development of competencies required to make the transition from academic research to the recognition and exploitation of a commercial opportunity (Vohora et al., 2004) and examine the influence of the development and transformation of networks upon the construction of requisite entrepreneurial competencies (Aldrich and Kim, 2007). Thus, we pose the following research question: *How do academic entrepreneurs form and develop their social networks to construct the entrepreneurial competencies needed to establish an independent spin-off venture?*

Given the paucity of theoretical frameworks, we addressed these questions with longitudinal case studies where we could follow network formation and development in of four emerging ventures. The selected university spin-offs emerged from universities in the UK and Norway, representing diversity across European contexts. The study draws upon 54 interviews conducted in 2004/2005 and followed up subsequently in 2014, supplemented with secondary sources that documented the narratives of the early start-up processes of these ventures.

By adding to the few studies of the process of network development (Milanov and Fernhaber, 2009; Slotte-Kock and Coviello, 2010) and the lack of longitudinal and qualitative studies on networks (Jack, 2010) we make two distinct contributions to the literature on networks and entrepreneurial competencies. Our first contribution concerns insights into the

under-developed area of the purposeful formation of network ties (Hallen and Eisenhardt, 2012). We provide novel richness by highlighting that strong and weak network ties may be transformed so that they play a multifaceted role over time. Specifically, network ties may help construct one specific competency early in the start-up process but be transformed to provide a different role later on in gaining another competency. This leads us to suggest that theories considering the formation of network ties in the emergence of new ventures also need to consider the transformation of network ties over the evolution of the venture as a vital component. Network tie transformation occurs when a network tie originally formed for the purpose of developing one competency is re-aligned to serve a different purpose. This has important implications for the understanding of entrepreneurial networks because the full value of some ties may only be realized through the transformation of these ties. Hence, the formation of useful network ties can follow a process of direct tie formation (Hallen and Eisenhardt, 2012), but also through the transformation of an existing tie originally developed for a different purpose. Thus, we emphasise the need to take a longitudinal perspective on the formation of network ties in emerging ventures.

Second, our study helps reconcile inconsistent findings regarding whether strong or weak ties are beneficial to the earliest stages of venture development. We suggest that the appropriate ties may be contingent upon the type of competencies considered and the process of the venture's development. An opportunity refinement competency may be initially developed through leveraging weak ties to industry partners and then building stronger ties. In contrast, resource acquisition and championing competencies may be constructed through initially building upon strong ties to colleagues and investors and subsequently developing new weak ties. Here, we complement recent contributions that have shown that the value of new venture networking differs by specific types of resources (Semrau and Werner, 2013) and types of innovation (Partanen et al., 2014). By covering three key areas where new ventures

need to develop networks; our entrepreneurial competency framework is more generic. It is also particularly suited to study networking processes because competencies are dynamically developed as the new venture evolves.

This paper proceeds as follows. Section 2 outlines a conceptual framework for studying the development of entrepreneurial competencies. The methodology is presented in Section 3. The fourth section provides an analysis of the data and propositions are derived. Finally, the implications of our study are discussed in relation to research and practice, and conclusions are provided.

2. Conceptual framework

2.1. The role of networks in accessing entrepreneurial competencies

Entrepreneurial firms utilize many different types of relationships in their development (Lechner et al., 2006; Partanen et al., 2014). The core assumption of the network perspective is that new ventures can mitigate the liability of newness by constructing an appropriate network and managing this network over time (Partanen et al., 2014; Steier and Greenwood, 2000). However, different network characteristics appear advantageous at different stages of new venture creation and development (Greve and Salaff, 2003; Hite and Hesterly, 2001; Sullivan and Ford, 2013). Strong ties appear necessary for the initiation of entrepreneurial activity while weak ties are more suited for rapid gestation activities (Davidsson and Honig, 2003). Although many studies have looked at the structure, content, and governance of networks, few have examined how networks are developed and transformed during the early development of new firms (Jack et al., 2008; Newbert et al., 2013). To gain a more fine grained account of this phenomenon, we consider the type of entrepreneurial competencies needed to develop university spin-off ventures and the use of networks for developing each competency.

2.2. *Entrepreneurial competencies*

The abilities required to set up a new venture can be conceptualized in different ways. We adopt the concept of entrepreneurial competencies as an effective way to capture the knowledge, skills, and abilities needed to develop a new venture (Man et al., 2002; Mitchelmore and Rowley, 2010; Rasmussen et al., 2011). Choosing a competency perspective allows us to disentangle elements of the entrepreneurial process as it unfolds over time (McMullen and Dimov, 2013). Entrepreneurial competencies are elusive, but the entrepreneurship literature points to the role of motivated individuals, the discovery and development of opportunities, and the acquisition of resources to exploit the opportunity as key aspects of the entrepreneurship process (Bruyat and Julien, 2001). Thus, we argue that a distinct set of entrepreneurial competencies related to opportunity refinement, resource acquisition, and championing are required to succeed with the new venture creation process.

Arguably, these competencies are in short supply within universities and among typically nascent academic entrepreneurs (Mosey and Wright, 2007). The development of university spin-offs is often characterized by a dynamic interaction of different individuals with different competencies throughout the start-up process (Clarysse and Moray, 2004; Vanaelst et al., 2006). For instance, the parent university and other university related actors play a key role in supporting spin-off development (Clarysse et al., 2007; Murray, 2004; Shane and Stuart, 2002), but equally important are contacts with external actors such as industry partners, investors, and customers (Munari and Toschi, 2011). Academics may be able to utilize existing ties within the university to gain certain competencies. But they may be constrained from doing so outside the university as their contacts with commercial actors are typically less frequent and constrained by cultural differences (Mosey and Wright, 2007).

Thus, academic entrepreneurs need to expand and transform their networks to gain the competencies necessary to be able to develop a new venture.

Access to each competency is, however, likely to be facilitated by the type of networks the new venture is connected with. In the following, we will explore the role of networks for each of the three competencies included in our conceptual framework.

2.3. Opportunity refinement competency

The first competency concerns the ability to develop and refine a viable business opportunity or business model for the new venture. The recognition of opportunities is central to the creation of new ventures (Shane, 2000). The identification of entrepreneurial opportunities is, however, a cognitive act, with different individuals playing different roles throughout the entrepreneurial process (Eckhardt and Shane, 2003). Technological resources are fungible (Penrose, 1959) and the resulting market application of technological inventions and knowledge is rarely clear from the outset (Danneels, 2007; Gruber et al., 2013; Shane, 2000). Business models are altered as entrepreneurs improve their knowledge about resources and opportunities (Chesbrough and Rosenbloom, 2002; Eckhardt, 2013) and external relationships can provide novel and valuable contributions to the process of opportunity refinement (Gruber et al., 2013; Partanen et al., 2014). As a result, a competence in opportunity refinement arguably has a significant impact upon the early development path of nascent spin-off ventures.

