The Early Growth of Academic Spin-offs

Factors Influencing the Early Growth of Dutch Spin-offs in the Life Sciences, ICT and Consulting

The Early Growth of Academic Spin-offs

Factors Influencing the Early Growth of Dutch Spin-offs in the Life Sciences, ICT and Consulting

Promotoren:	prof. dr. S.W.F. Omta Hoogleraar Bedrijfskunde Wageningen Universiteit
	prof. dr. T. Elfring Hoogleraar Strategisch Management Vrije Universiteit Amsterdam
Co-promotor:	dr. R.G.M. Kemp Universitair docent bedrijfskunde Wageningen Universiteit
Promotiecommissie:	prof. dr. J.C.M. van Trijp (Wageningen Universiteit) prof. dr. W. van Rossum (Technische Universiteit Twente) prof. dr. G. M. Duysters (Technische Universiteit Eindhoven) prof. dr. W. Hulsink (Wageningen Universiteit) prof. dr. H. Dons (Wageningen Universiteit)

Dit onderzoek is uitgevoerd binnen de onderzoeksschool Mansholt Graduate School of Social Sciences

The Early Growth of Academic Spin-offs

Victor E. Scholten

Proefschrift
ter verkrijging van de graad van doctor
opgezag van de rector magnificus
van Wageningen Universiteit,
Prof. dr. M.J. Kropff,
in het openbaar te verdedigen
op maandag 6 februari 2006
des namiddags te vier uur in de aula

Scholten, V.E. (2006). The Early Growth of Academic Spin-offs: Factors Influencing the Early Growth of Dutch spin-offs in the Life Sciences, ICT and Consulting.

PhD-thesis Wageningen University – with references – with summary in Dutch

ISBN: 90 – 8504 – 345 – X

Thesis Wageningen University and Researchcentrum, the Netherlands.

ACKNOWLEDGEMENTS

"It is difficult talking about the origin of an idea. It is one of those things you don't like to reveal. It is ... like a daydream, a flash, which is impossible to catch or conjure up... when an idea remains free in the air and has not been spotted by somebody else, it has the chance to fly and be happy and support the joy of creativity"

– Tapio Wirkkala, (1915-1985) –

After the Second World War, Tapio Wirkkala was one of the pioneers of the industrial arts in Finland, designing exclusive creations from glass, wood, stone and metal. In winter he lived in metropolitan centres around the world but in the summer he went back to the wilds of Lapland to find inspiration for new designs. Tapio may have hit upon original ideas in relative seclusion but often ideas emerge from discussions with other people. For me, the discussions I enjoyed with others were important in constructing my ideas for this thesis, and in my discussions with spin-off entrepreneurs I found out that, for them too, networks of contacts were important for dreaming up new business ideas and solving problems.

Tapio conjured up perfectly the conditions under which ideas had a chance to fly. When ideas "remain free" and have not been spotted by someone else, they can become opportunities. For academic entrepreneurs, the freedom to develop an idea that has not been captured by someone else combines the joy of creativity with the possibility of providing a spin-off with its early growth.

This thesis reports the results of a research project that investigated the factors that determine the early growth of academic spin-offs in the Netherlands. It could not have been completed without the advice and help of my advisors, colleagues, friends, family and many others. Words are insufficient to thank them for all the constructive criticism and advice they have offered me over the last few years.

First and foremost, I am greatly indebted to my advisors, Onno Omta, Tom Elfring and Ron Kemp for stimulating my academic interest and encouraging me to try to reach their own high academic standards. Onno, you taught me the skills required for conducting research. You were persistent and always pushed me to go just one step further. You showed me true commitment. Tom, you helped me shape the theoretical foundations of the thesis and pointed me towards the theoretical debates in the literature. The discussions I had with you were central to the thesis and I thank you for them. And Ron, you provided me with the encouragement and determination I needed to complete my doctoral work. Your knowledge of methodology and analysis was essential in translating theoretical concepts into sophisticated measures that could be applied to academic spin-offs. Thank you for all your help. I am also indebted to Emiel Wubben who helped me to establish efficient guidelines during the research process, and with whom I spent many hours discussing things on our train journeys to work.

I would like to thank the members of my Ph.D. committee for their careful revision of my thesis. Their criticism and constructive suggestions helped me to complete the thesis and it has certainly benefited from their advice and comments.

Special thanks go to my good friends and paranymphs at the Ph.D. ceremony, Justin Jansen and Wouter Stam, for their tremendous support and enthusiasm in helping with the final stages of the thesis. Our friendship has been invaluable to me.

I am equally grateful to my colleagues in the Department of Business Administration at Wageningen University. The laughter and fun we had over the years at work and in our free time were essential and allowed me to enjoy this research project. I also appreciate the discussions we had and the comments you made on my work-in-progress. I have learnt a lot and your support was important to me. I would also like to thank my colleagues at the Vrije Universiteit in Amsterdam. It was a pleasure to work with the faculty, staff and students there and they gave me new ideas about my research topic and offered particular support while I was finishing off my thesis.

This thesis would not have been possible without the help of many others. I thank the entrepreneurs and officials in the knowledge institutions who gave up their time for interviews and filled out my questionnaires. The discussions I had with two fellow Ph.D. students Suresh Bhagavatula and Wouter Stam, who are both conducting research on topics closely related to mine, provided me with good theoretical arguments and tips on conducting research. Also special thanks go to Wim Hulsink with whom I had many discussions about my research and who allowed me to use his facilities when I was in Rotterdam. I am also grateful to Gerhard van den Bunt and Peter Groenewegen who helped me with specific issues concerning network analysis. For the managerial implications of the results, I would like to thank Harmen Jousma and Rein Denekamp for their suggestions on interpreting the research findings. Their pragmatic views were essential for putting the findings into a broader perspective and they helped me to grasp the complexities of reality. I am also grateful to Ann Reeves who edited the thesis. Her flexibility and astonishing speed greatly helped me in the final stages of this project.

Writing this thesis could not have been realised without the assistance and support of my family and friends. Their interest and backing were invaluable. Throughout my life they have always supported me and provided me with the opportunities and possibilities necessary to complete my work. To my friend Danny – I thank you for designing the cover, and to Edward and Adriaan – thank you for reviewing the thesis. Special thanks go to my father, Egbert Scholten, and my mother, Christiane Haverbeke, who have always encouraged me and stood by me whenever I needed them. I would also like to offer my thanks to my sister Monique and her husband Eric for reviewing the Dutch summary. Finally, this acknowledgement would not be complete without mentioning the patience and resolve of my girlfriend, Jetty Coenraads. You kept me motivated and focused on finishing the thesis, and your love and happiness were essential. With you, I could relax and enjoy life – thank you.

Rotterdam, October 2005

Table of Contents

List of Tables

CHAPTER 1 INTRODUCTION

Academic entrepreneurial ventures or "spin-offs" play an important role in the modern knowledge economy. By "spinning off"[1] scientific findings and transferring them into commercial opportunities these ventures can contribute to a country's prosperity and that of its academic institution. Academic spin-offs are typically founded by one or more scientists who have participated in academic research programmes that have resulted in a specific scientific finding. To successfully exploit the scientific finding, it is important for scientists to understand the opportunities in the market. Scientists bring to the spin-off their scientific experience and expert skills. Experience and skills are important for translating the scientific finding into a feasible business proposition. Nevertheless, spin-offs start with some major disadvantages related to their newness and smallness. Spin-offs have a strong technological orientation that imbalances their entrepreneurial orientation. Consequently, a strong focus on transferring the scientific finding to a commercial goal is needed. As the focus shifts to market and start-up activities, spin-off entrepreneurs find themselves increasingly in new roles. The liability of "newness" is even more relevant when the knowledge to be transferred is new to the market. Besides the problems related to newness, spin-offs also experience liabilities of smallness due to a lack of resources. Spin-offs are constrained by their relatively small financial base, and lack of experience and assets. Support activities can help spin-offs to overcome their liabilities of newness and smallness and thereby allow them to focus more on their primary task, which is transferring a scientific finding to the market. Examples of supportive activities that can ease the start-up process are management support, financial support, equipment, accommodation and access to business contacts. These supportive activities can be found in the knowledge institution, from which the spin-off emerged, or in the external network in which the spin-off operates. The knowledge institution can provide the spin-off with specific technological expertise or equipment. Network contacts in the business environment, for instance, can help identify and evaluate a business idea and provide access to resources that are necessary during the start-up process.

[1] Fundamentally, the concept of "spin-off" describes an event that results from rotating an element. Usually it refers to a side effect or by-product of a core activity. Initially it was not intended but it occurs during the progress of the activity. The concept of spin-off can be used both to describe the spin-off process ('the act of spinning') as well as the result of the spin-off process (Maselli, 1996). Here the concept of the spin-off refers to a new entrepreneurial firm that is based on a scientific finding.

Although academic spin-offs may provide positive contributions to the knowledge institution,[2] spin-offs may carry risks as well because the prime objective of a knowledge institution is not to support a private firm. Becoming financially involved in a spin-off may, therefore, put a knowledge institution in danger. The financial repercussions may be significant for a knowledge institution if a spin-off fails. Repercussions can be crucial if serious investments have been required. Consequently the organisation and management of high- and low-investment spin-offs may need different approaches. This study distinguishes between spin-offs that need high investments (such as spin-offs in the life sciences) and spin-offs that demand low or moderate investments (for example spin-offs in ICT and consulting).

This manuscript addresses the following question:

What are the key success factors that affect the early growth of academic spin-offs?

However, before investigating the factors that increase the early growth of academic spin-offs, it is valuable to assess academic spin-offs in general. Since spin-offs represent a technology-transfer mechanism, the current standing of technology transfer in the Netherlands is outlined first. Next, it is important to know when spin-offs are appropriate, how often they occur and what types of spin-off support programmes exist. This manuscript presents the results of a study into the first years of Dutch academic spin-offs. The focus is on their early growth since these initial years are usually crucial. Based on four factors, the study describes and explains the early growth of the spin-off. These four main factors are the following:

- *the social network of the spin-off team;*
- *the involvement of the knowledge institution in the spin-off firm;*
- *the resources and capabilities of the spin-off founder(s);*
- *the characteristics of the spin-off firm*

This chapter starts by elaborating on the contribution of this research to the existing theoretical understanding of early spin-off growth and its practical relevance. The following sections provide an overview of the current setting in which academic spin-offs occur and the chapter closes with a detailed outline of the thesis.

1.1 RESEARCH CONTRIBUTION

The spin-off research stream has emerged in a variety of subjects since its introduction in the United States in the 1960s and 1970s. Research groups led by Edward Roberts (Roberts and Wainer, 1968; Roberts, 1968; 1991; Roberts and Malone, 1996), Arnold Cooper (1972; 1973) and later by Rogers (Larsen and Rogers, 1987; Steffensen, Rogers and Speakman, 1999) took the first steps in comprehending these types of start-ups. In Europe, research in spin-off activities took off with researchers like Mustar (1997) in France, Chiesa and Piccaluga (2000) in Italy, Stankiewics (1994) in Sweden, and Downes and Eadie (1999) in

[2] By knowledge institution we refer here to either a university or a public research institution. If we specifically discuss the knowledge institution where the spin-off originated, it is referred to it as the "parent organisation".

Ireland. Many of these research programmes used an explorative or descriptive approach to identify spin-offs and study their characteristics (Autio, 2000).

Today, three main perspectives can be distinguished in spin-off research: the national economy, the knowledge institution and the firm. The economic perspective shows how spin-offs can create economic growth by commercialising research findings that have initially been funded by public research programmes. For governmental authorities, spin-offs are then a mechanism to give societal relevance to publicly funded research findings and as such fit into the national innovation system (Etzkowitz and Leydesdorff, 1998). This research stream also compares academic spin-offs with other technological start-ups. The major findings are that academic spin-offs create more innovative products and services (Blair and Hitchens, 1998) and grow faster, and that relatively more spin-offs go public (Shane and Stuart, 2002). Academic spin-offs also create relatively more jobs (Cohen, 2000) than non-academic start-ups.

The second research stream investigates how academic spin-offs can contribute to a knowledge institution. This research stream has shown that spin-offs can commercialise early inventions whose potential is yet unclear (Shane, 2004; Thursby *et al*., 2001). Furthermore, spin-offs are believed to induce larger investments in academic research programmes than those generated by royalties from licences (Pressman *et al*., 1995). And the opportunity for faculty staff to take part in spin-offs can be a financial mechanism to retain and attract well-qualified staff members, particularly in the field of biomedicine (Matkin, 1990).

At the firm level, studies have investigated for instance, the definitions and typologies of spin-offs, the motivations for starting a spin-off, the role of the parent organisation and the development of the spin-off during its initial phases of growth, and the factors that differentiate successful from less successful spin-offs. The main typologies based on the objectives to the spin-off activity (Clarysse *et al*., 2005) are the relation between the spin-off and the parent organisation (Elfring and Foss, 1999; Nicolaou and Birley, 2003a; Pirnay *et al*., 2003; Steffensen *et al*., 1999). Research into the motivation for scientists to start a spin-off, concentrates on the conditions that bring the individual to change his/her career and to become self-employed (Davidsson, 1995; Scholten *et al*., 2004a; Tilburg and Vorstman, 1994). Spin-offs are a special type of start-up because of their relationship with the knowledge institution. Consequently, the role of the knowledge institution has been extensively studied during the venturing process of spin-offs (Allen and McCluskey, 1990; Doutriaux, 1987; Roberts and Malone, 1996; DiGregorio and Shane, 2002; Scholten *et al*., 2004b; Sorrentino and Williams, 1995). Recently, research has focused on identifying the factors that can explain early spin-off success. Using case studies, Vohora *et al*. (2004) investigated the development of academic spin-offs and found several critical junctures that spin-offs need to overcome if they are to succeed. Based on a survey of spin-offs in the UK, Nicolaou and Birley (2003a, 2003b) analysed the influence of social networks on spin-offs.

Over the years, research on academic spin-offs has shifted from observing the number, types and contribution of spin-offs to research that can unravel the factors that explain the success of academic spin-offs. While initial observations are useful, the dynamic processes leading to a firm's emergence and growth may be overlooked if classifications focus on static categories of this kind (Druilhe and Garnsey, 2004). To understand the emergence

and growth of academic spin-offs two main issues in spin-off research need further attention. First, studies in entrepreneurial strategies and small firms in general should develop better theoretical frameworks and causal models that reflect a real understanding of how value-creating entrepreneurial strategies result in performance (Lee *et al*., 2001). Although progress has been made in predicting the performance of new firms in general, most research on spin-offs has focused on a single characteristic, such as the spin-off team (Clarysse and Moray, 2004) or the spin-off network (Nicolaou and Birley, 2003a, 2003b), to explain its success. The present study develops a theory-driven research framework that incorporates factors regarding the spin-off team, the spin-off firm characteristics, its external network and the involvement of the parent organisation to understand how early growth is achieved. Second, with some notable exceptions (Nicolaou and Birley, 2003a, 2003b; Shane and Stuart, 2002) relatively little empirical work has attempted to combine the richness of measures of spin-off performance derived from fieldwork with large-scale statistical studies. Most research on spin-offs has provided insightful case studies but so far there has been no theoretical framework available (Markman *et al*., 2005). The factors that determine the early growth of spin-offs are still largely unexplored. The framework presented in this thesis helps to explain the role of each set of factors (the spin-off team, the firm, the network and the involvement of the knowledge institution) in the early growth of spin-offs.

1.1.1 RESEARCH QUESTIONS

The central research question of the present study is formulated as follows:

What are the key success factors that affect the early growth of academic spin-offs?

To answer this question, this study analyses the early growth of academic spin-offs in the Netherlands using an integrated framework built on multiple factors. These factors are based on previous spin-off studies: 1) the spin-off team and their resources and capabilities; 2) the spin-off firm's characteristics; 3) the social network of the spin-off team; and 4) the involvement of the knowledge institution. Understanding the influence of these four major factors can contribute to a better theoretical and empirical understanding of the early growth of entrepreneurial firms. These factors directly refer to two organisational theories: the resource-based view (Barney, 1991, 2001; Penrose, 1959; Wernerfelt, 1984) and the social capital theory (Leenders and Gabbay, 1999a; Lin, 2001). Each theory can explain the early growth of new firms but employ a different main argument. The resource-based view emphasises the importance of key resources that are controlled by the firm (Barney, 1991, 2001; Penrose, 1959; Wernerfelt, 1984). Key resources are valuable assets that are scarce, difficult to imitate and non-substitutable (Barney, 1991; Dierickx and Cool, 1989; Peteraf, 1993). These key resources can be the physical capital materialised in production facilities and finance, and the human capital embodied in the knowledge and skills of individuals. A combination of physical and human capital provides a firm with capabilities to compete in markets (Hatch and Dyer, 2004; Ray *et al.*, 2004) and allows them to achieve a competitive advantage by implementing value-creating strategies based, on resources and capabilities that cannot be easily duplicated by competing firms (Grant, 1996; Teece, *et al*., 1997).

The social capital theory explains the early growth of a firm primarily due to the existence of valuable relations with external resource holders. The social capital theory stresses the

importance of relationships among individuals and organisations that can be used to facilitate action (Adler and Kwon, 2002; Coleman, 1990; Lin 2001). The relations that firms have with chain partners, such as suppliers and buyers, can provide them with information benefits. These can manifest themselves in 1) access to resources; 2) timing opportunities; and 3) referrals (Burt, 1992). First, relationships with other firms provide access to key resources without the need to actually own them (Burt, 1992; Pennings and Lee, 1999; Uzzi, 1996). Small and newly established firms are rarely self-sufficient but they can compensate for this through relations. Second, business relationships can provide a timing advantage if significant information is available earlier to the firm than to its competitors (Burt, 2004; Rhee, 2004). Timing is crucial in the identification of entrepreneurial opportunities. Thirdly, relations can act as referrals to legitimise the new firm's action (Coleman, 1990; Stuart *et al*., 1999). They can provide organisational legitimacy by mentioning the firm in the right place at the right time.

The two perspectives have different views of the roots of value creation. The resource-based view stresses the importance of internally accumulated resources and capabilities, while the social capital theory underscores the firm's external network structure to explain the heterogeneity in its performance (see Table 1.1).

Table 1.1 Arguments of the resource-based view and social capital theory to explain firm growth

Perspective	Firm growth results from…	Authors
Resource-based view	… control over key resources	Barney, 1991, 2001a; Wernerfelt, 1984
	… inimitable capabilities	Teece *et al.*, 1997; Grant, 1996
Social capital theory	… a network that gives access to resources	Burt, 1992; Uzzi, 1996
	… a network that provides time advantages	Burt , 2004; Rhee, 2004
	… a network of referrals to increase legitimisation	Coleman, 1990; Stuart et al., 1999

Many studies on the early growth of firms have focused on either the social capital theory or the resource-based view and, consequently, have postulated a different set of factors for the 'value-creating process' (Lee *et al*., 2001). By merely taking a single theoretical approach, research would suffer from an inadequate view of the key factors for success that explain the early growth of spin-offs. Since both theories present powerful arguments to explain this early growth of new firms, it might be interesting to join the two theories together in one study. Some previous studies have already integrated these two theories (Lee *et al*., 2001; Pennings *et al*., 1998). Lee *et al*. (2001: 616) stress that the theories "*ought to be synthesised, since start-ups should develop firm-specific assets while obtaining complementary external resources through their social networks*". The authors indicate that more research is needed to compare the theories and analyse their interaction, but, they acknowledge that their "*study did not use fine-grained measures of external networks that can measure the quality and intensity of collaboration*". They also recognise that to explain start-up success, future research should "*investigate wider aspects and ramifications of internal capabilities and social networks*" (Lee *et al*., 2001: 635). The present study employs sophisticated techniques to measure the resource-based view and the social capital theory. Consequently, the results provide a bridge between the social capital theory and the resources based theory that not only allows a comparison but also investigates the extent to which they complement each other. The first theoretical research question is:

To what extent can the social capital theory and the resource-based view explain the early growth of academic spin-offs?

This research question develops understanding of the role of the social capital theory in explaining the early growth of entrepreneurial firms. One of the key issues under debate is the confusion between the specific aspects of social relationships that create social capital (see Adler and Kwon, 2002). One view proposes that social capital results from the structure of all social relationships (Burt, 1992, 2000; Baum *et al*., 2000; Rowley *et al*., 2001), while another argues that social capital results from the characteristics of individual social relationships (Burt, 1997; 2001; Podolny and Baron, 1997). The issue can be framed in the importance of structural embeddedness (the structure of social relationships) versus relational embeddedness (the characteristics of the individual social relationship) of social capital (Granovetter, 1992; Gulati, 1998). This manuscript builds on previous work on structural and relational embeddedness by examining the simultaneous influences of these factors.

Adler and Kwon (2002) stress that research would gain from a more systematic assessment of the benefits as well as the risks of social capital. Current interest in the concept of social capital is focused on the positive aspects. But, social capital can become a liability when strong relationships constrain the behaviour of actors, impeding their actions and their attainment of goals or when negative ties in the social structure affect actor's opportunities unfavourably (Gabbay and Leenders, 1999). Some studies have explored the dark side of social capital (Gargiulo and Benassi, 1999; Moerbeek, 2001; Omta and Rossum, 1999) but none have done so from an entrepreneurial perspective (Nicolaou and Birley, 2003b). This research also explores the influential role of the parent organisation during the early growth of a spin-off. The parent organisation can be beneficial to entrepreneurial actions, while unintentionally impeding others. An extensive analysis of the support of the parent organisation shows whether it encourages or discourages the early growth of a spin-off.

A consideration of social liability requires a contingency-based approach to be developed to analyse the value of networks in spin-off entrepreneurship. Nicolaou and Birley (2003b) advocate more analysis on content distinctions in entrepreneurial networks. McEvily and Zaheer (1999: 1154) also emphasise that a "*finer grained process through which network structure translates into the acquisition of competitive capabilities is an interesting and important area for future research*." And Hoang and Astonic (2003: 177) stress that "*mapping networks of general information flows may be too far removed from resource flows more closely linked to an outcome such as business performance*." Network analysis based on a detailed list of relevant business resources could have more predictive power (Foss, 1993). The present study analyses the resources that are important to entrepreneurial activity and links them to the social relations of the entrepreneur. Moreover, Lee *et al*. (2001) advocate a more systematic analysis and the use of fine-grained measures of social capital. To achieve this, the present study applies sophisticated network techniques (Burt, 1992; Marsden and Campbell, 1984; Wasserman and Faust, 1994). Regarding the social capital theory, the second theoretical research question is:

What types of social relations are beneficial and what types are detrimental to the early growth of academic spin-offs?

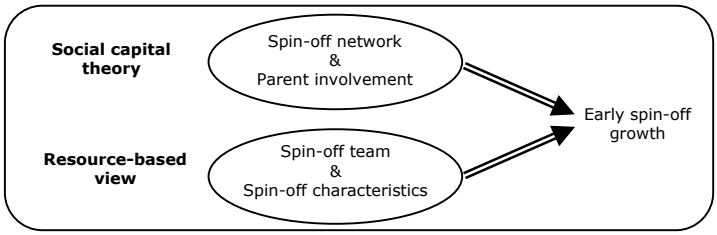
These two theoretical research questions and the central research question are closely related to each other and can be put together in a theoretical framework. The next section elaborates on the theoretical framework.

1.1.2 THEORETICAL FRAMEWORK

The early growth of new firms can be analysed using Cooper's framework (1993: 243) in which four types of factors that influence the early growth of the spin-off are deduced: 1) the spin-off network; 2) the involvement of a parent organisation; 3) the spin-off team; and 4) the spin-off characteristics. The spin-off network and the parent involvement are connected to the social capital theory, while the spin-off team and the spin-off characteristics belong to the resource-based view. Chapter 3 discusses how the theories can be formulated in concepts that are applicable to academic spin-offs.

The theoretical framework presented in Figure 1.1 forms the heart of this thesis. It captures concepts from the social capital theory as well as from the resource-based view. By using these concepts, the framework addresses both theoretical research questions. And by comparing the impact of the concepts in the resource-based theory (e.g. the spin-off team and the spin-off's characteristics) with the concepts in the social capital theory (e.g. spin-off network and parent involvement) on early spin-off growth, the framework contributes to a understanding of the extent that these theories can explain early spin-off growth. Moreover, deep understanding of the spin-off network and parent involvement increases our knowledge of how these theories interact.

Figure 1.1 **Theoretical framework**



1.1.3 PRACTICAL RELEVANCE

This study frames the main research question and the two theoretical research questions into a theoretical framework that is assembled from factors stressed by the social capital theory and the resource-based theory. The results from analysing the overall framework are not only valuable to scholars interested in the early growth of spin-offs or new firms in general, but also to practitioners. Spin-off entrepreneurs and officials in knowledge institutions that are involved in spin-off activities can find important practical implications in this study.

Entrepreneurs are, of course, interested in developing and establishing early growth in their spin-off. To gain spin-off success, it is essential to translate the intellectual property into a commercial application. The present study will provide spin-off entrepreneurs with an in-depth understanding of how to manage their spin-off activity and direct it towards early

growth. The study offers three specific ways. First, it informs current and future spin-off entrepreneurs of the resources and capabilities that are important to the early growth of a spin-off. This knowledge can help spin-off entrepreneurs to explore the best ways to gain access to these resources and how to develop their capabilities. The second contribution is to shed light on the benefits of support programmes provided by the parent organisation. Accessing resources and developing capabilities are not only dependent on the internal capabilities of the spin-off team or the provision of parent support. External networks, as well, are crucial to gaining access to new information, unique resources or capabilities that are difficult to imitate. Hence, the third contribution lies in the understanding of how to benefit from these external networks.

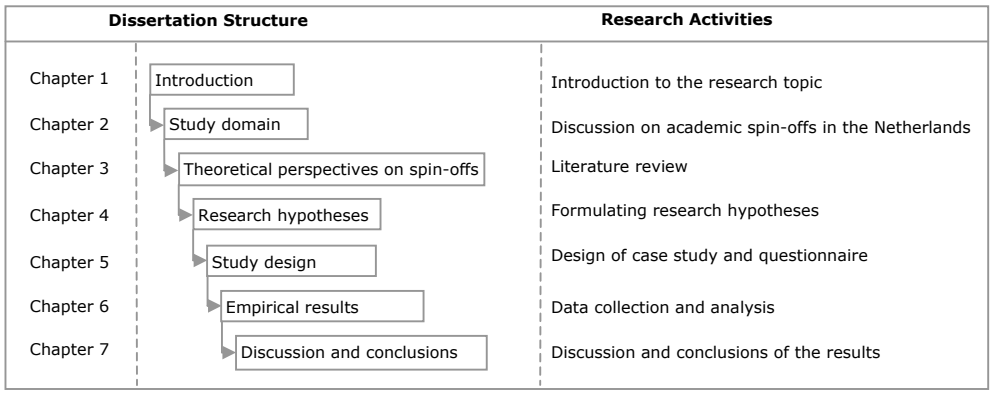
Spin-offs can also contribute positively to the knowledge institution they originate from. First, and most often mentioned, is the role spin-offs have in transferring and exploiting academic knowledge. Spin-offs are effective instruments in the transfer of scientific knowledge into new inventions that need further development (Shane, 2004). At American knowledge institutions, most of the early-stage inventions were licensed to new and small companies (Thursby *et al.*, 2001). Hsu and Bernstein (1997) thought that half of the licensed inventions from MIT would not have been licenced if there had not been a spin-off. Early-stage inventions need frequent assistance from faculty staff for further development and successful transfer. In most cases of the inventions licensed by American universities, the outcome would not have been successful without the active participation of faculty staff (Jensen *et al.*, 2003). Scientists have the expertise and knowledge to further develop the invention and keep the start-up investments relatively low. The intervention of the scientist in the spin-off may also be beneficial to the knowledge institution. Scientists who work for spin-offs can also increase investment levels in the academic research programme. This second contribution is mostly present with successful spin-offs that maintain a good relationship with their knowledge institution. Pressman *et al.* (1995) reported that investments induced by MIT spin-offs were far larger than the royalties from licences. In the long run, taking equity in start-ups generated higher rates of return compared to the average licence arrangement (Bray and Lee, 2000; Lockett *et al*., 2003). Moreover, collaboration between spin-off and faculty staff increased entrepreneurial activity in research groups. Research has shown that success of academic research departments depends on the organisational flexibility, autonomy and empowerment of staff (Omta, 1995). Learning from collaboration with start-ups enables researchers to tailor their expertise to the needs of industry. Louis *et al*. (2001) found that higher levels of entrepreneurial activity among researchers in the life sciences were associated with increased research productivity. The third contribution of spin-offs is that the faculty staff can take part in a spin-off. Part-time appointments in a spin-off provide a financial mechanism to retain and attract staff, particularly in the biomedical area (Matkin, 1990). Furthermore, spin-offs can provide opportunities for training and educating students (Lee, 1996). They can learn how to commercialise inventions, be cognisant of high-tech entrepreneurship and can benefit from job opportunities provided by the spin-off after graduation. Research grants from governmental authorities are increasingly being based on bipartite research agreements between knowledge institutions and the private sector. Thus, setting up a spin-off may result in extra research grants. Knowledge of the factors that affect the early growth of spin-offs may develop the supportive actions of university

officials and enrich their knowledge of the best way to found a spin-off maximising the chance of success while minimising financial and business risks.

1.2 THESIS OUTLINE

The rest of the thesis is divided into three parts. Figure 1.2 provides an overview of the structure of the dissertation and the research activities.

Figure 1.2 Dissertation structure and research activities



Chapter 1 discusses the research objective that guides the research activities and highlights its theoretical and practical contributions. The second chapter provides an overview of the study domain to familiarise the reader with the broader context of spin-off activities and the transfer of technology. The third chapter focuses on the theoretical explanations of the early growth of academic spin-offs. Drawing on the social capital theory and the resource-based view, it discusses the role of external networks and the internal capabilities of academic spin-offs in achieving early growth. The chapter concludes with an overview of the theoretical concepts that are relevant for academic spin-offs. In Chapter 4, the existing theories are formulated as hypotheses that address the early growth of academic spin-offs. The hypotheses are tested with empirical data that were collected from questionnaires. The design of the questionnaire, which was based on several scales to measure the theoretical concepts, is discussed in Chapter 5. In the development and validation of instruments, experts such as officials in knowledge institutions and spin-off entrepreneurs were consulted to arrive at a better understanding of the instruments when applied to spin-offs. The chapter concludes with an overview of the quantitative methods applied for data analyses. Chapter 6 starts with a description of the research setting and the spin-offs involved in this research. Discussion of the responses elaborates on the representativeness of this research. The chapter then analyses the data and gives a preliminary evaluation of the study sample. Most prominent in this chapter is the estimation of the early growth of spin-offs and the in-depth analysis of network contacts and support by the parent organisation. The formulated hypotheses are compared with the findings from the empirical data. The roles of each theory, the social capital theory and the resource-based view, are assessed in relation to the early growth of spin-offs. Finally, Chapter 7 discusses the

contribution and implications of this research. The chapter draws conclusions regarding its theoretical contribution, managerial implications and methodological implications. The theoretical contribution focuses on an assessment of both the social capital theory and resource-based view in explaining the early growth of spin-offs. The implications for managers are directed at the resources of the spin-off, the network in which it operates and the involvement by the parent organisation. Since the research employs several finely-tuned instruments to collect network data, the chapter also addresses the methodology used. The chapter concludes with an outline of possible meaningful pathways for further research.

CHAPTER 2 STUDY DOMAIN

Interest in academic spin-offs has increased noticeably over the last decade. Governments are interested in spin-offs to strengthen the knowledge economy and they emphasise the importance of spin-offs for two reasons. First, spin-offs transfer knowledge from the academic environment to business environments, and second, spin-offs encourage knowledge-based entrepreneurship. Interest from universities and other knowledge institutions is rooted in the exploitation of their expertise. The previous chapter discussed how spin-offs can contribute to their parent and to the economic development of a region or country. This chapter discusses an international benchmark of Dutch spin-off activities compared to other western countries. The chapter concludes with a discussion of some of the initiatives that exist today to increase spin-off activity in the Netherlands.

2.1 TECHNOLOGY TRANSFER AND SPIN-OFFS

Over the last decade, changes have taken place in the field of technology transfer in the Netherlands. Traditionally, technology transfer was more or less dedicated to several intermediate knowledge institutions such as the GTI.[3] Universities conducted fundamental research and the business environment was only interested in the exploitation of new applied knowledge. The intermediate institutes filled the gap that existed between fundamental research and the exploitation of applied knowledge. Today, as a result of increased interest in technology transfer, new and more direct and intense ties are emerging between the actors involved (Wijffels *et al*., 2004). Universities and knowledge institutes are increasingly involved in the transfer of their research results to the business sector. The merger of Wageningen University and the DLOs[4] into the WUR and the rise of Technology Top Institutes are good examples. Also large international companies change their R&D infrastructures by setting up research alliances with academia. Examples of these changes are Food-Valley in Wageningen and the Philips research campus in Eindhoven. Also new actors are entering the technology transfer arena. Polytechnic institutions are merging with universities and form partnerships with small and medium-sized firms. Consequently, the competitive arena is in a strong and dynamic flux of change, which is being intensified by the international orientation of technology transfer.

Academic technology transfer to the business sector can take place by three basic mechanisms. The first traditional mechanism is the education of students who are employed after graduation and make use of their scientific training. A second mechanism is that of consulting, contracting research and licensing academic knowledge to established industries. The third mechanism is the spin-off route by which knowledge is exploited through the founding of a new venture. New knowledge, which is very new to the market, has to go through the early stages of the innovation process. This type of innovation is often characterised by high uncertainty of the technological outcome and the market demands. Only a few pioneering firms, such as spin-offs will take the risks associated with these early stage innovations. In the early stage of the innovation cycle, the spin-off mechanism is an appropriate way to transfer basic knowledge.

Research has shown that spin-offs can create economic growth in three different ways. First, spin-offs may generate considerable economic value. In the UK and Ireland, academic spin-offs create more innovative products and services compared to other high-tech start-ups (Blair and Hitchens, 1998). And in the Boston area of the US, Shane and Stuart (2002) found that spin-offs grow faster and relatively more spin-offs go public than non-academic start-ups. The Association of University Technology Managers reported that between 1980 and 1999, US academic spin-offs generated US$ 33.5bn in economic value added (Cohen, 2000). In the same time-span, it is estimated that American spin-offs created approximately 280,000 jobs (Cohen, 2000). And at the University of British Columbia (Sudmant, 2002), more than fifteen years of spin-off support resulted in over 100 spin-offs that employ over 2,500 people and generate revenues of over CAN$ 155m. So job creation is the second way in which spin-offs can contribute to economic growth. The third way is by their contribution to the local economic development. Spin-offs apply academic

[3] GTI stands are the large technology institues (Grote Technologische Instituten).
[4] A DLO is a national institute for research on agriculture (Dienst Landbouwkundig Onderzoek).

knowledge and develop the creation and growth of knowledge-intensive, innovation-based industry in a region. Research has shown that in the Boston area and in Silicon Valley, spin-off firms were more important in the early stages of development of the scientific complex than were firms that were just attracted to or moved to the region (Mahar and Coddington, 1965). Roberts (1991) indicated that most spin-offs from MIT settled near the laboratories they emerged from and continued their relationship with them. In the Netherlands, spin-offs contribute in a similar way to economic growth. For example, it is estimated that between 1984 and 2004, some 400 companies spun off from Twente University, creating more than 4,000 jobs (www.utwente.nl/nikos). And according to the annual report of Biopartner (a Dutch programme that stimulated starters in the life sciences) at least 31 spin-offs in the life sciences were founded between 1998 and 2002, generating over 350 jobs (Hu and Mosmuller, 2003).

2.2 INTERNATIONAL BENCHMARK OF DUTCH SPIN-OFF ACTIVITIES

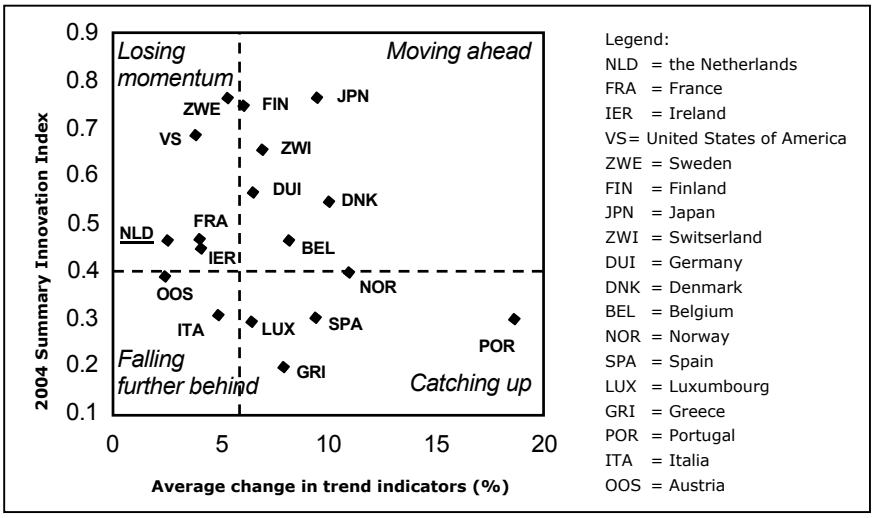
The international benchmark of spin-off activity offers some understanding of Dutch technology transfer and spin-off activity compared to those in other countries. Three types of benchmark are discussed. The first benchmark presents the indicators of the innovative climate in the Netherlands. The second discusses the amount of interest by private companies in publicly funded research. The level of this interest is an indicator of interaction between industry and academia. And the third benchmark addresses spin-off activity in the Netherlands compared to that in other European countries.

2.1.1 INTERNATIONAL BENCHMARK: THE DUTCH INNOVATIVE CLIMATE

In November 2004, the European Commission presented the fifth European Innovation Scoreboard, comparing 22 innovative indicators in 31 European countries, Japan and the United States. NOWT[5] has compared the European Innovation Scoreboard 2004 indicators with those of 2003 (NOWT, 2004). First, the Netherlands is falling behind regarding employment in the high-tech sector, investments by companies in R&D and the percentage of value added in the high-tech industry. Second, the amount of high-technology risk capital, expenses on innovation and profits from innovation are low compared to the European average. Third, the amount of publicly funded research and the number of patents are still above the European average. In total the Netherlands scores above average on innovativeness but below average when it comes to its level of growth in innovativeness. As a result, the Netherlands is *losing momentum* regarding its innovativeness (European Communities, 2004). Figure 2.1 represents this schematically. The figure leaves little doubt about the position of Dutch innovativeness. The Netherlands ranked fifth in 2000 and 2001, but lost that position and fell back to sixth place in 2003 and eighth place in 2004 (NOWT, 2004). Based on the report by the European Communities (2004), NOWT (2004) concludes that the Netherlands has a sound knowledge base but due to its low growth of innovativeness risks falling behind.

[5] NOWT (Nederlands Observatorium van Wetenschap en Technologie) is a Dutch organisation for the observation of scientific and technological developments.

Figure 2.1 Average country trends by Summary Innovation Index (NOWT update nr5, 2004)



2.2.2 INTERNATIONAL BENCHMARK: PRIVATE INTEREST IN ACADEMIC RESEARCH

The next international benchmark presents the interest of the private sector in publicly funded academic research. Researchers in private R&D labs make use of published research. According to Tijssen and Leeuwen (2004), the number of references by industrial researchers in professional publications to articles published by their academic colleagues may indicate the amount of knowledge that is flowing from academia to business. Comparing the figures of different countries shows how 'attractive' the publicly funded research projects are for the business sector. The report by Tijssen and Leeuwen is presented in the NOWT update nr5, 2004. Figure 2.2 illustrates the attractiveness index for each country, displaying the relative number of professional publications in a country that cite publicly funded research there. An index above 1 indicates that other countries too use the results from public funded research; while an index below 1 shows that the private sector is applying relatively more public research in other countries. Tijssen and Leeuwen have used data from the Thomson Scientific database between 1997 and 2003 for comparative purposes. Figure 2.2 shows that the Netherlands scores above 1, indicating that the Netherlands has an attractive research base for foreign industries.

Another indicator of private interest in public research is the level of expenditure in public research that is funded by the private sector. Figure 2.3 presents the percentage of innovative companies that cooperate with the public sector.[6] The figure clearly shows that in the Netherlands the interaction between the public and private sector occurs with large and established firms. Among the innovative small and medium-sized enterprises only a small proportion collaborates with the public sector. The figure furthermore shows that most interactions between the public and private sector take place with the universities.

[6] This figure is adapted from data in the NOWT update nr4 (2004). The data is based on the 3rd European Innovation Survey (CIS3).

Figure 2.2 Attractiveness of European countries as a source of information for scientific research by private companies, 2003 (Tijsen and Leeuwen, 2004).

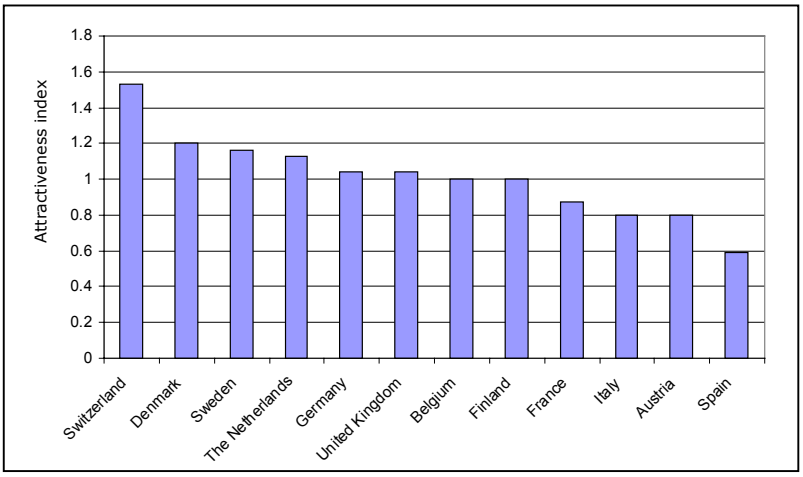


Figure 2.3 Percentage of innovative companies that cooperate with universities and research institutes (NOWT update nr4, 2004)

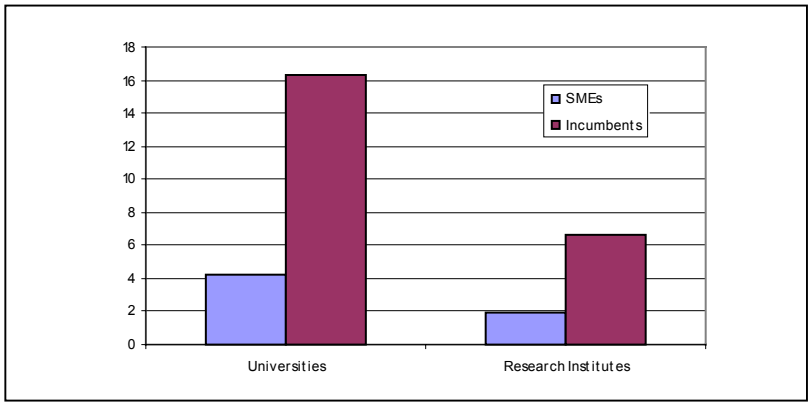


Figure 2.2 shows the Netherlands has an attractive academic research base according to the private sector. In other words, publicly funded research in the Netherlands is relatively more attractive to the business sector than that of other European countries. Figure 2.3, however, shows that this interest basically comes from the established and large firms, and not that much from small and medium-sized enterprises.

2.2.3 INTERNATIONAL BENCHMARK: SPIN-OFF ACTIVITIES

Comparing Dutch spin-off activities with those in other European countries is difficult. The figures are dependent on the goal of the report, the definition of spin-offs and access to data sources to identify spin-offs. The figures presented in Table 2.1 are not intended to present

a complete picture but are indicative of spin-off activities in a certain country. The OECD (2003) has published a comparison of high-tech start-ups and spin-offs in several European countries. Table 2.1 shows these comparisons, which indicate that the Netherlands is about average compared to other European countries.