To help develop such competence, Hansen (1999) suggests that weak ties are useful in identifying valuable yet easily codifiable knowledge within a corporate context, such as market research. By contrast, for the transfer of complex knowledge, such as the likely commercial demand for an early stage technology, strong ties between partners are necessary. Within the academic context, Bozeman and Corley (2004) observed a similar difference when

considering scientists' collaboration strategies. Here 'cosmopolitan' collaborations with a more diverse group were found to help develop research momentum yet stronger ties with mentors facilitated more complex collaborations with industry partners. While technology based ventures more generally have existing business and industry partners with whom they can refine their new opportunities, academic entrepreneurs, by contrast, may have made a technological discovery exclusively confined within the academic community. Somewhat paradoxically, the more renowned the research within the international academic community, the further the likely distance to apparent market need. As a result academics conducting international quality research can remain isolated from business actors who might provide competence in matching this breakthrough into a market opportunity (Bozeman and Mangematin, 2004). Thus, the progeny of ties for academic entrepreneurs may need to change over time to develop and refine nascent technologies into marketable opportunities.

We propose that the competency to refine their entrepreneurial opportunity is instrumental for new ventures and that networks play an important role in providing this competency. However, two more competencies are needed to sustain the venturing process.

2.4. Resource acquisition competency

The second competency concerns the assembly and organization of resources to exploit the opportunity (Alvarez and Busenitz, 2001; Barney et al., 2011; Brush et al., 2001). The resource-based literature shows that financial capital, physical assets, technological resources, human capital, and organizational resources are all important for new ventures. Intangible 'soft' resources are arguably more useful than tangible resources at the early stage of development (Lichtenstein and Brush, 2001). The resource acquisition process is, however, highly iterative and involves many different actors with appropriate diversity of competencies to effectively access and manage a diverse set of resources (Sirmon et al., 2011).

The network literature highlights how new firms can gain access to resources through networks (Hite and Hesterly, 2001; Semrau and Werner, 2013). Some recent studies of the development of network relations towards external resource holders show that these relations develop over time. Firms developing their investment ties early are building on the founders' networks, while if the same type of tie are developed later it is achieved on the basis of the firm's accomplishments (Hallen, 2008). It also seems clear that the development of networks to access resources is partly path dependent (Vanacker et al., 2014) but that entrepreneurs can also successfully use catalyzing strategies to obtain useful ties (Hallen and Eisenhardt, 2012). All these studies solely looked at networks between new ventures and investors, while questions about the interplay between different categories of resource holders providing different types of resources remain less explored.

We propose that resource acquisition can be seen as an entrepreneurial competency of crucial importance for new ventures, and that networks play an important role in providing this competency. However, the entrepreneurial process can be stymied without a third entrepreneurial competency discussed in the next section.

2.5. Championing competency

As entrepreneurship involves human agency (Shane et al., 2003), there is a pressing need for someone to take a championing role in the venturing process (Burgelman, 1983). Champions induce the commitment of others to the innovation by providing emotional meaning and energy to the idea (Howell and Higgins, 1990) and help mobilizing support with critical individuals and third parties (Walter et al., 2011). We propose that the championing competency is therefore crucial for nascent technology ventures to overcome the early stages of development. University spin-offs may be championed by academics, external entrepreneurs, or a combination of both (Nicolaou and Birley, 2003) and are often developed

by teams (Clarysse and Moray, 2004). Distributing the championing role among several individuals may be instrumental for successful venture development as it has been found that an individual's championing behavior is desirable up to some level in research-based spin-offs (Walter et al., 2011).

Networks are proposed to be instrumental in accessing and developing additional championing competency to the new venture (Aldrich and Kim, 2007). This is evident within academia where academics having strong ties to colleagues who are entrepreneurs are more likely to engage in venture creation (Kassicieh et al., 1996). New members of entrepreneurial teams are typically recruited among existing contacts that are likely to share the same characteristics as existing members (Aldrich and Kim, 2007; Beckman and Burton, 2008). In contrast, it appears most beneficial to have broadly experienced teams (Beckman and Burton, 2008), but developing new ties appears to be a challenge for entrepreneurs. Hence, academic entrepreneurs with prior business experience benefit from having broader network ties outside academia (Mosey and Wright, 2007). Yet how academic entrepreneurs can build such relationships with champions inside and outside academe is less clear (Franklin et al., 2001; Hallen and Eisenhardt, 2012).

To sum up, it seems reasonable to claim that the three important competencies identified during the early stages of the entrepreneurial process will be linked to many different actors both within and outside the university. Moreover, the use of networks is important to access and develop these competencies, but how the networks to construct each competency are formed and how the use of networks changes over time remains relatively unexplored.

3. Methodology

3.1. Research design

We adopted a case study approach, guided by the competency framework outlined above (Suddaby, 2006). From this prior literature it seems clear that different competencies are used at different times in the spin-off process and that the role of networks also changes over time. Thus, a longitudinal approach is warranted to capture such dynamic effects and reduce problems of retrospective biases (Pettigrew, 1990). The use of comparative case studies is appropriate to gain insight into organizational phenomena over time (Eisenhardt, 1989). We therefore mapped the initiation and early development of four university spin-offs using a longitudinal research approach. To enhance external validity, we selected cases from diverse settings.

3.2. Case selection

We sought to identify competency construction through the use of networks that transcend significant contextual variation. Thus, we adopted theoretical sampling (Eisenhardt, 1989) and chose to study cases within different national, university, and industry contexts (Yin, 1989). First, by including cases from the UK and Norway we explored distinct European institutional contexts. In the UK, commercialization of research has been high on the agenda since the 1990s and most universities have a well established infrastructure of technology transfer offices (TTOs). UK universities have been highly active in spin-off creation compared to other countries (Wright et al., 2007). By contrast, formal involvement in spin-off creation was relatively recent at Norwegian universities at the time of this study. IP ownership of academic research belonged to the individual academic until 2003 when it was assigned to the universities. This led to the establishment of TTOs at Norwegian universities,

with concomitant awareness within the institutions, and increased public spending to facilitate commercialization of research.