Table 2.1 Spin-off and start-up activity in European countries (Source: OECD, 2003)

		Spin-offs	Start-ups	Total
Netherlands (2000)	University	23	4	27
	Research institute	3	7	10
	All	26	11	37
Italy	University	14	13	27
	Research institute	9	0	9
	All	23	13	36
Switzerland	University	39	17	56
	Research institute	7	5	12
	All	46	22	68
Norway	University	15	1	16
	Research institute	24	27	12
	All	39	28	67
Belgium (Flanders)	Uni. and Res. inst.	11	4	15
Germany	University	28	9	37
Spain	Uni. And Res. Inst.	8	3	11
US	University	-	-	390

The international benchmark shows that the innovative climate in the Netherlands is above the European average but is growing more slowly than in other countries. In foreign countries there is a high interest by the private sector in Dutch academic research, however, within the Netherlands the importance of academic institutions as a source of innovation is low compared to other European countries and moreover collaboration between industry and academia is based on large companies. The conclusion to be drawn from this is that the Netherlands has a strong research base but is not adequately able to capitalise it in the direction of new start-ups (NOWT, 2004).

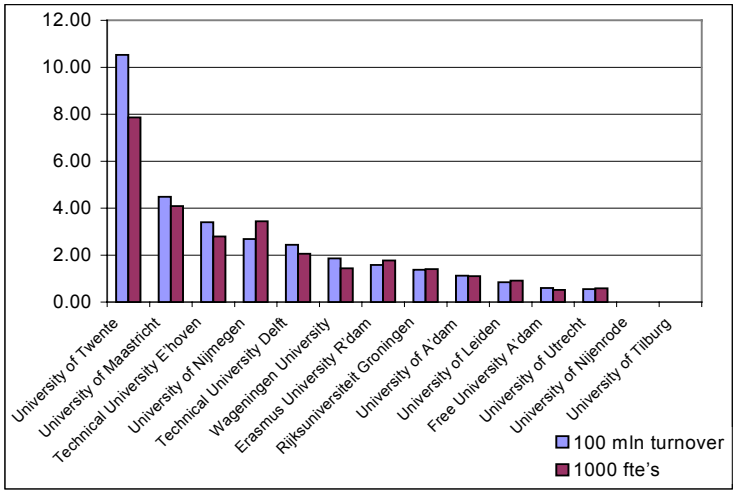
These observations form the key impetus to strengthen the climate of innovation in the Netherlands. The Netherlands Ministry of Economic Affairs (Ministery of Economic Affairs, 1998) and the Ministry of Education, Culture and Science (Ministery of Education, Culture and Science, 2005) have emphasised that the capitalisation of academic knowledge must get better. To accomplish this objective, the Ministry of Education, Culture and Science has declared that capitalisation of knowledge should be a prime task of universities (Ministery of Education, Culture and Science, 2005). As a result, among other criteria, possibilities for the application of knowledge have become an important criterion for research funding. The two ministries have formulated policy instruments that assess the applicability of research and other activities that facilitate the application of knowledge. The Foundation for Technology and Science (STW -Stichting Technologie en Wetenschap) is an agency founded by the Ministries of Economic Affairs and Education to fund scientific research. STW explicitly mentions the importance of transferring academic knowledge to new companies. To facilitate this transfer, they have set up the 'Valorisation Grant' programme that allows spin-offs to work out the technical and commercial

feasibility of a business plan. Between 2001 and 2004, 17 spin-offs emerged from STW-funded research projects. STW indicates that their programme is aimed at the initial funding of business ideas, and follow-up investments must be attractive to the business environment or to knowledge institutions. The next section explores the initiatives taken by knowledge institutions to facilitate spin-off activities.

2.3 SPIN-OFF ACTIVITIES IN THE NETHERLANDS

The amount and scope of spin-off activity in the Netherlands has not been widely recorded. Senter[7] (2001) found that between 1998 and 2000 a diverse set of 546 academic spin-offs received a total of approximately € 40m of innovation grants from the government. According to Senter, most of these spin-offs were in biotechnology or in the ICT sector and most maintained close relationships with their knowledge institution. Especially, in biotechnology, spin-offs used research performed in the parent organisation. The connection with this organisation provides insight into new developments and techniques, and the ability to attract well-educated R&D personnel. The Dutch Foundation for Technology and Science (STW) indicates in its 2004 annual report that 17 spin-offs had started with STW-financed research projects since 2001 (STW, 2004). In 2003 the Ministry of Economic Affairs investigated Dutch spin-off initiatives at 14 universities and 15 academic research institutions. In a period from 1999 to 2001, their study found 107 new spin-offs (Ministry of Economic Affairs, 2003).

Figure 2.4 Number of spin-offs per university, based on turnover and ftes (Minez, 2003)



[7] Senter is a Dutch organisation that assesses applications for a variety of innovation subsidies that are funded by the Netherlands Ministry of Economic Affairs.

On average this is 6.4 spin-offs from universities and 1.3 spin-offs from academic research institutions. In absolute terms, the largest contributor of spin-offs is the University of Twente, (see Figure 2.4), followed by the universities of Delft, Maastricht, Nijmegen and Wageningen. Among the research institutions, ESTEC is the main contributor with five spin-offs, followed by TNO (4) and ECN Petten (3). Regarding the size of the research institute, the Telematica Instituut is the largest followed by CWI and Marin. At the universities of Nijenrode and Tilburg no spin-offs were identified (see Figure 2.4). Comparing spin-off activity at universities is complex. Some studies define a spin-off only if the knowledge institution has some stake in the spin-off itself, while other studies count every self-employed student as a spin-off. As a result, the numbers are only indicative of spin-off activity.

There are major differences in the programmes of the various Dutch knowledge institutions regarding their support of spin-offs. The report by the Ministry of Economic Affairs (2003) indicates that many spin-off entrepreneurs mention the knowledge institution as being reluctant to support and lacking a positive attitude towards the spin-off activity. Since 2005, a new directive has been issued by the Ministry of Education, Culture and Science (2005) that commissions universities and other knowledge institutions to exploit their research. Among others, spin-off programmes are explicitly mentioned as a way to accomplish this new task. A quick check on the Internet of spin-off programmes at Dutch knowledge institutions reveals that most of them have initiated such programmes. But, since the support of spin-offs can involve financial risks, knowledge institutions are being selective about which individual spin-off initiatives they choose to back. Depending on the business model and the amount of capital needed, knowledge institutions will have different views of spin-offs. For example, at the University of Twente spin-off entrepreneurs can participate in the TOP programme (*temporary entrepreneurial position*). Entrepreneurs can receive an interest-free loan up to €14,500 and do not necessarily have to come from the university. An open approach, clear objectives and support for all applicants has made the TOP programme a success for over twenty years. At Wageningen University and Researchcentrum the spin-off programme is more cautious. The Wageningen Business Generator is a spin-off programme that aims to exploit academic inventions through entrepreneurship. The invention must have its origins in research conducted by Wageningen University and Researchcentrum and must be related to current research programmes. Many of these inventions are in the area of life sciences and can involve large amounts of funding. These examples show that the attitude of knowledge institutions to new spin-offs can be reluctant, especially if high financial risks are involved.

The embeddedness of a spin-off activity reflects the extent to which other organisations are involved in the spin-off programme. Almost all knowledge institutions have set up a legal entity to accommodate their spin-offs. This is often a holding that is fully or partly owned by the knowledge institution. The holding administers the stakes that the knowledge institution has in the spin-off. These stakes can take the form of financial support or licences to the spin-off. There are large differences among the various spin-off programmes in the diversity and number of private partners involved in the holding. These partners have often set up programmes themselves to stimulate technology-based starters. For example, the University of Groningen cooperates with the city of Groningen and other governmental authorities in the region to facilitate technology-based entrepreneurship. Since 2004, the

University of Groningen has involved private partners in the funding of their spin-offs. Also at the University of Nijmegen, partners such as the Chamber of Commerce, the city of Nijmegen, the province of Gelderland, the Foundation of Economic Development in Gelderland, and others are involved in its spin-off programme. In Eindhoven, the technical university participates in a cooperative named Incubator 3+ that stimulates technology-based starters in the Eindhoven region. In this programme, the university works with a governmental organisation for regional economic development and with private companies such as Philips and the Rabobank. The importance of partnering with private organisations is also indicated by a benchmark study on incubators (CSES, 2002). The benchmark study advises that incubators should be promoted by an inclusive partnership of public and private sector stakeholders.

Spin-off support programmes have different objectives and can be configured in various ways to accomplish these objectives. The support strategy describes how objectives can be achieved. Not all knowledge institutions have explicitly formulated their support strategy but three elements are noteworthy. They are 1) the objective or focus of these spin-off programmes; 2) the support instruments; and 3) the duration of the support.

The objective or focus of a spin-off programme shows the types of spin-offs that a knowledge institution is aiming at. In general terms, all spin-off programmes aim at the transfer of academic knowledge to the business sector and in doing so try to ease the start-up process and secure the interest of the knowledge institution. The interest of knowledge institutions can determine the types of spin-offs that are facilitated by the programme. Some programmes, such as the Wageningen Business Generator and Erasmus Medical Center, clearly state that the business activity of the spin-off has to be closely related to that of the knowledge institution. These spin-off programmes are geared to learning opportunities. The spin-off can learn and make use of the expert knowledge available at the knowledge institution, while the knowledge institution can benefit from practical issues. Other spin-off programmes are less strict and allow spin-offs to enter the programme with different types of business activities. The relationship between the spin-off and the knowledge institution has less emphasis and learning opportunities are not a priority. The goal of these programmes is to increase the number of knowledge-based firms in the region, such as the TOP programme at the University of Twente and the Area 010 at Erasmus University.

Knowledge institutions have developed different strategies to support their spin-offs. These can range from facilities with only secretarial services and/or financial support up to business coaching and training programmes. Although all spin-off programmes provide similar support activities, differences exist in the prices paid for these support services. Several spin-off programmes facilitate support activities below market prices. For example, at the Twente University spin-off entrepreneurs can apply for a loan that is free of interest for the first year. On the other hand, at the University of Utrecht spin-offs can find office accommodation on the university campus but they are charged market prices.

The third aspect, and probably among the most important in the support strategy, is the duration of support. Milestones are important in the success of a spin-off. They demonstrate to investors and entrepreneurs whether the objectives are being achieved and indicate when action should be taken. Terminating a spin-off is the ultimate action in this respect, but

timing is crucial. If milestones are not applied correctly, a spin-off may be terminated too late and both the spin-off entrepreneur(s) and the investors will be confronted with large debts. Furthermore, the exit strategy is closely related to the milestones. Knowledge institutions are, in principle, public agencies and investing public money in private enterprises is not appropriate. Most spin-off programmes, such as the Wageningen Business Generator and Univenture in Maastricht, clearly state that their programme is self-sufficient. Nevertheless, the question remains as to when a spin-off programme ceases to be just a stimulating program and becomes an investment initiative. The spin-off programmes at the University of Twente and the Area 010 programme at Erasmus University have definite milestones and exit strategies. After six months a spin-off's potential is assessed and after a year the spin-off must be market-ready or have attracted other investors. Other programmes allow spin-offs to continue for a longer period. At the University of Nijmegen, spin-offs can stay in the programme for a period of three to five years, and also at the Groningen University spin-offs can remain for about four to five years. In the Wageningen Business Generator, experts evaluate the business idea before it becomes part of the programme. If an idea is accepted, the spin-off entrepreneur is allowed to work on a 'proof of principle' for about 18 months. Within these 18 months, the entrepreneur must convince investors to invest 50% of the required capital before the spin-off programme will invest the remaining 50%. Exit or additional funding is based on how the spin-off develops over time. Box 1 presents a typical start-up of a spin-off at the Wageningen Business Generator. The example may provide some understanding of how spin-offs can be supported by the knowledge institution.

Box 1 A typical spin-off funding process at the Wageningen Business Generator

Wageningen UR coordinates its spin-off activities in a holding and adopts a clear process-oriented approach to the founding of a spin-off. During the process, three issues are critical and may result in the termination of the spin-off activity if they are not met satisfactorily. These issues are the maturity of the business proposition, the financing of the spin-off activity, and the quality of the scientist as an entrepreneur. The spin-off activity starts with the identification of the research invention as a feasible business proposition. The identification can be done by the scientist or through scouting activities by the research departments. The initial business proposition is than presented to the holding. The proposition is accepted if it meets the criteria of maturity. After being accepted, the scientist-entrepreneur will be financed for about 18 months during which the business plan will be written. The spin-off is at this stage a company still to be founded. The scientist is no longer a researcher but is appointed by Wageningen UR to set up the spin-off. The holding closely monitors the start-up activities and experts are invited to comment if necessary when needed. There is a change that an entrepreneur more capable of organising the spin-off activities will replace the scientist as the manager of the spin-off. After about 18 months a business case must be presented to an independent business investment committee that will assess its feasibility. Following acceptance, the committee will provide a further 25% of the initial investment needed, if the entrepreneur is capable of finding a further 25% of the investment. The remaining 50% will be found with the help of the holding.

(Sources: www.wbg.wur.nl; Interview W. Jongen - Director Wageningen Business Generator)

2.4 CONCLUDING REMARKS

This chapter discussed the various means of knowledge transfer from academia to the business sector and provided an international benchmark of the Dutch innovative climate, the interaction between academia and industry and an indication of spin-off activity. The benchmark shows that the Netherlands are performing, compared to other European countries, quite well but risk to fall behind. Furthermore, in the Netherlands the interaction beween academia and industry is basicaly through large established firms, and the number of spin-off start-ups stays behind compared to other European countries. The findings indicate that in the Netherlands academic researchers and knowledge institutions are reserved to transfer knowledge via the spin-off route.

CHAPTER 3 THEORETICAL PERSPECTIVES ON SPIN-OFFS

This chapter commences with a brief discussion on the four sets of factors that influence the early growth of academic spin-offs. These four factors are 1) the characteristics of the spin-off, 2) the experience and skills of the spin-off team, 3) the external network in which the spin-off operates, and 4) the involvement by the parent organisation (see introduction Chapter 1). The discussion concludes with a conceptual research framework based on two organisational theories, i.e. the social capital theory and the resource-based view. Section 3.1 discusses the relevance of the organisational theories along with a discussion of the premises and complexities of using these theories when studying the early growth of spin-offs. The section concludes with a conceptual framework based on the social capital theory and the resource-based view. Each organisational theory is then considered in more detail. Section 3.2 elaborates on the social capital theory and Section 3.3 on the resource-based view. Both theories have divergent views regarding the factors that influence the early growth of firms. While the resource-based theory stresses the role of resources and distinctive capabilities, the social capital theory emphasises the role of relations to explain the survival and growth of a new firm. Based on a review of previous empirical studies, the main contribution of each theory concerning the early growth of spin-offs will be discussed. Section 3.4 discusses the performance of spin-offs, which is partly dependent on contingent factors. Section 3.5 concludes the chapter with an integrative framework in which the theoretical concepts are drawn together. The integrative framework acts as an introduction to the following chapter, which discusses these hypotheses. In Section 3.5 the operational definitions of the theoretical concepts are reviewed.

3.1 THE ORGANISATIONAL THEORIES

Organisational theories explain the early growth of firms as a result of specific internal or external conditions. Internal conditions deal with a firm's human and physical capital and the way the business is organised. External conditions are those related to a firm's network and its relationship with specific partners. Two major theoretical approaches at the organisational level have been developed to understand the role of a firm's internal and external conditions: the resource-based view and the social capital theory. The social capital theory stresses that relational characteristics with external contacts determine the early growth of firms. In the case of spin-offs, these external contacts can be found in the spin-off network and are partly influenced by the involvement of the parent organisation (Figure 3.1). The resource-based view, on the other hand, states that resources controlled by the firm are important. Concerning academic spin-offs, these resources can be found with the spin-off team and the characteristics of the spin-off.

In entrepreneurship research, a start-up firm is assumed to be an extension of the founders (Brüderl *et al*., 1992; Brüderl and Preisendörfer, 2000; Lee *et al*., 2001). As a result, the internal aspects of a start-up refer to the founders and their resources. Several studies have noted that team starters perform better than individuals and when they are deeply committed to the founding of a firm and strongly entrepreneurial orientated, a firm tends to grow faster than one whose founders show less commitment and entrepreneurial orientation (Shane, 2003; Ucbasaran *et al*., 2003). Regarding the experience of founders, some studies have indicated that teams with experience in technology are in a better position to exploit their research finding (Chrisman *et al*., 1995; Franklin *et al*., 2001). Other studies claim that in addition to experience in relevant knowledge fields, complementarity of the experience of team members is important for successful early growth (Roberts, 1991; Shane, 2004). As far as physical resources are concerned, some studies found evidence that the amount of financial capital in the new firm is important for early growth (Lee *et al*., 2001; Shane and Stuart, 2002). Moreover, other studies indicate that the originality of the business idea and the firm's innovative capability contribute positively to the pace of growth (McGrath, 2001). The resource-based theory underpins the importance of the internal conditions for the early growth of spin-off firms.

The external aspects of the firm refer to the firm's business environment. In high-technology industries, companies face increased levels of competition due to constant changes in the competitive landscape (D'Aveni, 1994). To survive, companies need to develop their organisational capabilities and reconfigure their competencies to create value (Grant, 1996). In these high-tech industries, however, companies face serious deficiencies in their resources and face difficulties in gaining access to resources that they need (Zahra, 1996). Especially, start-up firms are often established with little more than the technology and the attributes of the founders who set-up the firm (Brüderl *et al*., 1992; Brüderl and Preisendörfer, 2000). Such firms can benefit from entering into an alliance or setting up a collaborative partnership with others. Alliances and collaborative partnerships provide access to resources and provide learning opportunities (Baum *et al*., 2000). Alliances with incumbents (Stuart *et al*., 1999), joint ventures (Wright *et al*., 2004) but also less formal relationships such as those of family and friends (Renzulli *et al*., 2001) have received much attention in recent studies. For start-ups, networks are seen as important gateways to

identifying opportunities, gaining access to resources and getting acceptance from business partners. Some authors go further and argue that networks and the way founding entrepreneurs use them are vital if they are to succeed (Aldrich and Zimmer, 1986; Birley, 1985) and they can even be seen as the final arbiter (Burt, 1992). Hence, the social capital theory provides insight into the role of networks and partnerships on the early growth of new firms.

3.1.1 ORGANISATIONAL THEORIES AND SPIN-OFFS

In the academic literature, both the social capital theory and the resource-based view favour increasing interest in the study of the early growth of new firms (Brüderl *et al*., 1992; Brüderl and Preisendörfer, 2000; Lee *et al*., 2001; Westhead *et al*., 2001; Larsen, 1992; Baum *et al*., 2000). Firms are heterogeneous regarding the resources they control and the networks they operate within. By combining these organisational theories we can zoom in on the resources and the networks of the individual firms and understand why some firms perform better or grow faster than others. Organisational theories can offer direct answers to our main research question: "*what are the key success factors that affect the early growth of academic spin-offs?"* Theories at the organisational level are still being debated for their explanatory power. Scholars are trying to extend the theories by focusing on specific empirical contexts. Although, the social capital theory and resource-based view are both organisational theories their main arguments differ. By bringing together two popular organisational theories and applying them to the special case of academic spin-offs, we can contribute to the theoretical debate and extend the knowledge and the explanatory power of these theories.

At the firm level, many factors are involved when providing a complete picture of the success of an individual firm. No one firm is identical to another. Start-up firms are going rapidly through different growth phases, and each growth phase may show its own factors that are positively related to performance.

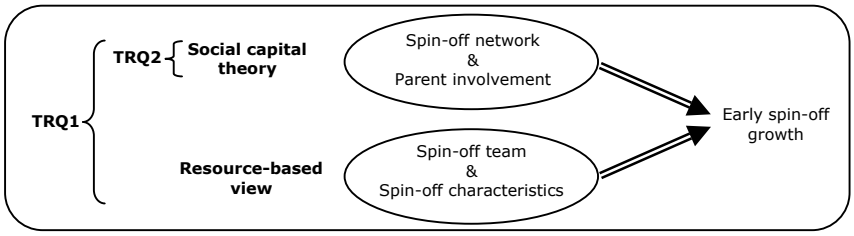
3.1.2 CONCEPTUAL FRAMEWORK

This study is firmly grounded in the social capital theory and the resources based view. These theories are applied here to understand the factors that determine the early growth of spin-offs. Both these theories are grounded in a theory-driven research framework (Figure 3.1). The framework incorporates factors regarding the spin-off team, the spin-off's characteristics, the spin-off network and the involvement of their parent organisation. The use of a theory-driven research framework provides at least three benefits. First of all, it guides the process of the research. While discussing the theories, building the research models and interpreting the results, the research framework remains in the background and prevents those involved from overlooking certain important aspects of the spin-off. Second, regarding the theoretical background of this research, the theoretical framework displays the combination of both the social capital theory and the resource-based view.

Several researchers emphasise that analysing the interaction between the two theories is more fruitful (Lee *et al*., 2001). As a result, in this research study we do not attempt to argue that one theory is more profound than the other or attempt to borrow from one theory

as a "gloss" for any theoretical lacunae in the other. This research positions the two theories next to each other and analyses to what extent they are distinctive or overlap. In doing so, the first theoretical research question (TRQ1) can be answered. This question assesses the extent to which the combination of the social capital theory and the resource-based view can explain the early growth of academic spin-offs. Second by zooming in on the social capital theory the second theoretical research question (TRQ2) can be answered. The second theoretical research question addresses the types of social relations that are favourable or unfavourable to the early growth of spin-offs. The third benefit of using the conceptual framework is its usefulness for practitioners. The research framework directly refers to factors that may be of value to spin-off entrepreneurs and officials in knowledge institutions. Figure 3.1 represents the conceptual framework.

Figure 3.1 Conceptual framework



3.2 THE SOCIAL CAPITAL THEORY

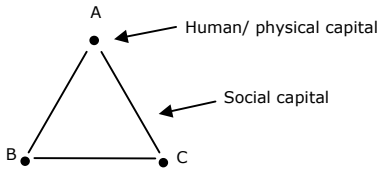
It has been long noted by scholars and researchers in strategy and organisation that networks play an important role in the performance of an organisation. Organisations whether established firms or start-ups, are part of a value chain and are dependent on external actors and changes in the environment. The firm's ability to build and maintain an inter-organisational network of relationships is increasingly viewed as key to sustained competitive advantage (Kogut, 2000; Omta *et al*., 2001). The source of innovation does not lie exclusively with the firm, but instead is commonly found at the intersection with actors outside the firm, such as competing firms, universities and business partners (Pisano, 1990; Powell, 1990). Moreover, for entrepreneurial firms, relations with external actors are important for identifying business opportunities, for gaining access to resources such as capital, expertise and for advice, guidance and endorsement (Aldrich and Zimmer, 1986; Birley, 1985; Greve, 1995). Entrepreneurs can draw upon their network contacts for emotional, material, social and creative support. Social networks thus play an important role in the early growth of new firms by helping to overcome the liabilities of newness and smallness, and by probing new business opportunities (Baum *et al*., 2000).

3.2.1 ORIGINS AND MAIN CONTRIBUTIONS

Social capital is a source of capital that is positioned alongside capital such as human and physical capital. Human capital refers to the experiences and capabilities of individuals (actors), whereas physical capital is embodied in observable assets used for production, such as tools and machines. Social capital refers to the relations among actors, individuals,

groups or organisations. According to Coleman (1990), social capital is not a part of human capital since it is not "located" in the actor but in the relationship with other actors. A single actor does not possess exclusive ownership rights to social capital because when the partner withdraws from the relationship, the connection dissolves with the social capital involved (Burt, 1992). In other words, social capital is between actors and is shared by these actors. Figure 3.2 shows the distinction between human and social capital. The nodes A, B and C are persons who have relations with each other. The human and physical capital resides in the nodes, while social capital resides *between* the nodes.

Figure 3.2 Three-person structure (Coleman: 1990)



The social capital theory was initially developed by sociologists and is based on two fundamental concepts: actors and actions. Over the last decades, the value of the social capital theory has been increasingly used to explain economic action. As a consequence, theories in social capital have taken two different directions (Coleman, 1988). On the one hand, sociologists see actors as social entities such as individuals, groups or societies who conform to social norms, rules and obligations. Economists, on the other hand, see the actor as an entity having goals, being self-interested and acting independently. This research follows the view of Coleman (1988: S96), that social capital "… *accepts the principle of rational or purposive action and attempts to show how that principle, in conjunction with particular social contexts, can account not only for the actions of individuals in particular contexts but also for the development of social organisation.*" As a result, the underlying principle of social capital is goodwill, such as a valuable resource that others have towards each other (Adler and Kwon, 2002). Adler and Kwon argue that goodwill is the sympathy, trust and forgiveness offered us by friends and acquaintances. The effect of goodwill is information, influence and solidarity. Consequently, Adler and Kwon (2002: 17) define social capital as "*the goodwill that is engendered by the fabric of social relations and that can be mobilised to facilitate action.*" Social capital can be described as a resource that actors derive from specific social structures or from specific social relations. Research in this area has particularly focused on the specific social structures and social relations that will provide higher levels of social capital that are believed to lead to increased performance. Research on network structure tries to underpin how the social context in certain firms is embedded and influences economic actions (Granovetter, 1985).

Research on network structure has found two types of network embeddedness (Granovetter, 1985): relational embeddedness and structural embeddedness. Relational embeddedness refers to the dyadic relationship between the actor and the partner (Bourdieu, 1985; Burt, 1992; Coleman, 1990; Boxman *et al*., 1991; Lai *et al*., 1998; Lin 2001), while structural embeddedness refers to the position of the actor in a network of relationships (Borgatti *et al*., 1998; Burt, 1992). Two aspects of relational embeddedness are believed to be important: reciprocity and the trustworthiness of the relationship. The presence of reciprocity is the main condition for the existence of a relationship. Reciprocity is strongly

associated with trustworthiness. Both reciprocity and trustworthiness are necessary for exchange in relations; the exchange of values, norms and beliefs, obligations and expectations. In the literature, the two aspects of reciprocity and trustworthiness are usually described in terms of the strength of the relationship.

The exchange of values, norms and beliefs becomes effective through the structural aspects of relationships (Coleman, 1990). Whereas relational embeddedness refers to the dyadic relationship between two actors, structural embeddedness addresses the structure of all relationships between all actors in a network (e.g. a group of friends or family, an organisation, a cluster of firms, or society in general). The structural dimension reflects the redundancy among actors. An individual, who has relationships with two actors that are connected to each other, has redundancy in its network. The connection between the two actors makes one of them redundant to the individual. Access to information held by either one of them may be also available through the other (Burt, 1992). Furthermore, in networks with high levels of redundancy, the actors are often more familiar with one another, making norms more effective and the flow of information easier (Coleman, 1990). Figure 3.3 illustrates this redundancy, the nodes A, B and C are persons and the lines between them represent their relations.

Figure 3.3 Three-actor structure with full redundancy (a) and without redundancy (b) (Coleman: 1990)

In the structure with redundancy (Figure 3.3a), action taken by actor A towards actor B is also known by actor C. This means that if actor A does not fulfil his obligations to actor B, actor C will be informed. A structure with redundancy, therefore provides mechanisms for collective sanctioning or rewarding. If redundancy is absent (Figure 3.3b), actor A can carry out actions that impose negative externalities on actors B or C or both (Coleman, 1990). Since there is no relation between B and C, they cannot warn each other or react through combined sanctioning. Moreover, in the structure with redundancy, information held by actor B is not only available to actor A, but also to actor C, while in the structure without closure (Figure 2.3b) information held by actor B is not available to actor C. The absence of a connection between actors B and C provides brokering opportunities for actor A (Burt, 1992). Actor A can tap into the knowledge of actor B and exploit this knowledge with actor C.

3.2.2 CONTRIBUTION TO SPIN-OFF RESEARCH

The concept of social capital with its structural and relational aspects has provided relative success for different streams of organisational research (Adler and Kwon, 2002). Regarding the individual level of analysis, the concept provides insight into how people enhance their career success (Burt, 1992), how people find jobs (Granovetter, 1973), and how entrepreneurship is facilitated (Chong and Gibbons, 1997). At an intra-organisational level,

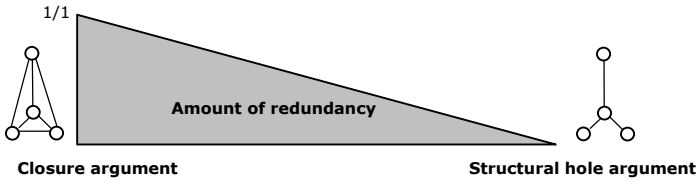
the concept has explained inter-unit learning and resource exchange (Hansen, 1999; Tsai and Ghoshal, 1998). At the organisational or firm level, the concept provides valuable insight into the performance of firms (Lee *et al*., 2001) and the emergence of new ventures (Steier and Greenwood, 2000). And at the inter-firm level, the concept explains the inter-firm learning and supplier relations (Baum *et al*., 2000; Rowley *et al*., 2000). Regarding research on spin-offs, it is only recently that the social capital theory has been used. Nicolaou and Birley (2003a; 2003b) found that the academic's embeddedness in a network of ties influences the type of spin-off and Shane (2002) concludes that the social capital of the founders is important in the early survival of the spin-off. The use of the social capital theory in a variety of organisational studies has resulted in a multiplicity of definitions of social capital (see Adler and Kwon, 2002). At the different levels of analysis, there is a common understanding that defines the concept of social capital as a resource that actors derive from a social structure. This resource can be explicit in the form of goods, but also implicit or tacit such as forms of obligations, norms or opportunities.

Both structural and relational embeddedness are important to understanding the role that social networks have in the early growth of a firm. How structural or relational embeddedness actually result in social capital is still being debated. Within the social capital theory, scholars agree on the importance of relations with external resource holders to explain the survival and growth of a firm. There is less agreement, however, about which structure and which aspects of relations influence early growth in a positive way. Social network analysts distinguish between two complementary dimensions of someone's network configuration: the structural dimension and the relational dimension (Granovetter, 1992; Gulati, 1998). The structural dimension refers to redundancy (i.e. the extent to which contacts overlap) in the network, while the relational dimension concerns the affective or emotional strength with a single contact. The usefulness of any type or configuration of relation(s) is dependent on the action that one pursues (Aldrich and Zimmer, 1986). This research focuses on how spin-offs grow through entrepreneurial action. First, the structural dimension is elaborated upon to explain how the closure argument and the structural hole argument can contribute to entrepreneurial action. Subsequently, the relational dimension is examined to see how the strong tie argument and the weak tie argument can contribute to entrepreneurial action.

STRUCTURAL EMBEDDEDNESS

The structural dimension refers to the degree of redundancy among network contacts. Contacts are redundant when they interact with each other, or at least are aware of each other. In an absolute redundant network, everyone is connected to all other actors in the network so that no one can escape the notice of others. Two arguments have been developed that stress the benefits for each side of the structural dimension. The two arguments are the closure argument and the structural hole argument, and are illustrated in Figure 3.4.

Figure 3.4 The structural dimension of embeddedness



According to the closure argument, in a redundant network the information known to one person is rapidly diffused to others and interpreted in similar ways (Granovetter, 1974). Network closure provides benefits in at least three ways. First, redundancy may facilitate trust among the people in the network (Coleman, 1990) and improves communication (Hansen, 1999). When someone interacts with others in a group in which everyone knows what the other knows, the fine tuning of activities is easier, more efficient and thus less costly. Second, in close networks, reputational effects can flow easily from one contact to the other. The norms and behaviour of the participants in the network are clearly visible and the mutual communication can facilitate the effective sanctioning of opportunistic behaviour but also rewards for high achievement. In redundant networks, it is less risky for people to trust one another (Coleman, 1990). Third, redundancy in the network provides the firm with continuity (Steier and Greenwood, 2000). In redundant networks, contacts are redundant with respect to the sharing of information. When a partner withdraws from the relationship, the connection dissolves but the redundancy allows the actor to switch easily to another contact and to uphold access to the resource or expertise.

The disadvantage of redundancy is that with each tie connecting to the same kind of people, the marginal value of each succeeding tie drops. Non-redundancy in the network increases the range of the network: a wider circle of information on opportunities, such as potential markets, investors and business ideas, is available to the entrepreneur. In non-redundant networks, people are not necessarily unaware of one another but they are focused on their own activities and have no interest in other people's activities (Burt, 2000). The structural hole argument claims that benefits result from diversity of information and brokerage opportunities created by the lack of connection between separate ties or clusters of ties in a social network. Non-redundant networks can provide a firm with three benefits (Burt, 1992). First, the firm can profit from access to information and resources that are not available to other firms. The firm has a control benefit when two individuals (e.g. suppliers or buyers) have an interest in the same resource. A third individual can exploit the competitive relation between the two to play them off against one another. By exploiting the lack of connection between the two individuals, the third has bargaining power that can yield profit. Second, the firm can benefit from time advantages (Burt, 2004; Rhee, 2004). The firm can use the separate contacts to scan for opportunities before others do. Third, the contacts in a non-redundant network extend to a larger, more diverse network of contacts. Contacts in non-redundant networks can be used as referrals to provide the entrepreneur with more diverse opportunities and potential business partners that are beyond the entrepreneur's immediate network.

The structural dimension reflects the redundant - non-redundant continuum and consists of diverging arguments on each side of the continuum. The closure argument stresses that

redundant network contacts can provide smooth communication, reputational effects and continuity in access to external resources. On the other hand, the structural hole argument claims that a network rich in non-redundant contacts provides access to more information about unique resources, opportunities and referrals to a wider scope of potential business partners. The social structure can be both a source of opportunities and a source of constraint (Granovetter, 1985). Research is still inconclusive as to the closure argument (Coleman, 1990) or the structural hole argument (Burt, 1992) is more effective in explaining the early growth of start-up firms. Advantages for start-ups that result from the closure argument are illustrated by Steier and Greenwood (2000), while Baum *et al*. (2000), present the benefits of the structural hole argument for start-ups. Regarding the spin-offs in this research, both arguments may work out in similar ways for start-ups in general.

RELATIONAL EMBEDDEDNESS

The other dimension of network configuration (embeddedness) is the relational dimension. The relational dimension refers to the dyadic characteristics of the relationship: the strength of tie. Strong ties require fairly frequent contact, are usually long-term, reciprocal, and involve a strong degree of trust and emotional closeness (Granovetter, 1992; Marsden and Campbell, 1984). People rely on strong ties for (personal) advice and support, and are less reserved about making heavy investments in this type of relationship.

The strong tie argument stresses that this type of relationship benefits the transfer of complex information (Hansen, 1999). Because people know each other quite well, they are more familiar with each other's interests, which make the transfer of the information less puzzling. Strong ties are reliable contacts that yield three benefits: trust, predictability and voice (Aldrich, 1999). The exchange with a strong tie entails less potential for opportunism and uncertainty compared to market-mediated transactions (Williamson, 1994). The trust in the relationship tells the entrepreneur who to count on in difficult situations and enhances the predictability of how the contact will behave if the situation changes. Furthermore, using voice in a relationship means that the persons involved will make their complaints known and negotiate, rather than suddenly leaving the arena (Hirschman, 1972; Aldrich, 1999).

On the other hand, weak ties are temporal, transient and normally involve little emotional investment. Communicating and exchanging ideas with people one does not meet very often and knows little about (i.e. weak ties) can provide new perspectives and give new arguments to discussions. According to the weak tie argument, such ties can provide novel information to the individual (Granovetter, 1974), and can be a source of opportunities and unique resources (Hansen, 1999). Consequently, spin-offs that have access to weak ties can choose whether to develop opportunities, while spin-offs without weak ties do not have access to these opportunities and consequently do not have that choice.

To summarise, the 'strength of tie' argument, a strong tie may constrain the search for novel information, whereas a weak tie may hamper the transfer of complex knowledge and reliable resources. Studies into the role of the relational aspects on the performance of new firms have not been conclusive. Several studies have stressed that linkages with strong ties are more advantageous to the early growth of firms (Gulati, 1995; Larson, 1992), while others argue for the importance of weak ties (Aldrich *et al*., 1996; Mitsuhashi, 2003). The

ambiguous outcome of the strength of ties may also explain why some studies have not been conclusive (Batjargal, 2003). Moreover, other studies have discussed the relational dimension not in terms of strength of tie but in proxies such as specific linkages: partnerships- and sponsorship-based (Lee *et al*., 2001), or direct and indirect ties (Shane and Stuart, 2002).

CONTENT OF THE TIE

Recent research on social capital has emphasised the importance of tie content (Adler and Kwon, 2002). Based on a review of social capital, Adler and Kwon (2002: 22-23) conclude that considerable disagreement remains as to the specific aspects of social networks that should be considered as social capital. They observe that studies in social capital are divided into two camps: those that solely emphasise the formal structure of the ties that make up the network, and those that also include a consideration of the content or quality of those ties. Although the structure of ties may produce important understanding of social capital, understanding the content of those relations cannot be ignored. Podolny and Baron (1997: 674) also stress that "*the network structure most conducive to organizational advancement depends significantly on the content of the social tie involved*". In an analysis of the interaction of network structure and content on the mobility of employees in high-tech firms, Podolny and Baron (1997: 673) found evidence that a large, sparse network of informal ties contributes to the acquisition of information and resources and enhances an individual's mobility. On the other hand, small and dense networks are for achieving well-defined performance expectations. Based on their findings, Podolny and Baron (1997: 690) claim that when applying the structural hole argument to organisational contexts, two additional dimensions should also be considered: first, to see whether the tie is principally a conduit of task-related information and resources; and second to decide whether the tie is primarily a link among positions, reflecting task interdependencies. Batjargal (2003) stresses that, to understand the role of both relational embeddedness and structural embeddedness, the content of the tie is important. Hansen (1999) addresses benefits to both the strong ties and weak ties for different types of business actions. To find new information, weak ties are important but strong ties are crucial for transferring complex information. Gulati and Higgins (2003) analysed the role of endorsement relationships with venture capitalists and strategic alliance partnerships, and found that the content of the tie could act as a contingent. Other studies have equally indicated that strong ties serve different purposes and require different sets of behaviour compared to weak ties (Rowley *et al*., 2000).

The content of the tie can be perceived as a contingent value of ties for interpersonal networks. The effectiveness of the network is not only dependent on the structural and relational dimension but also contextual factors (Provan and Milward, 1995). The contingency of the content of the relationship may reconcile the conflicting findings on research into social capital. These observations are particularly relevant to the study of the early growth of spin-offs. During early growth, spin-offs perform different entrepreneurial actions that force entrepreneurs to consider various forms of networks and strategic alliances to increase their efficiency and performance. As a result, employing the content of what is discussed with network contacts can provide valuable understanding of which

network structure or what type of relation is advantageous for particular goals during the entrepreneurial action.

SUMMARY

Discussion on the social capital theory shows that different arguments stress different structural and relational network configurations. Previous research has found evidence to support both arguments, which provides a puzzling picture of what is most conducive to the early growth of new firms. The ambiguous findings are an impetus for this study to find out the role of different network configurations in the early growth of academic spin-offs. Table 3.1 briefly recapitulates the arguments that explain the sources of social capital. The table assists in the formulation of hypotheses regarding the structural and relational embeddedness and the role of the content of the tie (see Chapter 4).

Table 3.1 Dimensions of social capital and corresponding benefits that may apply to spin-offs.

Dimension	Ends of the continuum	Benefits	Authors
Structural	Redundancy (closure argument)	Trust and enhanced communication Reputation Continuity of the linkage	Coleman, 1990; Hansen, 1999 Coleman, 1990 Steier and Greenwood, 2000
	Non-redundancy (structural hole argument)	Information and resources Time advantage Referrals	Baum *et al.*, 2000; Burt, 1992 Burt, 1992 Burt, 1992
Relational	Strong tie	Reliable contacts Transfer of complex knowledge	Aldrich, 1999 Hansen, 1999
	Weak tie	Opportunities and unique resources	Granovetter, 1973; Hansen, 1999
Contingent	Content of tie	Effectiveness of network structure or strength of tie depends on content of discussion and context	Provan and Milward, 1995 Podolny and Baron, 1997 Burt, 1997; Burt *et al.*, 2000 Gulati and Higgins, 2003 Rowley *et al.*, 2000

3.2.3 STRUCTURAL AND RELATIONAL EMBEDDEDNESS OF SPIN-OFFS

Social-network analysts have developed concepts that can be employed to explore the external network of the spin-off venture. The concepts and techniques in social-network analysis are focused on comprehending relations among social entities and the implications of these relations. In their book *Social Network Analysis*, Wasserman and Faust (1994) mention some fundamental concepts in social-network analysis. Based on their work, this study focuses on the following concepts of actor, relational tie, dyad, group, and relation. The actor is a discrete entity that can be an individual, an organisation or a collective group. The actor is called an ego when it is the focal actor in the network under study. The ties that link actors together, for example a friendship tie or kinship tie, are called relational ties. A relational tie establishes a linkage between two actors. The combination of a pair of actors and the relational tie is called a dyad. Dyadic analysis at the most basic level focuses on the properties of a two-way relationship between two actors. When several actors possess multiple relationships, this is referred to as a group. The power of network analysis lies in its ability to model the relationships among the actors in a network. Relations are then the collection of ties of a specific kind among members of a network.

In this study, the entrepreneur discusses the new business opportunity with other actors. The set of ties that exist between the focal entrepreneur and the network contacts define the relations. In terms of network analysis, the entrepreneur is the ego that operates in a network, which makes up the ego-network. The ego-network of the spin-off venture is then determined by its structural and relational embeddedness. Structural embeddedness is the extent to which a "*dyad's mutual contacts are connected to one another*" (Granovetter, 1992), while relational embeddedness describes the quality and depth of a single tie (Granovetter, 1992). In other words, structural embeddedness is a conduit for diffusing values and norms, which enhance coordination among the network participants, while relational embeddedness is a conduit for valuable information. Several concepts have been developed to describe the extent of structural and relational embeddedness.

STRUCTURAL EMBEDDEDNESS

The extent to which an ego is structurally embedded can be determined by the redundancy of the external network. Over the years, many researchers have developed different concepts to indicate the extent of redundancy in the external network of a firm. Concepts that are often used to measure redundancy in standard ego-networks are those such as network density, network heterogeneity, and the concept of the structural hole (see Table 3.2).

DENSITY

The density of the network conceptualises redundancy in terms of inter-connectedness among the contacts in the external network of the focal firm. When two contacts are connected to each other, they are redundant to the focal firm. The density conceptualises the proportion of contacts that are connected to each other in the external network. The contacts of an actor (ego) may be connected to each other as well. If contacts in an ego's network know each other well and have frequent contact, the network of ego is considered to be a dense network. High levels of density among contacts in networks allow them to readily enforce sanctions on divergent behaviour by individuals who violate shared beliefs, norms or values (Coleman, 1990). According to Burt (2000), density reflects redundancy among contacts. In his view, redundancy removes the opportunities for assessing and exploiting novel information.

HETEROGENEITY

In contrast to density, the heterogeneity of a network conceptualises redundancy in terms of certain relevant dimensions such as sex, age or occupation (Blau, 1977; Reagans and Zuckerman, 2001). This research perceives heterogeneity in terms of diversity in the background of the network contacts. Contacts can come, for instance, from an academic background or a business background. Contacts from different backgrounds are believed to bring with them different kinds of information. When the entrepreneur's network consists of contacts from diverse backgrounds, the network is more heterogeneous and the non-redundancy in the network increases.

STRUCTURAL HOLES

The concept of the structural holes indicates the number of contacts in the network that are not inter-connected with other contacts in the network. The structural hole concept claims that benefits of social capital result not only from diversity of information but also from brokerage opportunities created by the lack of connection between separate clusters in a social network (Burt, 1992). When entrepreneurs have control over structural holes, they have better access to information and enjoy comparative advantages in negotiating relationships. By occupying structural holes, entrepreneurs secure more favourable terms in the opportunities they choose to pursue (Gargiulo and Benassi, 2000).