Second, universities differ with respect to their research cultures and outreach to business and resources. Given the focus of our study, differences in the local support infrastructure in otherwise similar universities may influence competence acquisition through different ability to access networks. Accordingly, we chose one university with a relatively well developed institutional infrastructure for spin-off venture formation and one with a less comprehensive support tradition in each country. Third, to capture different industry contexts we selected cases from two contrasting research disciplines; biological sciences and engineering. As found by Mosey and Wright (2007), there might be differences in the use of networks between these disciplines and there might be differences in the need for resources (Druilhe and Garnsey, 2004).

Finally, we chose cases likely to exhibit a significant deficiency of entrepreneurial competencies. We therefore focused upon cases where the technological basis for the spin-off cases involved research groups that had international recognition for the quality of their research. We also focus on spin-offs where academic researchers with no prior business ownership experience played a significant role in the initiation and development of the ventures. Because we searched for projects in early stage of development, prospective cases had to be identified through key informants at the universities and access had to be negotiated. All cases had received initial seed funding from university or public support schemes, serving as a third party evaluation of the potential commercial viability of the idea. Table 1 shows the central properties of the selected cases.

INSERT TABLE 1 HERE

3.3. *Data collection*

Our aim was to document the entrepreneurial process longitudinally. Data was triangulated by including several sources of data to map the situation and critical events prior to and during the development of the four spin-off projects. Primary data was collected by personal interviews with people in various positions including: company founders and entrepreneurial team members, researchers, university managers, and people involved in commercialization support (see Table 2). The first interviews were conducted about one year after the venturing process had been initiated. To obtain longitudinal data from the inception of the venture we followed a narrative approach (Polkinghorne, 1988) by asking respondents to describe their involvement and knowledge about the spin-off project in chronological order from its inception to date. In most cases the interviewees described key events and actions with a minimum of interruption by the interviewer. Open follow-up questions were used to get more detailed information regarding when, how, and why actions and events occurred. Although we partially relied on retrospective accounts, this type of narrative interviewing (Czarniawska, 1998: 29) enabled us to get closer to actual events and to avoid personal views and theoretical perspectives influencing the data collection.

INSERT TABLE 2 HERE

The subsequent phases of the start-up process were followed in real time by conducting repeated interviews with key persons at regular intervals throughout a 12-18 month period from spring 2004 through to 2005. A total of 54 interviews were conducted, recorded and transcribed by two of the authors as part of the data analysis process. We believe that this time period was appropriate for purposes of our study because we sought institutional contexts at the country level that were at different stages of development and universities that

were at different stages of support provision for spin off companies. Other factors such as the differences between industry sectors and the theoretical mechanisms explored should, by contrast, be relatively time invariant. University spin-offs typically have long development paths and therefore we checked the status of the cases in 2014 to ensure that they had developed successfully (see Table 1).

For each firm, archival data, including financial reports, business plans, market analyses, and research documents, was obtained. In addition, relevant written documentation was collected both from respondents and other sources such as magazines, newspapers, and the internet. By combining the different sources of information and by collecting information over a period of time through repeated interviews with central people, an in-depth description of the research and commercialization process was obtained. The data collection ended when each case had passed the credibility threshold in terms of having established an entrepreneurial team as well as gaining initial external equity investments (Vohora et al., 2004). By entering the cases early in their development, we were able to establish close relationships and gain close to real time data, which helped reduce the retrospective bias problem.

3.4. Data analysis

From the different data sources we reconstructed the narrative of the start-up process by using case descriptions and tables. From this we identified critical characteristics and events that influenced how competencies were constructed through the use of networks. Following Granovetter (1973) and Yli-Renko et al. (2001), we distinguished between strong and weak ties by considering the amount of time invested in a relationship between actors, the frequency of interaction, the levels of trust, and the depth of reciprocal services observed between actors. In particular, we investigated the differences between ties within the

homogenous academic university network, where the focus was primarily upon research, and ties that provided bridges into commercial organizations such as industry partners, potential investors, or professional service providers.

The interview transcripts and other material were read and reread as data were collected; emerging themes were refined as this process progressed and checked through the repeat interviews with the main players (Yin, 1989). The views of the different respondents from each case were also compared. To derive theoretical explanations for the processes observed, we identified observations that matched theoretical concepts (Borch and Arthur, 1995). As the analysis proceeded, the overarching logical frame shifted from exploring data using retroduction to verifying theory through deduction (Van de Ven and Poole, 2002). In order to avoid confirmatory biases, one of the authors did not participate in data collection (Doz, 1996). The data analysis was undertaken in two-ordered steps (Taylor and Bodgan, 1984). Initially, a first-order analysis of the competency development within each case revealed how networks were used to access competencies, as summarized in Table 3. This was followed by a second-order analysis to develop propositions through analytical generalization (Yin, 1989). The results of the second order analysis are presented in Sections 4.1 to 4.3. For confidentiality reasons the cases are anonymized.

INSERT TABLE 3 HERE

4. The use of networks in accessing entrepreneurial competencies

Despite the unique technologies and markets and the different national, university, and industry environments exhibited by the four cases, each eventually developed into an independent new venture with a credible entrepreneurial team and external private sector equity finance from industrial, institutional, or venture capital investors. Each case

approached the goal via differing paths and from different starting points, yet remarkable similarities were observed in the use of networks to gain the competencies needed. Without exception, the actors involved acknowledged the need for entrepreneurial competencies to develop the new venture. For instance, an advisor involved in the Beta case explained: *'It is difficult to know how to commercialize an idea; to sell 'air' is difficult, so you need competence. [...] I think many commercialization projects fail because a lack of competence.'* (O1 - see Table 2).

The balance between developing internal competencies and accessing external competencies varied across cases, but the projects were not able to proceed towards obtaining external financing until all three competencies were sufficiently constructed. The complexity of the new venture creation process often required significant iteration within the entrepreneurs' initial networks and the purposive development of new networks to be able to develop and acquire the appropriate competency. Conceptually, the competencies do not need to be constructed in any particular order. Rather, they seem to be built in parallel and through iteration. For example, we observed that ties initially used to access one competency could later be used to access another competency, and that weak ties could be transformed into strong ties over time as the purpose of the tie relationship changed.

We discuss our findings related to each competency in more detail below and derive propositions related to the development and transformation of network ties to construct each competency.