Heterogeneity and density are different concepts because the redundancy of the network is based on inter-connectedness between contacts, while for heterogeneity the functional background of contacts is determinative. Furthermore, in low-density networks, contacts may not know each other but may come from a similar background, for instance the business environment, while in low heterogeneous networks contacts can all be co-workers. The structural hole concept is different from the density concept in that it indicates the number of non-connected contacts in the external network, while density reflects the average strength of connection in the external network. Figure 3.5 shows two networks, one with structural holes (Figure 3.5a) and the other with high levels of density (Figure 3.5b).

Figure 3.5a
A network with structural holes

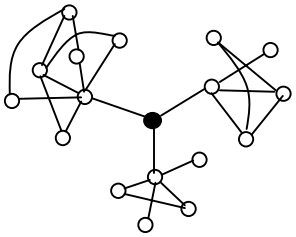


Figure 3.5b
A network with high levels of density

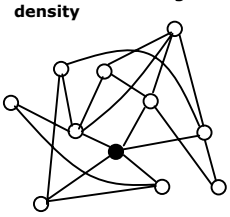


Table 3.2 provides an overview of previous studies that analysed the role of network structure on firm performance. The studies are categorised according to the closure and structural hole argument. The table presents an overview of equivocal findings regarding the role of redundancy. Several studies employed the closure argument to describe how firms can benefit from redundancy. In an ethnographic study, Larson (1992) analysed the innovation process in seven inter-firm alliances, finding that redundancy in the network of the firm increased coordination and collaboration. Also Uzzi (1999) found empirical evidence among 2226 firms in the US that redundancy in their network with banks and business partners helped entrepreneurs to receive loans. Furthermore, based on a longitudinal study of a start-up, Steier and Greenwood (2000) observed that redundancy lowers the risks from dependency on specific ties. If an actor withdraws from a relationship, for whatever reason, the redundant tie may secure access to a certain resource.

Others have found empirical evidence for the positive contribution of non-redundancy in an entrepreneur's network. In a study of 227 job shop manufacturers, McEvily and Zaheer (1999) measured non-redundancy in terms of density and showed that network non-redundancy aids the acquisition of capabilities. Several studies in high-tech firms found that

increased non-redundancy improved the performance and lowered the chances of failure (Baum *et al*., 2000; Powell *et al*., 1996; Rowley *et al*., 2000). Rowley *et al*. (2000) described non-redundancy in terms of external network density, while Baum *et al*. (2000) and Powell *et al*. (1996) discussed non-redundancy as the heterogeneity of contacts. From a sociological point of view, Renzulli *et al*. (2000) analysed the type of contacts in terms of family members or co-workers. Their study indicated that nascent entrepreneurs operating in heterogeneous discussion networks have access to a wider range of information that enables them to make the transition from idea to action. Rhee (2004) found among 230 employees in a high-tech firm that structural holes with updated ties were helpful to learning new practices. He referred to 'updated' ties as ties that are new or recently established. Bridging structural holes with 'old' ties did not show significant effects.

Table 3.2 Empirical arguments regarding structural embeddedness

Author(s)	Major findings	Network measure	Research characteristics
Closure Argument			
Larson, 1992	Redundancy aids the innovation process through high levels of coordination and collaboration	Density	Ethnographic, 7 inter-firm alliances
Uzzi, 1999	Redundancy increases the chances of being eligible for loans and financing	Density	Survey of 2226 US firms
Steier and Greenwood, 2000	Redundancy provides durable and secure access to resources	Density	Longitudinal, 1 firm case study
Structural Hole Argument			
McEvily and Zaheer, 1999	Non-redundancy benefits the acquisition of resources and capabilities	Density	227 job shop manufacturers
Rowley *et al.,* 2000	Non-redundancy is related to firm performance	Density	53 steel firms
Baum *et al*., 2000	Non-redundancy in terms of heterogeneity gives more performance	Heterogeneity	369 biotech start-ups
Powell *et al.*, 1996	Non-redundancy results in more resources and higher performance	Heterogeneity	Longitudinal, 40 biotech firms
Renzulli *et al*., 2000	Networks that span multiple domains provide multiple sources of information and enables the transition from idea to action	Heterogeneity	246 nascent entrepreneurs and business owners
Rhee, 2004	Structural holes from updated ties are advantageous to exploratory learning but structural holes with existing ties had no effect.	Structural holes	230 employees in a high-tech company

RELATIONAL EMBEDDEDNESS

Relational embeddedness describes the quality of a single relationship as a result of trust and reciprocity that is conveyed by the strength of tie. The strength of tie refers to the social proximity in a dyadic relationship (Granovetter, 1973; Marsden and Campbell, 1984). The strength of tie applies to every relationship in an ego's network. Regarding the spin-off network, the relationship with the parent organisation is special. Since the main business activity is derived from research undertaken by the parent organisation, the relationship between the spin-off and the parent organisation can be perceived as a 'very' strong tie. This research analyses the role of tie strength on the ego's network and a specific strong tie, which is the relationship between spin-off and parent organisation.

TIE STRENGTH

The strength of the tie is described in terms of strong and weak ties. Ties that entail trust, reciprocity and mutual confidence are referred to as strong ties, whereas weak ties are more casual and do not involve emotional closeness. Weak ties are typically of shorter duration or involve lower frequency. Although the measure was developed for the individual level, the usefulness of the measure inspired many scholars not only to apply the measure to ego-networks (Aldrich *et al*., 1996; Shane and Cable, 2002; Uzzi and Gillispie, 2002; Batjargal, 2003), but also at other levels of analysis. Table 3.3 shows some studies at an individual level, the intra-organisational level (Tsai and Ghoshal, 1998; Hansen, 1999), the firm level (Rowley *et al*., 2000; Elfring and Hulsink, 2003; Larson, 1992) and at the inter-organisational level (Shan *et al*., 1994; Gulati, 1995; Rindfleisch and Moorman, 2001; Mitsuhashi, 2003).

Aldrich *et al*. (1996) analysed the role of strong and weak ties to obtain business assistance between men and women. They distinguished strong and weak ties in terms of family acquaintances and strangers. Although men and women are equally active and successful in obtaining assistance, they found that friends and business partners (who they referred to as weak ties) were most often consulted. Based on a similar concept of strong and weak ties, Batjargal (2003) analysed the role of tie strength in networks of Russian entrepreneurs. Among 56 Russian entrepreneurs, he found that weak ties in the initial network increased their business performance. On the other hand, Shane and Cable (2002) found evidence favouring strong ties. They made a distinction in direct and indirect ties between 50 high-technology ventures and 202 seed stage investors. Direct ties were based on honesty and trust in the relationship, while indirect ties were more at arm's length. Their findings show that investors were more likely to invest in direct ties. Uzzi and Gillispie (2002) observed similar findings. When entrepreneurs were embedded with their bank, they could arrange financial benefits such as competitive loans and discounts more easily. Embeddedness with a bank is based on the duration of the relationship and the number of business and personal services used by the entrepreneur.

At the intra-firm level, Tsai and Ghoshal (1998) focused on the relationship between tie strength and resource exchange between business units in a large electronics firm. They found that extensive social interaction and high levels of trust between business units facilitated product innovation. Hansen (1999) also analysed the role of tie strength in knowledge sharing among business units. Hansen observed that strong and weak ties both have advantages. Weak inter-unit ties are beneficial in the search for useful knowledge but strong ties were needed to transfer the knowledge. When knowledge becomes more complex, strong ties in particular tend to be important.

Table 3.3 Empirical arguments regarding relational embeddedness

Level of analyses	Author	Strong tie argument	Weak tie argument	Strength measure based on …	Research characteristics
Individual	Aldrich *et al*., 1996	-	Friends and business partners help in resources	Family and acquaintances (strong/weak) + strangers.	217 business owners
	Shane and Cable, 2002	Investors are more likely to invest in direct ties	-	Direct ties as strong ties, indirect ties as weakties	50 high-tech and 202 seed investors
	Uzzi and Gillispie, 2002	Beneficially affects financial performance	-	Duration (years) and multiplexity.	Two samples: 1893 firms and 2422 firms
	Batjargal, 2003	-	Increases entrepreneurial firm performance	Friendship (strong ties) and acquaintances (weak ties)	56 Russian entrepreneurs
Intra-firm	Tsai and Ghoshal, 1998	Trust increased product innovation	-	Social interaction, trustworthiness	1 electronics firm, 15 business units
	Hansen, 1999	Transfer of complex knowledge	Recognising new knowledge	Ties measured by closeness and frequency	1 firm, 41 divisions and 120 projects
Firm	Larson, 1992	Reputable partner enhanced their reputation.	-	Closeness, cooperation, number of transactions	Ethnographic 7 high-growth starters
	Shan *et al*., 1994	Augments learning and innovative capabilities	-	Closeness and centrality	240 firms in biotechnology
	Rowley *et al*., 2000	Positive when exploitation is demanded	Positive when exploration is demanded	Alliances (strong) and at arm's length (weak)	53 steel firms, 45 semiconductor firms
	Elfring and Hulsink, 2003	Helps secure resources and gain legitimacy	Discovery of opportunities	Closeness, frequency and duration of relationship	Case study, 3 high-tech firms
Inter-firm	Gulati, 1995	Insight in firm's capabilities and reliability	-	Closeness, frequency and duration of relationship	166 publicly traded high-tech firms
	Rindfleisch and Moorman, 2001	increase acquisition and utilisation of information	-	Frequency, reciprocity and mutual closeness	106 US firms
	Mitsuhashi, 2003	Opportunity for successful alliance	Access to heterogeneous and new knowledge	Duration, frequency and dyadic performance	46 R&D alliances in 23 biopharm. firms

At the firm level, Rowley *et al*. (2000) analysed differences in network structure between the steel and semi-conductor industries. They observed that in industries with high levels of exploitation, such as the steel industry, partnerships were based on alliances, while in exploration industries (semi-conductor) cooperation at arm's length is more often present. Alliances were characterised by up-front resources and frequent interaction and cooperation at arm's length in joint ventures and smaller resource commitments. Elfing and Hulsink (2003) investigated the start-up process of three high-tech firms, demonstrating that weak ties are relevant to the discovery of opportunities, while strong ties are important to secure resources and gain legitimacy for a new venture. In an ethnographic study of seven high-growth firms, Larson (1992) analysed the role of a strong tie with a reputable partner and showed that the partnership gave the firm product quality benefits and enhanced their reputation. And among biotechnology 240 firms, Shan *et al*. (1994) found that strong collaborative ties augmented the learning and innovative capability of the firm.

The performance of the alliance itself was analysed at the inter-firm level. Networks that were characterised by long-term relationships and close cooperation assisted the establishment of alliances by providing valuable information to firms about the specific capabilities and reliabilities of potential partners (Gulati, 1995). Rindfleisch and Moorman (2001) analysed the role of tie strength on the acquisition and use of information. They asked vice presidents of R&D units to indicate the reciprocal services and mutual closeness between their firm and alliance partners. They observed that strong ties increased the acquisition and use of information in alliances. Finally, Mitsuhashi (2003) noted that strong ties among 46 alliances in biopharmaceutical firms created opportunity for building successful alliances but strong ties constrained them in their search for heterogeneous and new information.

Table 3.3 summarises the previous research in brief and shows that research in relational embeddedness has provided valuable insights into the type of relationship and its role in a firm's performance. Strong ties have proved beneficial in eliminating uncertainty in the acquisition of finance, the exploitation of activities and alliance performance. Weak ties on the other hand are crucial during initial entrepreneurial activities and in gaining access to new knowledge. In the end, both strong and weak ties can improve a firm's performance although in different ways.

PARENT ORGANISATION

The uniqueness of a spin-off firm is that it has emerged from another organisation. Academic spin-offs are based on a scientific finding that originated in a knowledge institution. In many academic spin-offs, the entrepreneur was a scientist in the knowledge institution. Furthermore, many knowledge institutions have equity in their spin-offs. As a result, spin-offs have, by definition, an inherent relationship with their parent organisation. Because of the long-standing relationship the parent organisation can be considered as being a strong tie. Strong ties can provide benefits in several ways and, as a strong tie, the parent organisation can help its spin-off to achieve early growth. To conceptualise the benefits from the relationship with the parent organisation, insight is taken from studies in business incubation, and small-large firm alliances.

Research on business incubators has mainly focused on the factors that help technology-

based firms in their early stages of existence. Ferguson and Olofsson (2004) state that clear evidence of exactly what and how firm development is being supported through a science park location is difficult to find. In their review they found few consistent benefits beyond a "*prestigious address*, *social signal or image effects*" for start-ups being located on science parks. But nevertheless they found among technology start-ups that those located on Swedish science parks had a better rate of survival than 'off-park' firms. In a benchmark report on business incubation, the Centre for Strategy & Evaluation Services (CSES, 2002) found that a location image benefit needs to be accompanied by four key incubator service areas. These key incubator service areas are 1) training of the entrepreneur; 2) business support; 3) financing; and 4) technological support. In addition to these findings, Aernoudt (2004) argues that business incubators should cooperate with business angel networks in order to stimulate high growth and gain help with handling financial difficulties. And Chan and Lau (2004) found that technology entrepreneurs are keen to get business advice in areas they do not know, such as marketing, and less so in areas they are experts in, such as product development. In addition, social networks can give entrepreneurial actors the necessary legitimacy, skills and resources needed when launching a new venture (Bøllingtoft and Ulhøi, 2004).

Another research stream focused on the alliance benefits for start-ups (Dyer and Singh, 1998). Alliances with partners provide opportunities for start-ups to learn new routines and acquire advanced technological and commercial know-how (Baum *et al*., 2000; Podolny, 1993). In particular, partnerships with firms that have a strong reputation in industry provided entrepreneurial firms with product-quality benefits as well as enhancing their own reputation (Larson, 1992). The involvement of a reputable rival increases the credibility of the new firm and raises the other external business partner's assessments of the start-up's quality and prospects (Stuart *et al*., 1999). Through affiliation with prominent actors, spin-offs can tap into their practical experience, and benefit from their contacts and reputation. Association with a reputable actor may enhance the attention paid to the new venture (Baum *et al*., 2000; Podolny, 1993; Stuart *et al*., 1999). It is important for spin-offs to benefit from their parent and any overlap there may be with their parent organisation (Sapienza *et al*., 2004). They need to conceptualise the benefits of links with a strong and reputable tie in terms of parent support (e.g. tangible and intangible resources) and relatedness with the parent.

PARENT SUPPORT

The parent organisation can be supportive through the transfer of explicit resources and implicit routines and legitimacy to the spin-off. To conceptualise parent support it is divided into tangible and intangible assets (Dierickx and Cool, 1989). Tangible support refers to all assets that can be physically observed, such as the provision of intellectual property rights, finance and accommodation, while intangible support is more oriented to the provision of contacts, expertise and coaching.

PARENT RELATEDNESS

The influence of the parent organisation as a specific strong tie is associated with the relatedness between the spin-off and the parent organisation. The extent that parent and spin-off are related influences the amount of support that the spin-off will receive. In

corporate venturing literature, the concept of relatedness is frequently discussed and defined as the extent to which a new venture and an established organisation have comparable activities, markets and strategies. In a study of industrial spin-offs, Sapienza *et al*. (2004) found that growth was maximised when the knowledge base partially overlapped with that of the parent. In other studies on corporate spin-offs, the role of relatedness was also found to improve venture performance. Sorrentino and Williams (1995) found that high levels of relatedness in combination with access to the parent's intangible assets provided corporate ventures of higher performance. Moreover, Thornhill and Amit (2000) indicate that relatedness combined with high levels of relational fit (commitment and awareness) benefits the performance of the corporate venture.

Table 3.4 Benefits from association with a prominent actor

Benefits	Author(s)	Major finding	Research characteristics
Support benefits (tangible/ intangible)	CSES, 2002	Value of support lies in training entrepreneurs, business advice, financial and technological support	Survey of 71 incubator managers in EU member states
	Ferguson and Olofsson, 2004	On-park starters report a greater image benefit and survival rate compared to off-park starters	Survey of 30 'on-park' and 36 'off-park' starters in Sweden
	Aernoudt, 2004	Incubators that cooperate with business angels networks are more beneficial to start-ups	Conceptual analysis
	Chan and Lau, 2004	Value of support lies in activities entrepreneurs have little experience in	Case study of 6 HT starters in Hong Kong
	Bøllingtoft and Ulhøi, 2004	Social networks in the business incubator allows entrepreneurs to share resources, skills and legitimacy in launching a new venture	One incubator with up to 70 tenants
Relatedness	Sorrentino and Williams, 1995	Performance increases when relatedness is supplemented with intangible assets	Survey of 88 corporate spin-offs
	Thornhill and Amit, 2000	Relatedness and relational fit between parent and spin-off increases venture performance	Survey of 97 Canadian corporate spin-offs
	Sapienza *et al.*, 2004	Partial overlap of the knowledge base between spin-off and parent maximises growth	Survey of 54 Finnish corporate spin-offs

TIE CONTENT

The content of the tie is a contingent value of the social network (Podolny and Baron, 1997; Provan and Milward, 1995). In the competition for growth, networks can facilitate entrepreneurs in three substantive areas: by providing conduits for resources and information, creating timing advantages and acting as a source of status and referral (Burt, 1992). Although it is important to aim at a network structure that is conducive to maximising these benefits, it is no less important to know who to consult. Regarding the early growth of spin-offs, this research focuses on entrepreneurial activities that are associated with these network benefits. When entrepreneurial activities are linked with network relations, the content of the tie and the types of structural and relational network embeddedness can be analysed. Consequently, more detailed understanding can be obtained about the type of embeddedness most conducive to a certain set of entrepreneurial activities.

Several authors have identified key entrepreneurial activities. In a study of 85 potential entrepreneurs, Gatewood *et al*. (1995) listed 29 activities involved in starting a business. These activities address the market, the operations and the organisation of the company. In

the spin-off venturing process, similar activities have been identified. In a study of spin-off starters, Elfring and Hulsink (2003) identified three benefits from 'network-oriented' entrepreneurial activities: 1) the discovery of opportunities; 2) the mobilising of resources; and 3) the securing of organisational legitimacy. Nicolaou and Birley (2003b) arrived at similar benefits from networks. They discuss how networks facilitate the opportunity identification process, the access of resources, timing advantages and the potential of referrals. Based on nine case studies, Vohora *et al*., (2004) identify four critical junctures that spin-offs must go through to progress to the next phase. The first is that of recognising the opportunity, the second juncture is showing commitment to transferring the idea to business, the third is that of gaining credibility to begin the business, and the fourth critical juncture refers to sustaining the business by commercial exploitation. Although these junctures do not directly refer to networks, they provide insight into the crucial entrepreneurial activities of spin-off starters. Based on these observations, a distinction of three types of activities is made: 1) the recognition of opportunities (the benefit of timing advantages); 2) access to resources (the benefit of conduit to resources); and 3) securing legitimacy (the benefit of using referrals).

Recognition of Opportunities

The source of entrepreneurial opportunities depends, in part, on the distribution of information in society (Kirzner, 1973). When people interact, they are exposed to new information that can inhibit potential opportunities (Granovetter, 1985). Consequently, a number of scholars have analysed the role of social networks in the identification process of entrepreneurial opportunities (Birley, 1985; Hills *et al*., 1997, Renzulli *et al*., 2000). Singh *et al*. (1999) found that the number of new business ideas identified and recognised was associated with the size and number of weak ties in an entrepreneur's social network. Although not specifically focusing on entrepreneurs, Burt (2004) found similar evidence that managers who were rich in structural holes were able to benefit from more 'good ideas'. Regarding spin-offs and technology-based starters, several studies have indicated that prior experience (Shane, 2000), social endowments (Shane and Stuart, 2002) and prior information (Fiet, 1996) are important in the discovery of opportunities. Hence, social networks are important for the evaluation and discussion of core ideas and business plans with various experts from the business environment, such as market experts, technology experts, financial experts, etc. (Aldrich *et al*., 1996, Aldrich, 1999). Social networks allow entrepreneurs to identify opportunities and provide timing benefits which enable them to capitalise on opportunities before others do (Uzzi, 1996).

Access to Resources

To seize business opportunities, new firms need to arrange certain resources economically but entrepreneurs rarely posses the resources required. Social networks can provide entrepreneurs with these necessary resources. Access to them is important to the early growth of the new venture. Not many new ventures have a strong financial position and paying the market price for resources is often too expensive. Entrepreneurs can, therefore, employ their network to acquire resources below market prices (Aldrich *et al*., 1986; Starr and MacMillan, 1990). The extensive alliance literature has stressed that alliance networks can play a vital role for firms in gaining access to resources (Nohria and Garcia-Pont, 1991; Hagedoorn and Schakenraad, 1992; Duysters and Vanhaverbeke, 1996; Gulati, 1998).

Larson (1992) analysed alliances between entrepreneurial firms and established firms, and found that firms engaged in relatively stable and sustained relationships characterised by multiple transactions and a high degree of cooperation and collaboration. Moreover, social networks can help start-ups to be eligible for attractive business loans (Uzzi, 1999). Contacts in a social network can act as conduits to specific resources that enable entrepreneurs to overcome their liability of smallness (Larson, 1992; Fichman and Levinthal, 1991)

Securing Legitimacy

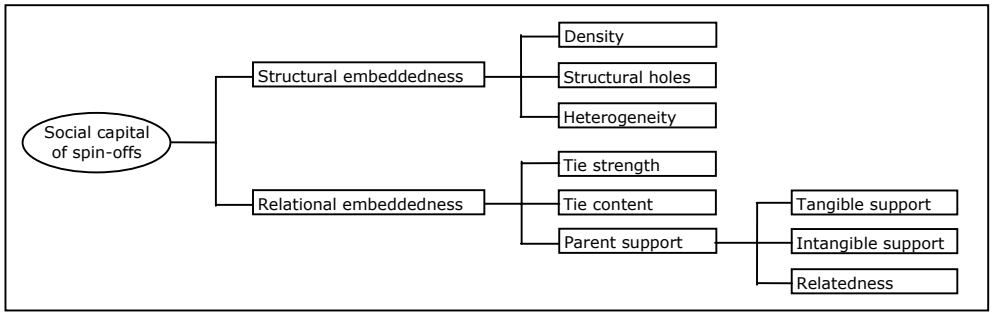
New firms lack a track record of customers, which makes it difficult for potential business partners to assess a new firm's credibility (Hannan and Freeman, 1984; Boeker, 1989). This liability of newness (Brüderl and Schussler, 1990; Fichman and Levinthal, 1991) is nourished by uncertainty regarding the quality of the new firm's products or services and its organisational stability that consequently results in a lack of social approval. Again, alliance literature postulates that partnerships with prominent organisations provide access to external legitimacy and status (Baum and Oliver, 1991; Miner *et al*., 1990). Several studies have found evidence that social networks can increase perceptions of credibility and the viability of entrepreneurial firms. Stuart *et al*., (1999) found evidence that inter-organisational endorsement increases the performance of entrepreneurial ventures. Furthermore, Sorenson and Stuart (2001) found that venture capitalists were more inclined to invest in start-ups they knew or were referred to by trusted business partners. Shane and Cable (2002) provide similar findings: seed stage investors are more willing to invest in entrepreneurs they know (direct ties) because they have fewer difficulties in overcoming the information asymmetry. In other words, social networks are important to assess the spin-off venture by providing potential flows of referrals among actors (Burt, 1992). The involvement and presence of a reputable organisation in the spin-off network can provide it with favourable signals about its credibility and viability (Baum and Oliver, 1991; Miner *et al*., 1990; Stuart *et al*., 1999).

Interaction between social networks and the content of ties can help an entrepreneur to understand what network structure and type of relationship is helpful in the mobilisation of certain resources. For academic spin-offs, this research analyses whether entrepreneurial activities regarding networks are important and subsequently links these activities to contacts.

3.2.4 SUB-FRAMEWORK OF THE SOCIAL CAPITAL THEORY

The role of social networks in the value creating process of entrepreneurial firms has been extensively discussed and analysed. The findings of these studies, however, are not conclusive. As far as relational and structural embeddedness go, scholars have found arguments that may seem contradictive. Consequently, they have postulated that the role and outcome of social networks is context dependent (Aldrich, 1999) and influenced by the contingency of the content of the tie (Podolny and Baron, 1997; Provan and Milward, 1995). To analyse the role of social networks in academic spin-off, this study has developed an integrative sub-framework based on the social capital theory. Figure 3.6 illustrates this sub-framework.

Figure 3.6 Sub-framework of concepts in the social capital theory relevant to spin-offs



3.3 THE RESOURCE-BASED VIEW

The previous chapter discussed how the social capital theory underlines the role of relationships. Relationships are, however, not sufficient for new firms to function, they need resources and capabilities to carry out their business activities. The role of these resources in the early growth of a firm is addressed by the resource-based view.

3.3.1 ORIGINS AND MAIN CONTRIBUTIONS

The resource-based view of a firm takes a broad view of the research into the importance of resources for the success and existence of the firm (Penrose, 1959; Wernerfelt, 1984; Barney, 1991). Penrose discussed the importance of resources but it was not until the work of Rumelt (1984) that a theory emerged. Rumelt stressed that, to survive firms need a strategy that answers the three following questions: 1) Are the objectives of the business strategy relevant? 2) Are the major policies and plans appropriate? 3) Do the results obtained confirm or refute the critical assumptions on which the strategy rests? To achieve growth, firms need strategies that are implementable, consistent and aligned to the requirements of the outside world. Two perspectives have emerged to rationalise the appropriate business strategy: the inside-out and the outside-in perspectives. According to the outside-in perspective, firms should identify attractive market opportunities with potential customers whose needs could be better satisfied than are currently being done by other firms. The firm's strategy should then be aimed at this market. The outside-in perspective is therefore also called the positioning approach (Mintzberg, 1990). The inside-out perspective emerged as a reaction to the outside-in perspective. The outside-in approach was criticised because if all firms identify the 'most attractive' niche, who will get it and why would competition not destroy its attraction? The inside-out perspective became known as the resource-based view. Barney (1991) explains that the resource-based view addresses two assumptions. First, firms within an industry (or group) may be heterogeneous with respect to the strategic resources they control, and second, these resources may not be perfectly mobile across firms, and thus heterogeneity can be long-lasting. Based on these two assumptions, the resource-based view stresses that not the external opportunities but a firm's own strengths should be the point of departure for strategy formation. The strengths of the firm are laid down in its difficult-to-imitate competencies and unique assets. Firms can achieve a sustained competitive advantage by implementing value-creating strategies that cannot be duplicated by others (Barney, 1991; Peteraf, 1993; Wernerfelt, 1984, 1995). The resource-based view focuses on the rents flowing to the owners of scarce firm-specific resources rather than the economic profits from product-market positioning (Teece *et al*., 1997).

The resource-based view has provided valuable insight as to how firms can compete more effectively. Having control over critical resources is essential if they are to maintain and strengthen their position. According to the resource-based view, it is important to identify and develop the key resources of an organisation. These deliver added value and a sustainable competitive advantage. Specialised skills, expert knowledge and novel technologies are resources that distinguish the organisation from its competitors. By bringing key resources together in business processes, an organisation may develop unique capabilities and, in turn, core competencies, if the capabilities are difficult to copy.

3.3.2 DEVELOPMENT OF THE THEORY

Initially the resource-based view stressed that a firm should control key resources that enable it to compete more effectively and efficiently than others. Some scholars (Prahalad and Hamel, 1990; Rumelt, 1984) claimed that having key resources was one thing, but to achieve excellence firms needed establish synergy advantages throughout the organisation that flowed from combining these resources (competence based view). Again, some scholars think that key resources to competencies are a leap too far (Stalk *et al*., 1992). Firms need to set up distinctive work processes that allow them to combine key resources and provide new ways to run their business. A firm's capabilities that are captured in work processes reflect the potential of a firm to benefit from its key resources (Teece *et al*., 1997). This section elaborates on the resources, competencies, and capabilities of the firm.

RESOURCES APPROACH

Resources can be described as the means by which an organisation runs its business. Resources are a subset of assets, which assets are defined as things, properties or qualities possessed by an individual or organisation. Resources are those assets that directly contribute to an organisation's business. Barney (1991: 101) defines resources as "*all the assets, capabilities, organisational processes, knowledge etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness*". Amit and Schoemaker (1993) are more specific and describe resources as assets that are externally available and transferable, owned and controlled by the firm and that can be converted to gain increased value. They make a distinction between resources and capabilities. In their view, capabilities are more information-based organisational processes and more firm-specific. Resources help and enable firms to create/produce valuable products and services for markets. Dierickx and Cool (1989) divide resources into two types: tangible and intangible resources. Tangible resources are, for example, machines, equipment and housing; intangible resources are carried within the members of the organisation, such as knowledge and skills, or are ascribed to the organisation, like reputation and image.

COMPETENCIES APPROACH

The resource approach describes the tangible and intangible resources in a firm. A combination of these resources allows for strategic forms of learning and knowledge management, which can improve the performance of firms. This view is demonstrated by the competence approach of the firm (Prahalad and Hamel, 1990) that focuses on intangibles like knowledge, technology, skills and synergy. Prahalad and Hamel (1990) define core competencies as combinations of technologies and production skills that underlie a company's myriad product lines. Sanchez *et al.* (1997) provide a broader definition of competencies: competence is the ability to sustain a coordinated deployment of assets and capabilities in a way that promises to help a firm to achieve its goals. According to Teece *et al*. (1997), competencies constitute the organisational routines and processes that are configured such in a way that distinctive activities can be performed. Moreover, competencies are addressed as *core competencies* when they refer to a firm's fundamental business (Teece *et al*., 1997). Core competencies span multiple competencies from research activities to services. In principle, core competencies are difficult to duplicate

by competitors. A firm possesses a sustained competitive advantage when competition is not able to implement a comparable strategy and thus cannot duplicate the benefits of the strategy. Moreover, competencies are built up over long periods of time before they emerge (Barney, 1995; Hitt and Ireland, 1985; Teece *et al*., 1997). Prahalad and Hamel (1990) stress that a firm's competitiveness is the result of its ability to build, at lower cost and more quickly than competitors, core competencies that spawn unanticipated products. Rumelt (1984) adds that collective learning and the acquisition of skills underlie a core competence. The competence perspective is a derivation of the resource-based view in the sense that it argues that firm's resources are laid down in knowledge or beliefs that can be used to 'cause' certain desired effects. The knowledge and its practice are the fundamental aspects of the skills and capabilities of an organisation (Prahalad and Hamel, 1994).

CAPABILITIES APPROACH

The capabilities approach links the individual resources and skills of a firm with its strategy. The capabilities view flows from the thinking of the resources approach, and emphasises that competitive advantage rests on distinctive processes (ways of coordinating and combining) that result from a firm's unique resources. Four basic principles justify the difference between resources- and capabilities-based competition (Stalk *et al*., 1992). 1) Not the products and markets but the business processes are a firm's building blocks; 2) processes should be transformed into capabilities; 3) capabilities are supported by investments in infrastructure; and 4) capabilities cross functions which subsequently makes the entrepreneur the champion. The capabilities view refers to routines that emerge from path-dependent processes (Nelson and Winter, 1982; Teece *et al.*, 1997). The unique history of a firm infers that the distinctive routines make the resource endowments 'sticky', and may benefit or handicap the firm (Teece *et al*., 1997).

The main concepts in this view are the speed with which a firm responds to changes, its consistency in production and services, its accuracy in assessing the competitive environment, and its innovativeness and agility to generate new ideas and adapt simultaneously to different environments. The capability view emphasises the key role of strategic management in appropriately configuring internal and external organisational resources to fit a firm's environment. Capabilities are specific and identifiable business functions such as product development, strategic decision-making, and alliances with partners (Eisenhardt and Martin, 2000). These processes are characterised as detailed, analytic and stable with predictable outcomes. The *dynamic* capabilities view extends the capabilities view with an understanding of how firms operate in environments of rapid technological change (Teece *et al*., 1997). Dynamic capability is defined as the ability of a firm to renew competencies and adapt or reconfigure its internal and external resources to match the requirements of a changing environment. Dynamic capabilities are more focussed on change than capabilities.

3.3.3 CONTRIBUTION TO THE EARLY GROWTH OF SPIN-OFFS

Regarding the resource-based view, two main mechanisms have been developed to explain the early growth of a firm: resource picking and capability building (Makadok, 2001). According to the *resource picking* mechanism, heterogeneity in a firm's performance is a

result of the ownership of resources that have differential productivity (Makadok, 2001). To generate a competitive advantage over rivals, a firm needs to control resources that are valuable and rare. If these resources cannot be inimitable and are non-substitutable, the firm can sustain its competitive advantage (Barney, 1991; Peteraf, 1993; Wernerfelt, 1984). Regarding spin-off firms, the resource picking mechanism stresses that the early growth of the spin-off is a result of the entrepreneur's ability to gather information and analyse it to outsmart the resource market. Scholars have criticised the resource mechanism for inadequately explaining how and why certain firms have a competitive advantage in changing environments (Grant, 1996; Eisenhardt and Martin, 2000; Priem and Butler, 2001a, 2001b; Zahra and Nielson, 2002). Especially in markets that change rapidly, high levels of competition require firms to adapt, integrate and reconfigure their resources (Teece *et al*., 1997). The resource mechanism by itself cannot explain how entrepreneurs can integrate resources into routines that create revenue-producing products and services. The capability-building mechanism extends the resource mechanism by explaining the ability of entrepreneurs to combine existing resources and develop new ones (Eisenhardt and Martin, 2000). The capability-building mechanism is therefore based on the dynamic capability approach and emphasises that not only the resources are crucial for rent-creation but also a firm's ability to build capabilities (Grant, 1996; Kogut, 1996).

Recent studies stress that the two mechanisms, resource picking and capability building, do not contradict but complement to each other. Possessing key resources might be essential but is not conditional for performance. To take advantage of these resources, a firm should develop dynamic capabilities. But then again, merely having dynamic capabilities does not lead to success if key resources are absent. In other words, key resources and capabilities interact with each other. Using a mathematical model, Makadok (2001) explains that an importance difference between resources and capabilities is timing. In the resources approach, the rent is created when resources are picked, while the capability approach argues that rent is created when the resource is deployed in a capability. Makadok (2001: 389) extends his argument by stressing that "… *capability-building only creates economic profit if a firm is successful at acquiring other resources on which the capability in question can exert its productivity-enhancing influence*". In other words, capabilities are only profitable if resources, whose productivity would be enhanced by the capabilities, are acquired. Furthermore, Hatch and Dyer (2004) argue that valuable and rare resources provide firms with the potential to develop learning capabilities that result in higher firm performance. They found that the selection, development and deployment of human capital can significantly improve the learning capability of a firm. In other words, control over key resources allows a firm to build competitive capabilities. Table 3.5 gives an overview of the arguments related to the resource-based view.

Table 3.5 Arguments of the resource-based view to explain firm growth

Theoretical mechanism	Value creating trough	Author
Resource picking	Possession of key resources	Barney, 1991 Wernerfelt, 1985
Capability building	Organisational resource configurations	Zahra and Nielsen, 2002 Eisenhardt and Martin, 2000
Interaction of resources and capabilities	Resources help build capabilities and vice versa	Makadok, 2001 Hatch and Dyer, 2004

The resource-based view explains how firms can utilise their resources and capabilities. It is widely recognised that new high-tech ventures in particular experience shortages of resources and capabilities. For their early growth and survival, these ventures pursue specific strategies that focus on the accumulation of resources (Lee *et al*., 2001). Academic spin-offs are endowed with specific resources and capabilities (Shane and Stuart, 2002) but these may not be sufficient to successfully transfer their idea to the market (Shane 2004). Especially for spin-offs operating in technological areas, it is important to develop innovation and technological capabilities to adapt their intellectual property to market demands (Grant, 1996; George *et al*., 2002). Furthermore, during start-up, spin-offs need to develop and apply entrepreneurial capabilities to overcome critical junctures and enter a new phase of growth (Vohora *et al*., 2004). Research has shown that prior experience is important to develop capabilities and overcome critical junctures. Regarding spin-offs, it has been indicated that prior knowledge is more important to the discovery of opportunities than special attributes in the entrepreneur (Shane, 2000).

3.3.4 RESOURCES AND CAPABILITIES OF ACADEMIC SPIN-OFFS

Previous studies in entrepreneurship assume the start-up firm as an extension of the founder or founding team (Brüderl *et al*., 1992; Brüderl and Preisendörfer, 2000; Chandler and Jansen, 1992; Lee *et al*., 2001). A study of initial public offerings suggests that founder influence may persist well into the life of a firm (Nelson, 2003). Hence, we conceptualise the resources and capabilities of a spin-off based on the attributes of its founder or founding team (Shane, 2004). Founding teams can tap into their prior experience, knowledge and expertise to run their spin-off. The prior experience of each team member adds to the diversity of views and skills, and can help to develop the new business. Furthermore, the diversity and combination of different experiences in the founding team reflects the spin-off's capabilities. Several studies have provided insight into the role of team experiences to explain their innovation capability, learning routines, entrepreneurial orientation and eventual firm performance. Studies of management teams in the upper echelons of large firms (Hambrick and Mason, 1984; Wiersema and Bantal, 1992; Kor, 2003) in entrepreneurial teams (Brüderl *et al*., 1992; Chandler and Hanks, 1994a; Westhead *et al*., 2001), and in spin-offs (Shane and Stuart, 2002; Corroleur *et al*., 2004; Vohora *et al*., 2004) will be used here to formulate the relevant resource-based concepts.

RESOURCES

Spin-offs are founded with little more than the technology that the company will exploit and the attributes of the founders who are setting up the company (Shane, 2004). In general, spin-offs lack a track record and cannot rely on customers or large budgets to gain access to and acquire initial resources. Also, the amount of seed money that venture capitalists will invest is, in part, determined by the human capital that the starters' team brings to the spin-off venture. Vohora *et al*. (2004: 165) stress that besides "...*intangible technological assets in the form of know-how and IP there was often very little else they had to demonstrate their credibility other than their own published scientific research*". Lee *et al*. (2001) provided evidence that finding initial financial capital was important to the early growth of a new venture. Although it is believed that larger amounts of financial capital invested in a new firm will lead to better performance, it is questionable how spin-offs can access

finance early. Previous research has shown that entrepreneurs with certain endowments are in a better position to get attractive loans (Shane and Cable, 2002). Some of these endowments are network related (Uzzi, 1999), while others are based on the previous experience and skills of the founder(s) (Baum and Silverman, 2004; Zacharakis and Meyer, 2000) or excellent business plans (Foo *et al*., 2005). The role of prior experience is demonstrated by several studies on opportunity identification in spin-offs (Shane, 2000; Murray, 2004; Corolleur *et al*., 2004). Spin-offs start with resources that members of the start-up team bring into the new firm. These resources are specific experiences that they have accumulated during earlier working relationships. Previous studies of new and entrepreneurial firms indicate that four types of prior experience are important to a new spin-off. These include management, research, industry, and starters' experience. Table 3.6 provides an overview of the important findings of previous research.

Prior Management Experience

Management concerns the organisation of business activities, such as marketing, logistics and finance. Managers negotiate resources and coordinate the deployment of these recourses. In doing so, they develop and maintain planning and budgeting systems to reduce the chances of failure and to increase eventual returns. Accordingly, management activities can be characterised as risk reduction and warrant the continuity of business. The importance of management activities is manifested by their role in converting a firm's resources into value-generating activities (Castanias and Helfat, 2001). Prior experience in management practice is present when the individual has collected knowledge of monitoring and controlling tasks before entering the new firm. In other words, prior management experience provides team members with knowledge on how to run a company. The importance of management experience is expressed in several studies of small firms. Firms that were founded by individuals with experience in managerial tasks concerning production and marketing activities were better at innovation and quality control (Chandler and Hanks, 1994b). Furthermore, management experience helped small firms to set up export activities (Westhead *et al*., 2001), and to acquire early growth (Duschenau and Gartner, 1990; Chandler and Jansen, 1992).

Prior Research Experience

Basically, spin-offs are founded on a technology that needs further adaptation to the market before it can be exploited commercially. Teams that have experience in the development of technologies find it easier to start a business (Shane, 2000, 2004). Experience is critical for the translation of research into a commercial product or service that serves customer needs, and especially when it concerns complex knowledge with tacit components, the translation requires common languages and frequent face-to-face interaction (von Hippel, 1994; Cohen and Levinthal, 1990). Moreover, the development trajectories that the spin-off must perform to translate the finding to commercial ends can be estimated more accurately. The importance of research experience is stressed by a number of studies. Scientists who are excellent in their field of research are in a better position to start a successful spin-off. Their success is in part due to knowing the academic environment (Murray, 2004), which allows them to access equipment and personnel more easily. Furthermore, the more experienced scientists run spin-offs that are more innovative, making the spin-off more valuable (Corolleur *et al*., 2004).

Table 3.6 Types of prior experience relevant to the growth of entrepreneurial firms

Author(s)	Major findings	Resource measures	Data source
Eisenhardt and Schoonhoven, 1990	Industry experience is linked with higher growth	Prior industry experience	Longitudinal, annual reports of semiconductor foundings
Duschenau and Gartner, 1990	Successful entrepreneurs attained prior start-up and managerial experience	Prior management experience Prior start-up experience	Interviews with 26 successful/ unsuccessful entrepreneurs
Brüderl *et al*., 1992	Schooling, work experience and industry-specific experience are most important	Prior functional experience Prior industry experience Prior start-up experience	Survey of 1849 business founders in Germany
Chandler and Jansen, 1992	Entrepreneurial, managerial and functional skills were positively associated with higher growth	Prior management experience Prior start-up experience Prior functional experience	Survey of 84 manufacturing firms and 50 service firms
Siegel *et al*., 1993	Industry experience was associated with high growth ventures	Prior industry experience	Survey of 1600 small and 105 large companies
Chandler and Hanks, 1994	Better resources lead to high-quality opportunities and high performance	Management experience	Survey of 155 small manufacturing firms
Chandler, 1996	Pre-ownership was positively related to venture performance when it concerned business similarity	Prior start-up experience Prior industry experience	Survey among service and manufacturing start-ups in US
Shane, 2000	Prior knowledge is more important to the discovery of opportunity than entrepreneurial attributes	Prior research experience	Case studies, interviews with 22 individuals in 8 MIT spin-offs
Westhead *et al*., 2001	Firms with management know-how and industry-specific knowledge are significantly more likely to be exporters	Prior management experience Prior industry experience	Survey of 116 small firms in the UK
Shane and Stuart, 2002	Spin-offs with industry experience in the team were more likely to go public	Prior industry experience	Survey of 134 MIT spin-offs (1980-1996)
Kor, 2003	Industry experience contributes to seizing new growth opportunities	Prior industry experience Prior management experience	Longitudinal, publicly held medical instrument firms
Vohora *et al*., 2004	Successful spin-offs were founded by scientists that are at the forefront of research in their field.	Prior research experience	Case studies of 9 *spin-offs* from 7 different UK universities
Corolleur *et al*., 2004	Experienced academics are best positioned to run radical innovations	Prior management-, research-, industry- and start-up experience	Survey of 132 founders in 62 French biotech *spin-offs*
Shepherd and DeTienne, 2005	Prior knowledge of the market increases the number of opportunities identified	Prior industry experience	Survey among 78 MBA students
Foo *et al*., 2005	Task-related diversity (half-time / full-time students) enhances team effectiveness	Prior work experience	Survey among 154 teams of students

Prior Industry Experience

Industry-specific experience involves the knowledge of competitive conditions and specific technologies in the industry the firm is competing in (Kor, 2003). Prior industry experience is the accumulated know-how of specific customers, suppliers or shareholders (Westhead *et al*., 2001). One that has experience in a certain industry knows the habits of that industry (Chandler, 1996; Fiet, 1996; Shane and Stuart, 2002). Such knowledge is important to understand the developments in technology, in competition, in regulations set by national and regional authorities and other industry conditions. Furthermore, the starters team

understands the influence of certain stakeholders and how to get along with them. Their industry-specific experience provides knowledge of how to serve markets and solve customer problems (Shane, 2000). Previous studies have indicated that industry experience allows entrepreneurs to identify emerging opportunities and position their new products and services accordingly (Shepard and DeTienne, 2005; Castanias and Helfat, 2001).