4.1. Opportunity refinement competency

Although academic research was necessary for the business opportunity to be created, it was not sufficient for the new venture process to start. Some form of market related competence was also needed to initially frame the business idea. In all cases, the university

researchers played a central role in the earliest stages of this process, while other actors external to the university played an increasingly important role in later stages, as illustrated by one of the Alpha founders: *The initial idea was different [...] but [Professor x] came up with the current concept based on his industry experience [...] and then the ball started to roll. [...] The final idea was a result of an iterative process with [Industry partner] and the ideas we initially started with.* (F2)

The role of industry networks and close interaction with industry were decisive for developing the business concept that eventually became attractive for external investors. Often, the project initially benefited from discussions and interaction with a broad range of actors, as explained by one of the Delta inventors: *“We didn’t know how to engage with industry and sell them the idea. Once we got the young post doc on board he went out and looked at what was out there, started us thinking about what was better about our device.”* (F1) This emphasizes the central role of networks in the opportunity refinement process (Jack, 2005; Nicolaou and Birley, 2003).

The type of network tie that is most beneficial may, however, be dependent on the type of benefit sought (Ahuja, 2000; Semrau and Werner, 2013). We observed that the use of existing weak ties was important initially in the process to identify possible business models and prospective partners, as explained by one of the Alpha founders: *“It would not have been possible to build this company without F4, with his network from 10 years as manager in industry. His contacts, combined with the professor titles, open doors at top manager level in the companies we approach.”* (F2) Such initial iteration with industry was also evident in Gamma, as explained by one of the founders: *“Each medic we spoke to gave us another hurdle to jump over that we had no idea was there. We went away, jumped over it and then came back with positive results only to find another hurdle, another type of test or whatever.”* (F2) While one of the Alpha founders had a broad network in industry, the Gamma founders

had fewer links, but one of these was particularly useful in helping to frame the business model, as noted by one of the Gamma inventors: *“I knew one of my old post docs was working within industry so I rang him up and asked if he could give us some advice. He became interested and joined us, initially as a consultant, to help convince the medics that what we had was useful.”* (F1) Here building upon existing weak ties with industry provided a crucial bridge away from academe and into industry.

Once a potential market opportunity was identified, an iterative process of business model development together with industry partners was observed. Here founders had to rely on transforming existing weak ties with industrial partners and customers into stronger ties. This was clearly illustrated by a Delta team member: *“The firm we partnered with was first introduced by the IP office. Once we had signed a partnership agreement the relationship developed over time as we worked more closely together. [...] [They] provide advice, collaboration and time. They provide market info as we have access to their customers who would make use of this technology so we have a route to market. They gave us an insight into how companies work with customers and how the system should be changed to meet customer needs.”* (T1)

It seems that weak ties are important to scan for possible market opportunities and strong ties are important to better refine the opportunity. In all our cases, the initial idea was refined several times during the start-up process. This lack of market related competence appears particular to academic entrepreneurs. By contrast entrepreneurs in a more general context are more likely lacking in technological expertise. To sum up, the opportunity refinement competency requires a transformation of network relationships with industry actors to discover opportunities based on scientific research and to further refine these opportunities into a viable business concept. Thus:

Proposition 1: Nascent spin-off ventures are more likely to construct opportunity refinement competency through initially leveraging existing weak ties with industry actors and subsequently through iteratively developing these weak ties into strong ties.

The temporal construction of opportunity refinement competency through the transformation of ties with industry partners is shown in Figure 1:

INSERT FIGURE 1 HERE

4.2. *Resource acquisition competency*

The second competency explored related to the acquisition of resources for the new venture creation process. Due to their complexity and high demand for resources, university spin-offs are typically dependent on contributions from several actors to develop and acquire the resources they need (Partanen et al., 2014). All our cases were developed by teams and the university or its TTO often initially provided access to resources. For instance, university management stepped forward to support the Beta project both internally and externally and both Gamma and Delta received initial support from the TTO. Moreover, access to public funding sources was crucial in the initial phases of developing the nascent ventures and industry actors also provided important resources.

Similar to opportunity refinement, the use of networks was also important in constructing the resource acquisition competency. However, entrepreneurs initially relied more on strong ties for resource acquisition. Access to university resources was partly dependent on the relationship between the academic founders and university management. The Beta founders were well respected within the university and were able to capitalize on this strong relationship, as noted by a new team member: *“The University has shown great*

goodwill and been more enthusiastic than could be expected. They probably realize that this is a very exciting project that is worth to put a stake at.” (T1)

Strong network ties also facilitated access to public funding sources for entrepreneurs and early stage product development. In the Alpha case, one Professor knew an experienced entrepreneur who joined the team and contributed with resources to build the venture through his network with early stage funding sources, as acknowledged by a founder: *“T1 has been crucial in obtaining funds for further development, through his good contacts, broad network, and knowledge of funding possibilities.” (F4)* This is in line with Ahuja (2000), who found that strong ties provided both resource-sharing and information spillover benefits, while weak ties provide only the latter. The importance of prior relations for accessing resources is well known (Hallen, 2008; Shane and Stuart, 2002).

However, evidence from the evolution of the venturing process enables us to extend these insights. As the nascent ventures needed resources from an increasing number of actors, they had to build new relationships outside the university. For instance, the Beta founders initially relied on strong ties to obtain funding, but were later able to gain equity investment from more than 20 investors. The Delta founders initially relied on university support, but subsequently developed new contacts as described by one of the founders: *“To attract potential partners the IP office suggested we make some commercial in-confidence flyers. We disseminated these everywhere we could think of. [...] Six firms of differing sizes came to visit us and signed confidentiality agreements. We had a dialogue with a number and then one came on board as development partners. They have been absolutely fantastic.” (F2)* Thus, while prior research has indicated that strong ties are important to obtain access to some initial resources, our evidence indicates that as the credibility of the venture increases, weak ties are important in obtaining additional resources, as noted by an Alpha founder: *“The alliance with [Industry partner] has created a ‘domino effect’ related to other customers.” (F4)* Thus:

Proposition 2: Nascent spin-off ventures are more likely to construct resource acquisition competency through initially leveraging existing strong ties with resource providers and subsequently through developing new weak ties with additional resource providers.

The construction of resource acquisition competency through the transformation of types of network ties can be seen in Figure 1.

4.3. Championing competency

The third competency related to the personal commitment or the leadership role needed to carry on the venture start-up process. Mere opportunity recognition is not sufficient for resource allocation to occur (Danneels, 2007), there is also a need for impetus, a driving force. Our cases illustrated very clearly the important role of champions. As with the other competencies, championing was not static but developed as the new venture matured (Clarysse and Moray, 2004). In our cases, the champion role changed from developing internal support and legitimacy within the university context to developing external support and legitimacy towards industry partners, customers, and potential investors.

Compared to other studies of championing (Howell and Shea, 2001), our definition of championing is narrower, focusing only on the driving force and not the ability to spot opportunities and get access to resources. The founders of the ventures relied on their strong ties to colleagues and other acquaintances to recruit the entrepreneurial team and champion the venture, as described by an Alpha founder: *“Both me and F4 had worked on [...] systems for 10 years in industry and academia. [...]. I and F1 knew F3 from previous projects, and knew he was very efficient and an expert on software development, an expertise that was important in this project. We (F2 and F4) have been working together with F1 for many*

years, so it was natural to include him as a team member. F1 knew a very competent business developer, T1, who was invited for the first meeting. F4 had a childhood friend who now is a business lawyer, T2, which he believes in, who also was invited for the first meeting. The chemistry among the six of us turned out to be very good.” (F2)

A division of championing roles may be necessary in start-ups built from internationally renowned research (Day, 1994). Thus, academic researchers might be important champions initially, while individuals with a more commercial background may be needed in a championing role in later stages, as noted by one of the Gamma founders: *“We got our finance director, our marketing director, all with contacts into the industry. In a few months they wrote a new business plan and took me along to pitch it to a local VC. [...] We walked away, after a few legal meetings with half a million”.* (F1)

Our cases show that an effective team is important to be able to respond to and deal with rapid changes in the business concept. The motivation and capabilities of academics to become entrepreneurs are important, particularly in the early phases of competency development. Internal bottom-up champions are crucial, but also external individuals or individuals higher in the organization can provide championing competency (Burgelman, 1983; Day, 1994). Alpha and Delta emphasize the important role played by ‘godfathers’, that is, influential individuals in industry or other resource providers who make an additional effort to help the project. Examples included the university managers in Beta and the experienced (surrogate) entrepreneur (Franklin et al., 2001) who became chairman of Gamma. Access to such persons is facilitated by the networks of the championing entrepreneurs involved in the project and their ability to mobilize support (Walter et al., 2011). This use of strong ties to engage champions in external organizations was clearly explained by one of the Alpha founders: *“We contacted [Industry partner 1], where I knew the top management. [...] Although we were received positively at top level in [Industry partner 1], the project got into*

a deadlock when it was delegated down in the organization. [...] Things seemed difficult, but I talked to [Director X] about the problem. He took action and allocated money to the project and made it attractive for the staff to work on it. [Director X] is one of our 'godfathers' who believed in us and took action to help in a difficult phase.” (F4).

Access to external champions was initially built on the strong ties of the entrepreneurial team as observed by Murray (2004). As the ventures evolved this gradually changed, and new team members and external champions were recruited through the use of weak ties. In several instances we observed that actors who originally had been introduced as new weak ties in the process of opportunity refinement or resource acquisition later became champions of the ventures. For instance, the founders of Beta expanded the entrepreneurial team by recruiting an experienced business developer who they previously had used as a business consultant: *“Since the first job I have not been formally involved, but I had running contact and been a sparring partner for Beta.” (T1).* Thus, network ties originally constructed to develop one competency could later become important for the development of a different competency, which is another aspect of network transformation.

Changing from reliance on strong ties to relying on weak ties to gain additional champions was important to broaden the competency base. Strong ties are important to get access to the championing competency initially in the start-up process, but as the credibility of the venture increases, new champions are increasingly obtained by developing existing weak ties. Thus:

Proposition 3: Nascent spin-off ventures are more likely to construct championing competency through initially leveraging existing strong ties with key partners and subsequently through developing existing weak ties with new partners.

The temporal transformation of existing weak ties to construct championing competency is shown in Figure 1.

5. Discussion

This longitudinal study has enabled us to unlock insights into a neglected part of the new venture creation process, the formation and development of network ties in the initial phases of venture development (Hallen and Eisenhardt, 2012; Slotte-Kock and Coviello, 2010). The competency approach helps identify how networks are used for different purposes throughout the entrepreneurial process and, in particular, the transformation of network ties. The main findings of our study are summarized in Table 4.

INSERT TABLE 4 HERE

5.1. The role of networks in developing entrepreneurial competencies

We propose that initially in the process, weak ties play a particularly important role for the opportunity refinement competency by facilitating opportunity recognition and development. In this setting, weak ties provide a broader base to explore opportunities and enable transition from a research oriented to a business oriented focus. Leveraging existing strong ties, on the other hand, contributes towards resource acquisition and championing competencies early in the venture development process. This relates to the lack of credibility and track record for the new venture, which calls for strong ties to be able to acquire resources and convince other people to become involved while the opportunity is formative.

Later in the process, the opportunity refinement competency increasingly relies on iteratively transforming weak ties with industry to stronger ties. The developed strong ties are

able to transfer more complex knowledge which is crucial for building a viable business model. In contrast, as the venture emerges, gaining resource acquisition and championing competencies becomes more dependent on transforming existing weak ties and building new weak ties to attract additional resource providers and key personnel. This appears feasible only when the value of the opportunity is easier to articulate. The formation and transformation of ties to construct entrepreneurial competencies is illustrated graphically in Figure 1.

The competency perspective entails that all three competencies are developed concurrently for a new venture to succeed. Although we developed separate propositions and figures for each competency, we also contribute by outlining the interrelationship between competencies. Ties initially developed to access one competency could later be used to access another competency. This was clearly evident when new weak ties were established with individuals to access resources who later became champions of the venture. Hence, networking activity for the purpose of developing a specific competency may also result in new network relationships that benefit the development of the other competencies.

5.2. The role of network transformations

The primary contribution of this study is an emerging theoretical understanding of the role of network transformation in the entrepreneurial process. Although several recent studies have theorised on how networks can be strategically formed by developing new ties (Hallen and Eisenhardt, 2012; Vissa and Bhagavatula, 2012), and how existing ties can provide access to new ties (Milanov and Fernhaber, 2009; Vanacker et al., 2014), no theoretical frameworks have incorporated the role of network transformation.

The transformation of ties appears to be a crucial mechanism in the development of networks for emerging new ventures. It is difficult to know in advance which type of ties may

be more useful later on in the venturing process. As stressed by our competency framework, the opportunities pursued tend to be refined and changed over time and the appropriate networks need to evolve along the same paths. Hence, our contribution lies in uncovering that the ability to form and transform networks may be as important as the type of networks possessed at venture initiation.

Specifically, the value of a network tie is contingent upon the purpose it is used for, but also for its latent value of being transformed and used for a different purpose later on. Hence, our qualitative approach provided novel observations on the underexplored issue of network development (Jack, 2010; Newbert et al., 2013). We observed that over time a tie can change both in strength and purpose. Some existing weak ties are iteratively developed into strong ties as opportunity refinement progresses. In a different transformation, new weak ties originally built to access resources can later be transformed for the more time consuming and trust based role of championing the venture. Thus we provide a richer explanation of the path-dependent nature of network development (Hite, 2005; Hite and Hesterly, 2001; Milanov and Fernhaber, 2009) by offering novel insights into how nascent academic entrepreneurs can mitigate path dependencies and shape the early network development of university spin-offs.