PRIOR START-UP EXPERIENCE

When founding a new venture, team members have to deal with issues that are typical for the start-up phase. For entrepreneurs it is important to be able to recognise a business opportunity. This ability increases when they have experienced how to think in options and not to be threatened by change and the unknown, (Erikson, 2002). Although recognising a potential business opportunity is one aspect, it is even more important to be able to seize a potential business opportunity. In seizing the business opportunity, the start-up team members must deal with the liabilities of newness and smallness that their start-up are subject to (Eisenhardt and Schoonhoven, 1990). To deal with he liability of newness, they need to understand how to overcome the critical junctures in the start-up process (Vohora *et al*., 2004). For spin-offs these activities involve the translation of idea to business, show entrepreneurial commitment, and gain credibility and ultimately sustainability (Vohora *et al*., 2004). Obviously, these activities are not immediately part of the scientists' experience but are often learned by experience (Lamont, 1972; MacMillan, 1986). Entrepreneurs that have experienced a start-up before are better able to predict the resources they will need and how to access them, which increases their chances of survival. Regarding the liability of newness, members of entrepreneurial teams need to learn to work together, build relationships and above all convince financiers, suppliers and potential customers of their credibility, even though a track record is absent. Furthermore, new firms may adjust their business plan several times, which requires flexibility and keeping administrative tasks simple so as not to slow down decision-making processes. The importance of star-up experience can be illustrated by an example of a new business idea. In a large firm, a new idea can be supported by 99 people and be abandoned after being rejected by just one superior, but in an entrepreneurial firm, the plan can be rejected 99 times but it can still go ahead if one crucial respondent approves. Teams with start-up experience will move on but teams that lack this experience will go back and rethink their business idea.

CAPABILITIES

Capabilities reflect a firm's ability to integrate, build and reconfigure resources to adapt to a rapidly changing environment (Teece *et al*., 1997). Start-ups that are in a better position to develop these capabilities have a competitive advantage in changing environments (Grant, 1996; Zahra, 1996; Zahra and Nielsen, 2002). In other words, the extent to which the start-up team can learn new methods and adapt their work relationships is important to the survival of the start-up firm. The ability to learn is a result of how team members interact and work together. Kor (2003) stresses that knowledge possessed by the founding team "*can be a crucial asset in the path-dependent development of the capabilities leading to new growth opportunities for the firm*" (Kor, 2003: 709). Previous studies on spin-offs have suggested that companies with multiple founders tend to perform better on a variety of performance measures than companies with a single founder (Roberts, 1991; Shane, 2003).

Multiple founders can have complementary experience and capabilities in various functional areas of the firm. Similar observations have also been made in research on management teams and R&D teams. R&D teams with diverse backgrounds have more different ideas which can affect their view on their current activities (Ancona and Caldwell, 1992a, 1992b; Reagans and Zuckerman, 2001).

ADVANTAGE OF DIVERSITY

Diversity among the members of a start-up team may facilitate learning and creativity and so increase their capability to adapt to a rapidly changing environment. A plethora of studies on the upper echelons of large companies suggests that demographic diversity in corporate teams results in a wider area of information sources, a greater variety of perspectives and creativity, and in innovative decision-making. A heterogeneous team brings diversity to a team's cognitive base. Team members gather information from a variety of sources and have diverse interpretations and perspectives. Members in such teams will be able and willing to challenge each other's viewpoints. In the process, heterogeneous teams come up with more diverse solutions, which stimulates effective group discussion and, in turn, results in high-quality decisions. Evidence is provided that diversity in top management teams leads to more changes in corporate strategy (Wiersema and Bantel, 1992; Boeker, 1997; Haleblian and Finkelstein, 1993) and more innovative organisations (Bantel and Jackson, 1989; Simons *et al*., 1999).

DISADVANTAGE OF DIVERSITY

However, team members with diverse backgrounds find it more difficult to communicate with each other than homogenous teams do (McCain *et al*., 1983). Homogeneous teams have higher perceptions of similarity and attraction to others. They share a common language with similar experiences, beliefs and values that enhances team communication. At high levels of diversity, communication will become increasingly strained and conflict-laden (Priem, 1990; McCain *et al*., 1983, Wiersema and Bantel, 1992). Research has shown that conflict is multidimensional with a cognitive and affective dimension (Pinkley, 1990; Jehn, 1994, 1995; Amason and Sapienza, 1997; Ensley *et al*., 2002). Cognitive conflict is task-oriented and results from differences in the views of team members. Affective conflict is individual-oriented and reflects the disputes and dissimilarities that may lead to distrust among team members and unwillingness to cooperate. Team members that suffer from affective conflict exchange little information and have little commitment for one another and their decisions. Hence, affective conflict decreases the effectiveness of the team and produces poor strategic decisions (Amason and Sapienza, 1997). If teams want to be effective they "*must encourage cognitive conflict by building diversity and by fostering confrontational interaction*" (Amason and Sapienza, 1997: 497), without undermining the harmony and commitment among the team members. When teams can keep the conflict task oriented, not only does decision quality improves but so does team member commitment and satisfaction.

ROLE OF COHESION

Team cohesion, the way team members work together, is an important characteristic of team demographics for solving the paradox of conflict (Amason, 1996; Knight *et al*., 1999). Team cohesion prevents team members from dysfunctionality, which arises from affective

conflict, while allowing them to discuss their cognitive conflicts. Cohesive teams exhibit higher levels of affinity and trust, and team members are more satisfied and keen to be part of such a team (O'Reilly *et al*., 1989). Cohesion differs from diversity in that it reflects how individuals work together whereas diversity reflects their demographic background. Cohesive teams are likely to be stable and characterised by long-term interpersonal relationships (Ensley *et al*., 2002). Cohesive teams are more likely to share tacit values. They will understand one another better and so do not need to discuss underlying assumptions and goals. As a result, cohesive teams work well together, are more flexible and can move quickly when considering multiple issues.

Table 3.7 provides an overview of previous studies that have analysed the role of team diversity and team cohesion. Research on team demography and performance shows some interesting findings. The diversity of top management teams, or the upper echelons, is discussed in concepts such as tenure, functional, and industry diversity. The general finding is that diversity in top management teams increases cognitive conflict and is positively related to team performance (Boeker, 1997; Amason and Sapienza, 1997). Diversity in teams, however, results in more difficult communication and may induce affective conflict that can hamper effective decision-making. This eventually decreases team performance (Pelled *et al*., 1999). Similar findings are suggested by research on R&D and project teams. Tenure and functional diversity have an important influence on the frequency of technical communication (Zenger and Lawrence, 1989) and team productivity (Ancona and Caldwell, 1992a; Reagens and Zuckerman, 2001). Hence, the innovation capability increases with the diversity of teams. Functional and industry diversity equip firms with unique disciplinary skills and competencies in an area that may give advantage in research productivity (Henderson and Cockburn, 1994). Regarding research in entrepreneurial firms, scholars have focused on member diversity such as tenure, functional, and industry to predict a firm's performance (Ensley *et al*., 2002). Teams that have worked together before are found to be more cohesive (Ucbasaran *et al*., 2003) and this benefits the growth of sales (Smith *et al*., 1994). Following suggestions in previous studies, this research examines the capabilities of spin-offs in terms of a team's tenure diversity, functional diversity, industry diversity and team cohesion. The next section explains these concepts in more detail.

TENURE DIVERSITY

Tenure diversity describes the length of time that each member of a team has been associated with the team. Tenure diversity is believed to have an effect on how team members interact and communicate with each other (Zenger and Lawrence, 1989; O'Reilly *et al*., 1989). If team members join the team at different times, they are believed to have different views and understandings as to how the firm should operate. Teams with high levels of tenure diversity will discuss issues more often and question the status quo. Consequently, teams with high levels of tenure diversity are better equipped to come up with creative solutions and to adapt to environmental changes. Studies on the upper echelons have indicated that tenure diversity in teams stimulates more action (Hambrick *et al*., 1996) and strategic change (Boeker, 1997; Wiersema and Bantel, 1992). The role of tenure was not only found to be significant in a profit-making environment but also in academic research groups (McCain *et al*., 1983) and R&D teams (Ancona and Caldwell, 1992a; Reagens and Zuckerman, 2001). Regarding entrepreneurial firms, Ensley *et al*.

(2002) found positive effects of tenure diversity on venture growth. These observations in previous research indicate that tenure diversity is associated with innovation capability. We apply the concept of tenure diversity here to the spin-off firm. Although the differences in tenure among team members in start-ups are smaller, we believe that because of the rapid changes in roles and activities during the initial start-up phases, the concept is useful in assessing the early growth of spin-offs as well.

FUNCTIONAL DIVERSITY

Functional diversity captures experiences and skills relevant to the cognitive tasks at work (Pellad, 1996). Members with distinct functional experiences may complement each other and are more effective in joint problem-solving. In upper echelon teams, members with different histories of functional experience are likely to differ in their attitudes, knowledge and perspectives (Hambrick and Mason, 1984). This may affect the way that team members interact. Functional diversity is found to be positively related to debate (Simons *et al*., 1999), and conflict among members that resulted in higher levels of innovation (Bantel and Jackson, 1989) and performance (Pelled *et al*., 1999). Among members of project teams, Pinto *et al*. (1993) found that cross-functional teams are vital to the implementation of projects. And in entrepreneurial teams, functional diversity improves initial growth (Roure and Madique, 1986; Ucbasaran *et al*., 2003).

INDUSTRY DIVERSITY

Industry diversity reflects the variety of industries in which each member of the team has worked before joining the team. As explained in Section 3.3.4, industry experience is important to understanding the habits of that specific industry (Chandler, 1996; Fiet, 1996) and developments in technology (Shane and Stuart, 2002). Industry experience may encourage the identification of emerging opportunities (Shepard and DeTienne, 2005; Castanias and Helfat, 2001). Teams that have a diverse set of industry experiences may benefit from the fact that more opportunities in different industries are available to them. Especially in research on entrepreneurial firms, diversity in industry among team members is found to positively effect a firm's growth (Roure and Madique, 1986).

TEAM COHESION

Team cohesion describes how well team members work together. Cohesion differs from diversity in that diversity is based on demographic differences, while cohesion is based on the perception of the individual's sense of belonging to a particular group and feelings of morale associated with membership of that group (Bollen and Hoyle, 1990). Ensley *et al*. (2002: 368) state that "*cohesive teams are likely to have stable and solid foundation of interpersonal relationships that allows them to interact in a flexible and efficient manner*". Teams that are cohesive share similar understandings and values, and especially when these are tacit, they are quicker at considering multiple issues since they do not need to go through the underlying assumptions and goals (Ensley *et al*., 2002). Although team members may show demographic diversity, the role of team cohesion is to keep them as a group.

Table 3.7 Types of diversity relevant to the growth of (entrepreneurial) firms

Author(s)	Major findings	Diversity measures	Data source
Upper echelons			
Bantel and Jackson, 1989	Functional diversity leads to more innovative banks	Tenure and functional diversity	Survey, 199 state and national banks in the USA
Hambrick *et al*., 1996	Heterogeneous teams take more action but are slower in their responses	Tenure and functional diversity	Trade publications of 32 TMTs[8] of US airliners
Wiersema and Bantel, 1992	Teams with higher tenure diversity undertake more strategic change	Tenure diversity	Survey of 100 Fortune-500 firms
Boeker, 1997	Tenure diversity is associated with strategic changes especially under poor conditions	Team tenure and tenure diversity	Longitudinal data of TMTs of 67 semiconductor firms
Keck, 1997	Functional diversity positively relates to performance in stable environments while tenure diversity to changing environments	Tenure and functional diversity	Financial publications of 56 cement firms (1919-1984) and 18 computer firms (1968-1980)
Amason and Sapienza, 1997	Team openness resulted in higher cognitive conflict and when team mutuality was high the affective conflict was lower	Tenure diversity, team openness and team mutuality	Survey, 48 teams of food-processing firms
Knight *et al*., 1999	Diversity is negatively related to team consensus. Group processes have a positive mediating effect on consensus	Tenure, function, age and education, personal conflict & agreement seeking	Interviews of TMTs of 53 high-tech firms in US and Ireland
Simons *et al*., 1999	Functional diversity interacted with debate at the level of performance	Tenure and functional diversity	Interviews TMT, 57 manufacturing companies
Pelled *et al*., 1999	Functional diversity increases task conflict that results in performance; other diversities drive emotional conflict	Tenure, functional, race age diversity, Emotional and task conflict	Survey, 45 teams in three major electronic firms
R&D or project teams			
O'Reilly *et al*., 1989	Group members that are more distant are more likely to leave	Heterogeneity, social integration and turnover.	Survey, 20 groups and total of 79 respondents
Zenger and Lawrence, 1989	Age and tenure diversity influence the frequency of technical communication	Age & tenure diversity, in- and outside communication	Survey, 1 organisation, 19 projects: 88 respondents
Tsui *et al*., 1992	Tenure diversity is related to lower commitment and intent to stay	Tenure diversity	Survey, 3 organisations, 151 groups: 1705 respondents
McCain *et al*., 1992	Teams that are dominant or have gaps in tenure have higher employee turnover	Tenure diversity, member entry and exit.	Survey, 32 departments in state universities
Ancona and Caldwell, 1992a	Organisational tenure diversity results in higher team productivity	Tenure diversity	Survey, 409 individuals in 45 new product teams, 5 firms
Pinto *et al*., 1993	Cross-functional teams are vital to the implementation of projects	Functional diversity	Survey, 62 hospitals, 274 project team members
Reagans and Zuckerman, 2001	Organisational tenure diversity results in higher team productivity	Tenure diversity	Survey, 224 corporate R&D teams
Entrepreneurial firms			
Roure and Madique, 1986	Functional and industry experience plus working together before relates to growth.	Functional and industry experience, and cohesion	Longitudinal study of 8 VC-backed high-tech firms
Smith *et al*., 1994	Cohesion in teams is directly related to ROI and sales growth, demography is related to cohesion	Tenure, social integration, heterogeneity, informal & frequency of communication	Survey, 53 high-tech firms, total of 230 respondents
Ensley *et al*., 2002	Team cohesion is positively related to venture growth	Team cohesion, cognitive and affective conflict	Survey of 70 new ventures
Ucbasaran *et al*., 2003	Functional heterogeneity weakly associated with member entry; heterogeneous prior entrepreneurial	Functional and prior entrepreneurial diversity, member entry and exit	Interviews, Principal owner of 92 firms

[8] TMT is the abbreviation for the Top Management Team. The top management team is "*often identified using the measurement heuristic of senior hierarchical level, as indicated by title or position*" (Carpenter *et al*., 2004: 753). The individuals in the top management team are expected to influence the strategic decisions of the firm.

	experience positive to exit		

ENTREPRENEURIAL ORIENTATION

Entrepreneurial orientation reflects entrepreneurial attitudes (Stevenson and Gumpert, 1985). Much research has focused on individual levels of entrepreneurial attitude in terms of risk propensity (Simon *et al*., 2000), persistency and self-efficacy (Bandura, 1997). This research attempts to determine entrepreneurial orientation at firm level. Miller (1983) emphasised not only the individual characteristics of entrepreneurial orientation but also the characteristics at firm level, thereby focussing the issue not primarily on the "who" of entrepreneurship but more on the "process". Miller described the firm-level entrepreneurial orientation as a combination of innovativeness, proactiveness and risk-taking. Innovativeness reflects a firm's novelty and creative processes, and proactiveness its posture of tracking and anticipating future needs that may emerge in the market. Risk-taking is thus the willingness to commit resources to projects where the outcome is uncertain. The combination of the three creates a competitive advantage in emerging markets. Organisations with high levels of entrepreneurial orientation are more apt to identify and exploit opportunities (Wiklund and Shepherd, 2003). Numerous studies have provided empirical evidence of the role of entrepreneurial orientation on firm performance (Covin and Slevin, 1989; Zahra and Covin, 1995; Lee *et al*., 2001; Wiklund and Shepherd, 2003) (see Table 3.8). Another approach to entrepreneurial orientation is Stevenson's opportunity-based entrepreneurship (Stevenson and Gumpert, 1985).

Table 3.8 Studies on entrepreneurial orientation (EO)

Author(s)	Major findings	EO measure	Data source
Stevenson and Gumpert, 1985	Entrepreneurial organisations encourage individual's imagination, flexibility and willingness to accept risks	Strategic orientation, commitment to seize opportunities and resources, control of resources and management structure	Conceptual
Covin and Slevin, 1989	Entrepreneurial orientation, organic structure and long-term orientation related positively to performance	Frequent and extensive innovation, competition orientation and risk propensity	Survey, 161 small manufacturing firms
Zahra and Covin, 1995	Corporate entrepreneurship is associated with better performance among firms that operate in hostile environments.	Risk-taking, innovativeness and aggressive competitive action	Survey, 3 samples of 24 manufacturing firms, 39 chemical firms and 45 large industries
Lee *et al*., 2001	EO has a weak effect on performance, while technological capabilities and financial resources are stronger	Innovativeness, risk-taking and proactiveness	Survey, 137 Korean technological start-ups
Wiklund and Shepherd, 2003	EO enhances the knowledge-based resources and thus affects the firm performance	Frequent and extensive innovation, competition orientation and risk propensity	Survey, 384 Swedish small and medium sized firms

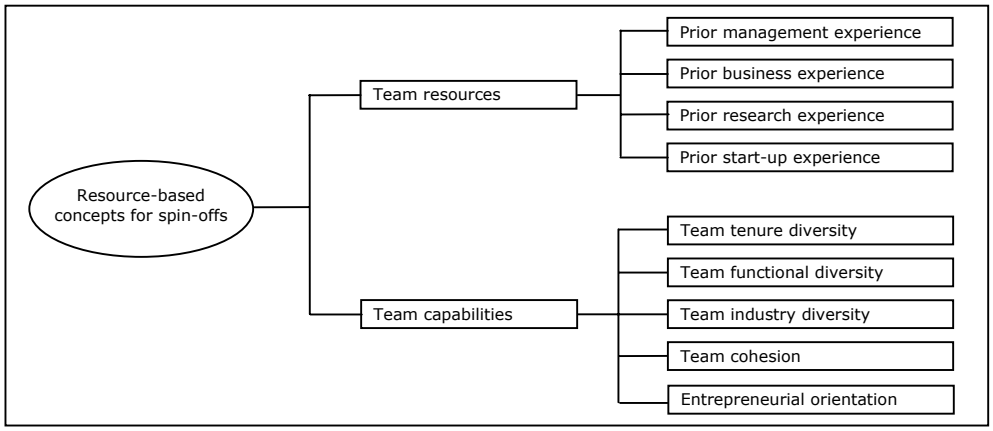
To sharpen the contrast between entrepreneurial and less-entrepreneurial firms, Stevenson and Gumpert (1985) made a distinction in entrepreneurial and managerial behaviour. They discussed entrepreneurial orientation of organisations in terms of an entrepreneurial focus versus an administrative focus. Firms with an entrepreneurial focus are more driven by perceptions of opportunity, are committed to seizing the opportunity and are less worried about the resources they control. On the other hand, teams with an administrative focus first

list the resources they control and then negotiate their strategic course and plan coordinate their existing resource base and reduce risks. Based on the distinction between entrepreneurial and managerial behaviour, this study adopts the definition of entrepreneurship by Stevenson, Roberts and Grousbeck (1989): "*Entrepreneurship is a process, by which individuals – either on their own or inside organisations – pursue opportunities without regard of the resources they currently control*".

3.3.5 INTEGRATIVE SUB-FRAMEWORK OF RESOURCE-BASED VIEW

Section 3.3 has discussed the resource-based view and drew up several concepts that can be used to assess spin-off resources and capabilities. These concepts are prior experiences, diversity, cohesion and the entrepreneurial orientation of the start-up team. Their prior experience affects the resources that team members bring to a spin-off. The capabilities of the firm must develop over time but are dependent on the diversity of team members and how well they work together (team cohesion). Regarding team diversity, the concepts of tenure, functional and industry diversity have been used. Moreover, the entrepreneurial orientation and cohesion that team members exhibit affect the entrepreneurial activity of the team. Figure 3.7 illustrates the concepts of the resource-based view that are relevant to a spin-off.

Figure 3.7 Sub-framework of concepts in the resource-based view relevant to spin-offs



3.4 PERFORMANCE OF SPIN-OFFS

The performance of new firms is often difficult to assess. Various studies have developed performance indicators but their definitions and evaluations are numerous and only a few are widely accepted. Performance indicators such as financial performance and employee growth are difficult to assess because small firms are not obliged to make their performance indicators public. Furthermore, the short history of start-ups makes the indicators difficult to evaluate (Brush and Vanderwerf, 1992). The evaluation of spin-off performance is complicated because of different start-up conditions. While some spin-offs start from scratch, others are performing activities that were previously done by the parent organisation. Moreover, during the initial years, performance changes as the spin-off develops. Besides factors that can be explained by either the resource-based view or the social capital theory, other factors as well are also relevant to an understanding of the early growth of spin-offs. These other factors are often referred to as contingencies and are factors such as the degree of exploration in the spin-off activity and the level of capital investment needed to start up. This section discusses the performance measures appropriate for evaluating early spin-off growth and the contingencies associated with such growth.

3.4.1 PERFORMANCE MEASURES

In general, the performance of start-ups can be assessed using objective and/or subjective measures. Objective measures are hard data about the success of the new firm, such as traditional growth-rate measures. Subjective measures are "softer" and express the success of the new firm based on the perceptions of individuals. Objective measures show difficulties in terms of their cross-comparison, sensitivity and completeness (Covin and Slevin, 1990). The cross-comparison of standard growth measures among multiple new ventures is often blurred. New ventures may have a variety of growth objectives (Cooper, 1996), which makes the interpretation of data difficult. Furthermore, the growth measures of small and new firms are very sensitive to the smallness of the new venture and relatively large changes in growth. In new firms, the percentile growth-rate difference can be enormous, for instance if the firm grows from 1 to 4 persons compared to a firm that increases from 10 to 14 persons. Absolute growth rates are then preferred (Baum *et al*., 2000). Objective measures also encounter difficulties regarding their completeness, for example depending on the respondent's willingness to provide financial or employee data. Small ventures are not obliged to publish their financial position. Another objective measure that is often used in early firm growth is the survival rate, indicating the number of firms that still exist after a specific number of years. One problem with this measure is getting information about the firms that have ceased to exist. The reasons for stopping can be different, perhaps due to failure or maybe to selling out to a competitor.