Although the entrepreneurs in our study were embedded in academic networks, they also had some predominantly weak ties outside academia. It was apparent in all our cases that the transformation of some of these weak ties to strong ties through collaborative opportunity refinement was a critical catalyst in the building of entrepreneurial competencies. Thus, while the initial networks of academic entrepreneurs form an important precondition for their ability to successfully build a new venture, our findings point to the key role of strategic action and agency involved in constructing a relevant network for this task.

Here we show one mechanism that potentially explains the variance seen in spin-off performance from seemingly comparable institutions in terms of research quality rankings

(Bercovitz and Feldman, 2008). The non-linear nature of the spin-off process is highlighted by the insight that small changes in the weak, and therefore seemingly less important, relationships academic entrepreneurs have with industry actors can unfold into significant differences in spin-off venture performance over time (Rasmussen et al., 2014).

By investigating the role of network transformation in the initial phases of venture emergence, we also shed novel light on where firm capabilities come from. As asserted by Teece and Pisano (1994), organizations need to renew their competency sources in order to respond to shifts in the business environment. Our investigation shows that the ability to strategically develop competencies is important from the very beginning of the firm's development. The nascent ventures needed to change the way they used networks to construct the specific competencies required at early phases of development. As such, our study extends the emerging research stream focusing on the role of different network types in accessing resources (Semrau and Werner, 2013) by looking at entrepreneurial competencies.

Finally, by adopting such a longitudinal approach, our evidence helps reconcile contradictory findings related to the importance of strong and weak ties (Semrau and Werner, 2013). Strong ties appear important early in the start-up process (Jack, 2005), but so also do weak ties (Greve and Salaff, 2003; Steier and Greenwood, 2000). Our study extends this work by showing that these ties serve different purposes related to the need for different competencies concurrently during the start-up process. Both the competencies and the networks to construct such competencies need to be built over time. For instance, the opportunity refinement competency is dependent on industry interaction, the resource acquisition competency is related to the legitimacy of the entrepreneurial team, and the championing competency is related to individual motivations.

5.3. *Managerial and policy implications*

Our findings bring clear practical implications for how new ventures can form and develop their networks, and also suggest implications for how research intensive universities across the European context such as those in UK and Norway can help facilitate these networks.

Networks are generally seen as beneficial, but new ventures have liabilities of newness and smallness that restrict their access to resources and networks (Partanen et al., 2014). Hence, the efficient formation of networks is crucial for venture performance (Hallen and Eisenhardt, 2012). Our study suggests that entrepreneurs can develop a network tie for one purpose and later transform the same tie for another purpose. This strategy can be particularly useful for developing strong ties with prominent actors that are out of reach of the venture's current network. These actors, such as reputable investors or entrepreneurs, may first be contacted in the role as more informal advisors for the venture's opportunity development and later become involved as champions.

By considering that networks can be transformed, entrepreneurs of new ventures may act more strategically when forming new ties. They may be forming networks that are useful for their current purpose but also have a latent potential if later transformed for another purpose. Given that forming and maintaining networks require time and effort, and that forming useful ties often takes time, strategic formation and transformation of network ties may be an efficient strategy to form and manage network ties.

For universities and policy-makers, our fine grained understanding of competency development leads to several implications. Because many aspects of the competencies are connected to individuals and are therefore difficult to address by short-term policy initiatives by universities, a longer term perspective appears necessary to facilitate the networks of nascent entrepreneurs. The implication is that this would mark a notable departure from much

of current university support for science PhDs, post-docs and faculty which, where it exists, focuses on developing academic capabilities (Wright et al., 2012). Within universities, this might involve the development of greater links between science departments, TTOs and business schools (Wright et al., 2009). Interventions such as entrepreneurship education, business mentoring, and networked incubators can all potentially contribute (Bøllingtoft and Ulhøi, 2005). Further, as there may be different attitudes and approaches to academic entrepreneurship by different departments, there may need to be systemic initiatives in conjunction with the professional bodies of particular scientific disciplines in order to gain legitimacy and change mindsets.

The different nature of the three competencies implies that, while their emergence takes place concurrently, universities and firms may not be able to apply the same policies and schemes to support the development of networks to construct each competency. Opportunity refinement often depends on interaction with customers or industry, while the championing competency may be related to cultural factors, prior experience, and incentives. Because opportunity refinement and championing competencies have a stronger connection to the individuals involved, the influence of managers can only be more indirect. However, an important implication of our findings concerns where the individuals to fulfil these roles are to come from. We know that while many post-docs may be interested in becoming entrepreneurs, they are much more likely to go to work for corporations (Wright et al., 2012). These individuals may represent a potentially promising source of recruitment. Universities with strong research cultures might usefully invest systematic effort in maintaining links with alumni such as post-docs in order to develop a potential stock of individuals with both the appropriate understanding of the science and the commercial skills and the contacts with other experienced individuals with the potential to perform the required roles.

In contrast, resource acquisition is dependent on a range of factors that can be supported more directly through networks with many different actors. Universities and support actors need to assist in accessing and acquiring resources through developing an evolving portfolio of strong and weak ties, for instance through organizing networking events between academics and industry and working with organizations that give access to resources. Moreover, the competency approach developed in this paper is highly appropriate for assessing the existing networks of an individual or team, thus highlighting areas where new ties are needed or existing ties might be transformed for new purposes.

Overall, these insights have implications for the resource and research bases of universities. Universities in general differ in their resources and in the match between the resources they devote to the promotion of and their strategies towards academic entrepreneurship (Clarysse et al., 2005). Our findings reinforce the need for universities to devote sufficient resources particularly in respect of developing support mechanisms that can help academic entrepreneurs access and build the networks they need. Resource constrained universities may need to make careful choices about supporting those research areas with the greatest potential for successful academic entrepreneurship, rather than spreading themselves too thinly. This may require not simply focusing on the strongest disciplines from an academic research perspective but on those with research strength which are also open to having a commercial impact since there is more likely to be a base upon which to build.

5.4. Limitations and research implications

Our study has a number of limitations that provide opportunities for further research. We adopted theoretical sampling that provided contextual variation on the basis of national, university, and industry differences. As such, these dimensions provide boundary conditions to the generalizability of our theorizing. Further, dimensions of the differences in research

cultures, scope and strengths, outreach, attitudes to business, and the level of resources relate to universities created at different points in time. For instance, in the UK there is a stark contrast between the research – industry interactions of different types of universities such as the former Polytechnics (e.g., Oxford Brookes etc.), the 1960s universities (e.g., York, Warwick, Loughborough), and older universities (e.g., London, Oxford, Nottingham). In particular, newer universities are less likely to have established support infrastructures and less strong research cultures but may devote more attention to reach-out (Hewitt-Dundas, 2012). Additionally, there may be considerable variety between universities within a particular geographical region in terms of these aspects (Harrison and Leitch, 2009), which may generate differential roles for networks. Future qualitative and quantitative studies might usefully explore the influence of these further dimensions of variety between university and regional contexts on the role of networks and development of competencies.

Since entrepreneurship is a dynamic process, theorizing on particular phases of development is justified (Shane et al., 2003). According to Aldrich and Kim (2007), the best place to begin theory development of entrepreneurship and networking is by understanding the role of social networks in the initial start-up phase. Our model has theorized the process leading to initial credibility and investment, while future studies should explore the role of network formation and transformation in explaining the further survival and growth of the venture. We subsequently followed up the cases beyond our initial interviews to explore the continued utility of our framework. The cases were still making use of network ties formed during the period of initial study, although these had typically been transformed in terms of strength and purpose as the ventures subsequently grew. For instance, Gamma gained equity investment through their strong ties to a local venture capitalist in 2005. Subsequently this investor utilised their strong ties to other local investors and formed a syndicate to raise a much larger investment to support the international expansion of Gamma in 2011. In case

Beta, two individuals originally assisting in opportunity refinement and joining the team as champions in 2005, still held key positions in the company in 2014.

Another question emerging from this study is what networks are exclusive to the start-up process and what networks are important to construct the competencies needed for the further operation and development of the new firm. These questions are important because while networks may contribute temporary competences, it is important that more enduring competences are built within the new firm. As our cases reveal, there might be a trade-off between the degree of competency development internally in the venture and the use of networks to access external competencies. This appears particularly related to the opportunity refinement and resource acquisition competencies, as championing needs to be tightly connected to the venture. Moreover, our findings imply that the issue of network transformation needs to be explored further.

6. Conclusions

This study sheds new light upon the formation and development of network ties to construct entrepreneurial competencies for university spin offs. Our synthesis of the competency perspective with network theory revealed that the use of strong and weak network ties was dependent on the type of competency sought and the process of venture evolution. We present a framework that explains how academic entrepreneurs not only form distinct networks ties to develop specific competencies but also transform existing ties to serve other purposes. While prior research mainly has considered the formation of network ties, we suggest that the issue of network tie transformation needs to be considered if we are to better understand the role of networks in new venture development.

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Table 1

Central properties of the spin-off cases.

	Alpha (A)	Beta (B)	Gamma (C)	Delta (D)
University context	Norwegian university with long history of industry collaboration	Norwegian university with weaker industry contacts	UK university	UK university
Founder(s)	Four professors	Two professors	One senior lecturer one post doc	Two Professors
Previous business experience	Industry work experience and industry collaboration	Industry collaboration	Industry collaboration	Industry collaboration
Founding year	2003	2003	2002	2003
University ownership	No	Yes, major	Yes, minor	Yes, minor
Premises	University incubator	University incubator	City incubator	University incubator
Main R&D partner	Industry	University	University	Industry
Main source of idea development	One professor's industrial experience	Professors' prior industry cooperation	Post doc's industrial experience	Post doc's networking
Field of research	Engineering	Biomedical	Biomedical	Engineering
Product	Software	Medicine	Medical device	Electro-mechanical
External investment	Equity investment by industry partner in 2005 and additional equity in 2007	Equity from private placement in 2005, 2006, 2007, 2009, and 2010	Equity investment from venture capital funds in 2005 and 2011.	Equity investment by industry partner in 2005
Performance in FY 2012-2013	Total sales ~ \$ 14 million	Development funded by equity, 16 employees.	Total sales ~ \$1.4 million	Asian sales ~\$450K, 12 employees

Table 2

Persons interviewed (number of interviews in parenthesis).

	Alpha (A)	Beta (B)	Gamma (C)	Delta (D)
Founders (F)	Professor F1 (4) Professor F2 (2) Professor F3 (2) Professor F4 (2)	Professor F1 (3) Professor F2 (1)	Senior lecturer F1 (4) Post doc F2 (4)	Professor F1 (2) Professor F2 (2)
Team members (T)	Business developer T1 (3) Lawyer T2 (1)	Bus. developer T1 (1) Bus. developer T2 (1) Administrative support T3 (1)	Researcher T1 (1)	Post doc T1 (2)
Board members (B)	Same as founders	First Chairman B1 (1) New Chairman B2 (1)	Chairman B1 (1) Finance Director B2 (1)	Same as founders
University management (U)	Department manager U1 (1)	University manager U1 (1) Department manager U2 (1) Department manager U3 (1) Dean U4 (1)	Department manager U1 (1)	Department manager U1 (1)
Support actors (S)	TTO CEO S1 (1) TTO Business developer S2 (1)	CEO science park S1 (1) University administrator S2 (1) University administrator S3 (1)	TTO S1 (1)	TTO S1 (1)
Others (O)		Informal advisor O1 (1)		Development partner O1 (1)
Total number of interviews*	16	16	13	9

*The total number of interviews may be less than the sum of persons interviewed because some interviews were done with more than one person and some persons have more than one position.

Table 3

Summary of the competency development and transformation in each case.

	Opportunity refinement	Resource acquisition	Championing
Alpha	Idea identified from professors' industry experience. Idea refined in interactive process with several industry actors accessed through the founders networks. Stronger relationship built with two industry partners that invested in the spin-off and played a key role in further developing the business concept.	The entrepreneurial team had strong networks with some industry and public support actors which were used to access resources (e.g. early-stage funding). Subsequently it became easier to develop new relationships and attract resources from a variety of resource providers.	The entrepreneurial team was recruited among people the professors knew well from prior work relationships. Additional champions and new employees found among industry contacts and prior students.
Beta	Inventors learn about business through seeking advice from many industry actors and support actors (Science park). Later in the process new team and board members are recruited among the advisors to help framing the idea into a viable business model.	The inventors initially receive strong support from the university and local actors they know. When the venture had reached some initial milestones the team was able to build new relationships that secured additional resources and investments.	Inventors had high motivation to succeed and gained much assistance among champions within the university to set up the venture. New team members were recruited among contacts established during the start-up process.
Gamma	Effort needed to communicate the idea to industry. Iteration to meet industry requirements. Iteration showed step change in effectiveness when researcher with industry experience joined the team.	Initial support from TTO. Experienced entrepreneur framed and legitimated the business model. Using his network he added credible management team to give confidence to the investors.	Motivated inventor. New team members with prior experience of venture growth and development joined to develop idea and business model.
Delta	Idea framed by active interaction with market. The idea was a solution looking for a problem. A researcher with industry contacts helped discover the unique selling point through working closely with acquaintances that were interested in the concept.	Initial support from TTO. New development partner provided business knowledge, prototyping facilities and scale up expertise. Resource acquisition gave credibility and momentum and attracted interest from new investors.	Inventors believed in the technology. Post doc enjoyed being an entrepreneur. The relationship with industry partners helped develop a champion within the partner firm. As the venture grew the new investors championed the venture to secure further rounds of investment.

Table 4

The use, formation, and transformation of network ties to access entrepreneurial competencies.

	Opportunity refinement	Resource acquisition	Championing
Competency role	Opportunity recognition and further exploitation of the opportunities.	Accessing and combining new sources of resources (tangible and intangible).	Identifying with the opportunity and take responsibility of moving it forward.
Key tasks throughout process	Initial technology and market development and subsequent adaptation and refinement of the business concept into a profitable business model.	Initial gaining of resources from familiar sources (e.g. within the university) and gradually more gaining resources from external sources.	Initial entrepreneurial drive and gradually more professional management.
Use of networks initially in the spin-off process	Using weak ties to scan for possible applications of the technology and initial development of the business concept.	Using strong ties to get access to initial set of resources. Weak ties are reluctant to commit resources at an early stage when the risk is perceived as high.	Using strong ties to gain initial champions to help develop the venture. Connected to the founders' professional and personal relationships.
Examples and quotes illustrating the use of networks initially in the spin-off process	“We talked to investors in Norway and abroad, and had a terrible work to find a solution [...]. We lost a year in the company's development. But on the other hand, this year [...] gave us a unique understanding [...] So we got many advices, and many contacts, so we came out much stronger in order to be able to develop a company, compared to if we got the patents right the way. So when Beta was established we had considerable knowledge about what existed, we had some contacts, and so on. So in this way we were able to work faster when we finally started.” (Beta F2)	Support from the TTO. “Once (Founder 1) explained what they had to me, I did my best to keep them going. We paid all the patent costs and persuaded the head of school to allow them to use the lab to test their prototypes, during idle periods, free of charge.” (Gamma S1)	In the beginning the senior lecturer gave the venture legitimacy within the school through building a relationship with other researchers and the TTO. He then delegated responsibility to his ex post doc to reconfigure the technology to meet the need of the medics, the potential customers of the device. “My post doc really wanted to become an entrepreneur, [...] we gave him the technology and he spent hours working with the medics he knew to build a business around it” (Delta F1)
Formation and transformation of networks later in the spin-off process	Some of the weak ties transform into strong ties that become the prominent partners for developing and refining the business concept.	Formation of new weak ties to get access to additional resources. These weak ties commit resources based on the perceived potential of the venture.	Some of the weak ties used for the two other competencies transform into strong ties that become champions of the venture.

Examples and quotes illustrating the use of networks later in the spin-off process

‘The first idea was not right. [Industry partner] did not see any value in it. We had several rounds to better understand them from the inside so that we could adapt our ideas. The first half year was an iteration with [Industry partner]. We had numerous meeting at all levels to understand how they think. This was a heavy period, but very decisive.’ (Alpha F2)

‘[University Science Park] have followed this project over time, so when they saw some structure and competency coming into the company they were involved and pushed this process. So they have both contributed with funding and legitimizing the company.’ (Beta B2)

“T1 suggested we should try [Industry partner 2], and I had contacts there as well. We felt misunderstood by the development people in [Industry partner 2], but this time another ‘godfather’ [N.N.] believed in the project and championed it internally. [...] Without the help of these ‘godfathers’ it would have been difficult to get further.” (Alpha F4)

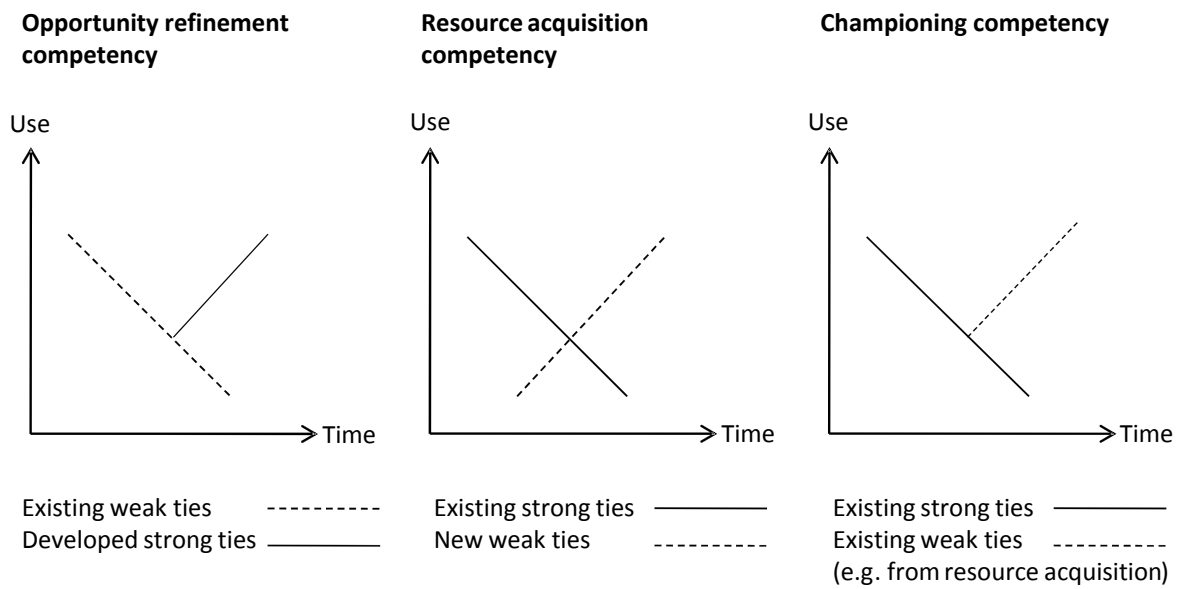


Figure 1

The development and transformation of strong and weak ties to construct entrepreneurial competencies.