Subjective measures, on the other hand, reflect the opinion of the respondent to operational activities, such as satisfaction with the progress of technological development, or with a counterpart (Bensaou and Venkatraman, 1995; Mohr and Spekman, 1994). These subjective measures have potential limitations as well. Relatively small issues that occur when the respondent fills out a questionnaire may influence the respondent's opinion on a subjective measure and consequently affect its validity and reliability. For example, satisfaction about a business relationship could have been harmed due to shipment problems over the last

week. Also stagnation in technological progress may be influenced by sudden setbacks. Levels of satisfaction are associated with *a priori* expectations. Subsequently, low satisfaction levels may result from high expectations before starting a technological development or due to some miscalculated time frame.

Based on the observations of performance measures in start-up firms and especially in spin-off start-ups, this study applies the early growth measure in terms of change in full-time employees within two years as the main indicator for spin-off success. This growth measure is generally used to differentiate between successful and less successful start-ups (Baum *et al*., 2000).

3.4.2 CONTINGENCIES TO EARLY SPIN-OFF GROWTH

The early growth rate of a spin-off is also determined by the extent to which some contingent factors apply to the spin-off. Contingent factors that are applicable to the early growth of spin-offs are the degree of exploration and the level of capital investment needed.

DEGREE OF EXPLORATION

Sections 3.2 and 3.3 explained that the firm's network of social relations and the firm's resources and (dynamic) capabilities are crucial to carrying out tasks and adapting these tasks to uphold the competitive advantage of the firm. Especially in entrepreneurial environments, organisations must be able to cope with changes and complexity (Grant, 1996). How important these networks, resources and capabilities are depends on the degree of exploration that the spin-off aims for. The degree of exploration is dependent on the extent to which the firm applies new routines, targets new markets, and/or uses new technologies (McGrath, 2001). Explorative activities are vital for creating internal variety, and hence, to adapt to changing circumstances (March, 1991). McGrath (2001) stresses that the degree of exploration is a contingency to firm performance: how much new knowledge the firm needs to develop and how much existing relevant knowledge is available are critical issues here. Too many explorative activities may cause a firm never to capitalise on its discoveries and too few explorative capabilities may cause a firm to become outdated. If existing knowledge does not cover the complexity and changes in the environment, the organisation needs to gather enough new knowledge to make "long jumps" (Levinthal, 1997). As a result, the degree of exploration is a critical contingency for the amount of internal variety the organisation seeks (McGrath, 2001).

LEVEL OF CAPITAL INVESTMENT

Another contingent factor to the early growth of spin-offs is the level of capital investment that is needed. Many studies have indicated that financial resources are important in explaining the performance of a firm (Lee *et al*., 2001). Stated differently, firms that need high investments are more dependent on financial resources than firms that are in lower need of investment. If firms need high levels of investment but are not able to attract such investment they will eventually cease to exist. Investors such as venture capitalists and bank managers have to assess the spin-offs that approach them for funding. Their assessments are not only based on financial expertise but also technological risks (DeCoster and Butler, 2005). Technological risks increase with the degree of exploration. If more

research in technology or the market is needed, there will be higher risks associated with the spin-off. Furthermore, expensive equipment or long periods before revenues emerge may also require high levels of investment. For example, starters in biotechnology often face high investment requirements due to specific laboratory needs or the time necessary to register their products. Based on these findings, the level of capital investment is also contingent to the early growth of spin-offs.

3.5 CONCLUDING REMARKS

This chapter reflected on the theoretical understanding of spin-offs in high-technology industries. In this sector, companies face high levels of competition due to constant changes in the competitive landscape (D'Aveni, 1994). In order to gain early growth, spin-offs need to deploy their networks to find opportunities, gain access to resources and legitimise their actions. Furthermore, resources that are both valuable and scarce allow spin-offs to develop capabilities that are difficult to imitate and substitute. The understanding of how networks and resources interact and affect the early growth of spin-offs would provide an answer to the main research question, which is stated as follows:

What are the key success factors that affect the early growth of academic spin-offs?

This chapter has approached this main research question using two organisational theories: the social capital theory and the resource-based view. The theories have divergent views to explain the early growth of a firm. The social capital theory underscores the role of the network, while the resource-based view emphasises the firm's unique combination of resources and capabilities. In other words, instead of owning resources, the social capital theory argues that a unique configuration of relations determines the early growth of firms, while the resource-based view underscores the role of controlling unique resources. We are interested in the extent to which either theory can explain early spin-off growth. The first theoretical research question is then formulated:

To what extent can the social capital theory and the resource-based view explain the early growth of academic spin-offs?

Although the social capital theory stresses the role of networks, still there is controversy as to what network structure of relationships or what characteristics of relations are beneficial to the early growth of firms. Structural embeddedness refers to the network structure of relations, while relational embeddedness refers to the characteristics of relations. Regarding structural embeddedness, a redundant network is beneficial in that it provides trust (Coleman, 1990) and enhances communication (Hansen, 1999), thereby facilitating the effective sanctioning of opportunistic behaviour and rewarding high achievement (Coleman, 1990). Moreover, redundancy allows firms to build robustness in their network, if one contact disappears, access to the resource remains (Steier and Greenwood, 2000). The disadvantage of redundancy is that with each tie that connects the same kinds of people, the marginal value of each succeeding tie decreases. So, non-redundancy increases the network range: a wider circle of information on opportunities such as potential markets, investors and business ideas is available to the entrepreneur (Burt, 1992). Networks that are non-redundant provide access to more diverse information and resources not available to other firms that allow playing other contacts off against one another. Non-redundancy may

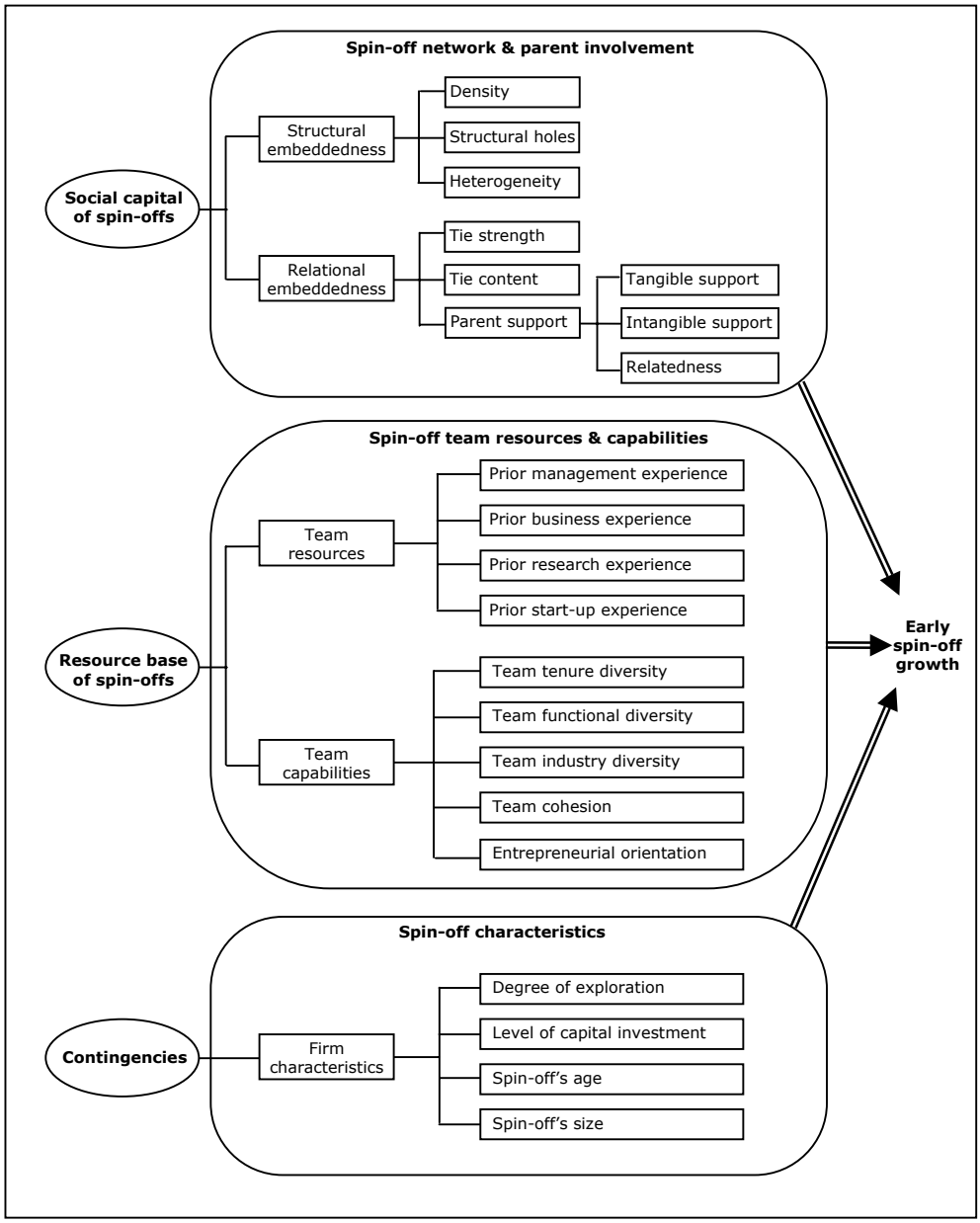
also provide timing advantages and early opportunities, and it can be used as referral beyond the network of the entrepreneur (Burt, 2004; Rhee, 2004).

Regarding relational embeddedness, there is disagreement over the relational characteristics of ties that help new firms to grow. Some authors stress that relational characteristics in terms of tie strength are relevant to answering whether specific ties are beneficial (Granovetter, 1973; Marsden and Campbell, 1984). Others emphasise that the importance of specific ties is determined by the content that these ties offer (Podolny and Baron, 1997; Provan and Milward, 1995). The strength of tie can be perceived in terms of strong and weak ties. Strong ties benefit the transfer of complex information (Hansen, 1999), and because people know each other quite well, strong ties are more reliable and involve less potential for opportunism and uncertainty compared to market-mediated transactions (Williamson, 1994). Furthermore, strong ties will use their voice in a relationship to make their complaints known and negotiate differences, rather than suddenly leaving the arena (Hirschman, 1972; Aldrich, 1999). On the other hand, weak ties are temporal, transient and normally involve little emotional investment. They tend to occur among a larger group of actors that link to others from different backgrounds (Hansen, 1999). As a result, weak ties can provide novel information to the individual (Granovetter, 1973), which can be a source of opportunities and unique resources. Communicating and exchanging ideas with people one does not often see and knows little about (e.g. weak ties) can provide new perspectives and give new arguments to discussions (Burt, 1992). Concerning the content of ties, several authors have indicated that the type of relationship that is beneficial depends on the activity involved (Podolny and Baron, 1997; Burt, 2004). Stated differently, strong ties may be advantageous to a certain set of activities, while weak ties are advantageous to a different set of activities. Consequently, the second theoretical research question was formulated as follows:

What types of social relations are beneficial and what types are detrimental to the early growth of academic spin-offs?

This chapter considered the social capital theory and the resource-based view in specific concepts that are relevant to understanding the early growth of spin-offs. Regarding the social capital theory, Section 3.2 discussed concepts that clarify structural embeddedness and concepts that clarify relational embeddedness. For structural embeddedness, these concepts are network density, structural holes and heterogeneity, and for relational embeddedness the concepts are tie strength and tie content. Regarding the resource-based view Section 3.3 discussed concepts that clarify the resources of the spin-off and concepts that clarify the capabilities of spin-offs. For the resources, these concepts are prior experience in management, business, research and starting a firm. For the capabilities, these concepts include the team's diversity in tenure, previous functions and the industries they worked in, and the team's cohesion and entrepreneurial orientation. Section 3.4 discussed the performance of spin-offs and factors that are contingent to the early growth of spin-offs. Figure 3.8 shows the integrative research model that is based on the conceptual model of Chapter 1 and flows from the theoretical discussions in this chapter.

Figure 3.8 Integrative framework to explain the early growth of spin-offs



CHAPTER 4 RESEARCH HYPOTHESES

This chapter translates the integrative model in the previous chapter into research hypotheses. The factors that are relevant to the explanation of early spin-off growth are presented in Figure 3.8 and are restated in hypotheses. The following sections deduce the hypotheses from the underlying principles of the social capital theory and the resource-based view. The theoretical arguments that are used to formulate the hypotheses are supplemented with findings from previous theoretical and empirical studies. Section 4.1 starts with a description of the hypotheses based on the social capital theory and Section 4.2 presents the hypotheses regarding the resource-based view. Section 4.3 concludes this chapter with an overview of the hypotheses.

4.1 HYPOTHESES REGARDING THE SOCIAL CAPITAL THEORY

To what extent can the combination of the social capital theory and the resource-based view explain the early growth of a spin-off? To answer this central question, this research starts with formulating hypotheses regarding the social capital theory. To start a new venture, entrepreneurs need new ideas and opportunities to build their new venture (Shane and Venkataraman, 2000). New venture ideas can arise in an individual's mind but often they originate from discussions with others (Aldrich and Zimmer, 1986). These persons may help the firm to overcome the liabilities of newness and smallness by actively helping or incidentally counselling entrepreneurs. This research focuses on the business discussion network of entrepreneurs (Renzulli *et al*. 2000; Marsden, 1987). Through this business discussion network entrepreneurs can evaluate and obtain information about their current activities and planned course of action. Previous research studies stress that the extent to which one gains access to new information is dependent on the structure of the business discussion network. Section 3.2.1 described the structural and relational embeddedness of networks (Gulati, 1998). The investigation of the role of structural and relational embeddedness showed two fields of tension that apply to entrepreneurial networks. First, entrepreneurs may find themselves in the duality between the urge for non-redundancy to find potentially profitable opportunities (Burt, 1992) and the urge for redundancy to legitimise their actions (Coleman, 1990). The second tension is regarding the type of contacts. Weak ties are important to get access to novel information but when this novel information is based on complex information strong ties are more appropriate to transfer that information (Hansen, 1999). The next section translates the field of tension regarding the structural and relational embeddedness into hypotheses.

4.1.1 STRUCTURAL EMBEDDEDNESS

Section 3.2.3 discussed three relevant concepts for structural embeddedness: the density, the number of structural holes, and the heterogeneity in the network. Hypotheses will be formulated for each of these concepts.

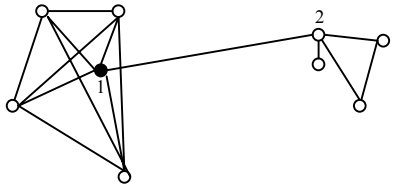
DENSITY VERSUS STRUCTURAL HOLES

The density of a network describes the redundancy among actors in the external network of the spin-off. Section 3.2.3 defined redundancy as the extent to which contacts in a focal firm's network are linked to one another. High density networks are characterised by *many ties* among alters in the network. According to Coleman (1988), a dense network promotes trust and cooperation among its members. The norms and behaviour of alters in the network are clearly visible and the mutual communication makes sanctioning effective and prevents opportunistic behaviour. Furthermore, mutual understanding and smooth flows of communication that are present in dense networks facilitate the articulation of complex knowledge (Hansen, 1999). In dense networks, firms interact closely, which aids the fine-tuning of activities and is thus more efficient and less costly. Moreover, dense networks are important for the continuity of the spin-off. Especially for start-ups, which are dependent on external ties for their resources, relationships that disintegrate, for whatever reason, may harm their chances of survival. Redundant contacts are then crucial to having continued access to certain resources (Steier and Greenwood, 2000). Spin-offs that operate in dense

networks favour a guiding frame of reference. They can evaluate cooperation with other business partners more easily (Walker *et al*., 1997) and are less vulnerable to the opportunistic behaviour of others (Coleman, 1988). Furthermore, redundant contacts can act as conduits for the flow of reputation. They can signal the credibility of the spin-off and thereby legitimise its actions, which leads to a positive perception by venture capitalists, potential customers and suppliers. Dense networks may therefore persuade venture capitalists and business partners to invest in the spin-off (Steier and Greenwood, 2000; Uzzi, 1999). The closure argument is often cited to refer to the benefits of redundant networks.

In contrast to the closure argument, the structural hole argument stresses another view on redundancy in the external network. Burt (1992) suggests that individuals who are embedded in sparsely connected networks will enjoy more diverse sets of resources and perspectives that will lead to more efficiency and brokerage advantages. According to Burt (1992), entrepreneurs can find potentially profitable opportunities through establishing ties between previously unlinked networks. By connecting two unlinked networks, the focal firm bridges two separate networks, or as in Burt's terminology, the tie spans a structural hole. Entrepreneurs who bridge structural holes can broker the flow of information between people and control projects by bringing people together from opposite sides of the hole. Figure 4.1 is taken from McEvily and Zaheer (1999) and illustrates this bridging tie. Actor 1 is the focal actor and operates in a nearly closed network (e.g. completely dense) except for its relationship with Actor 2. Through the tie between Actor 1 and 2, Actor 1 bridges its network with that of Actor 2. When the network of Actor 1 is more non-redundant, Actor 1 has access to more diverse networks and hence more diverse resources. In other words, sparse networks with few linkages among contacts, are important for discovering opportunities (Burt, 1992) and gaining access to resources (McEvily and Zaheer, 1999) before others do (Burt, 2004; Rhee 2004). Regarding the early growth of a spin-off, it is important for the articulation of the business idea that the entrepreneur identifies ideas and recognises opportunities. Spin-offs that have networks rich in structural holes may be filled with more new information and resources than firms that have fewer structural holes.

Figure 4.1 Bridging a structural hole (Source: McEvily and Zaheer, 1999)



The closure argument and the structural hole argument have divergent views on the role of redundancy in external networks on early spin-off growth. These views are formulated in two rivalling hypotheses, which we refer to as hypothesis 1a 'Coleman' and hypothesis 1c 'Burt':

Hypothesis 1a. (Coleman) The more dense the external network of the spin-off, the faster the spin-off's early growth will be.

Hypothesis 1a. *(Burt) The more structural holes there are in the external network of the spin-off, the faster the spin-off's early growth will be.*

HETEROGENEITY

In these hypotheses, redundancy in the external network of a spin-off network is described by the extent that alters are connected to each other. The basic view in both the closure and the structural hole arguments are that redundancy implies that alters have similar perceptions and information. But when contacts are not connected it does not necessarily mean they have different views, or other information. For instance, when contacts are active in similar environments, they may not know each other but can have identical perceptions about certain issues and the information they posses may be comparable, especially when it is job-related. Contacts that are active in similar environments are referred to as homogenous contacts: their demographic backgrounds are similar. In contrast to this, heterogeneous contacts come from different environments or places. Granovetter (1973) argued that contacts that come from different places have more variety in their perceptions and, therefore, give access to a wider range of information. Marsden (1987) has shown that diverse contacts integrate several spheres of society, which often facilitates instrumental action. Hence, heterogeneous networks increase the likelihood of obtaining non-redundant or diverse information for spin-off entrepreneurs who seek novel information to start their new business,. More diverse sets of information provide the spin-off with increased possibilities to choose from and this enables the spin-off to select the most promising business opportunity for faster growth. The hypothesis is then formulated as follows:

Hypothesis 1b. *The more heterogeneity there is in the external network of the spin-off, the faster the spin-off's early growth will be.*

4.1.2 RELATIONAL EMBEDDEDNESS

Relational embeddedness describes the dyadic relationship between the ego and a single alter. For the dyadic relationship, this research focuses on two specific characteristics of the tie: the tie strength and the tie content. Moreover, since spin-offs emerge from knowledge institutions, the role of this specific strong tie is discussed in depth. The parent organisation is viewed as a strong tie due to its long relationship with the spin-off and the relatedness of the spin-off's activities with the parent. The parent organisation as a strong tie, may help its spin-off in resources (tangible and intangible support) and can legitimise its actions. Hypotheses have been developed for both the tie strength and the parent organisation as a strong tie. Hypotheses have not been formulated for the tie content, since research on this concept is still in its infancy. Analysing the role of tie content is explorative in nature. Therefore, this part of relational embeddedness will be explored in the analysis of the external network of the spin-off in Chapter 6.

TIE STRENGTH

Tie strength indicates the emotional intensity, mutual confidence and reciprocal services that characterise a relationship (Granovetter, 1973). When two individuals are emotionally close to each other, their levels of trust, the duration of their relationship and their

willingness to provide reciprocal services are high. These types of relationships are referred to as strong ties. On the other hand, weak ties are more causal and involve low emotional closeness. Strong ties may involve two types of advantages. Strong ties are suitable relationships for exchanging complex knowledge (Hansen, 1999) and provide valuable information through the mechanisms of trust and reciprocity (Rowley *et al*., 2000). Strong ties can also affect the governing of the partnership (Larson, 1992). In a study among small entrepreneurial firms, Larson (1992) found that strong ties were important for developing inter-firm partnerships. Moreover, in research on the financing of entrepreneurial firms, Uzzi (1999) found evidence that strong ties were beneficial in getting attractive loans. And regarding university-based start-ups, Shane and Stuart (2002) suggest that when a new venture's founding team had an existing relationship with a venture capitalist that pre-dated when the spin-off was founded, the chances of failure were about 70% lower. Hence, spin-offs may enjoy increased growth rates due to attractive loans and reputated benefits. Stated more formally:

Hypothesis 1c. The more strong ties there are in the external network of the spin-off, the faster the spin-off's early growth will be.

The alternative hypothesis is that, instead of strong ties, weak ties are more important to early spin-off growth. Weak ties are essential to recognising novel information (Hansen, 1999) and identifying and exploiting opportunities (Aldrich *et al*., 1996). Relations based on weak ties are less bound by social expectations and obligations (Burt, 1992). Based on these findings, Batjargal (2003) found evidence in his study that weak ties were positively related to the revenue growth of Russian entrepreneurs. Consequently, the alternative hypothesis can be formulated as follows:

Hypothesis 1c. (Alternative) The more weak ties there are in the external network of the spin-off, the faster the spin-off's early growth will be.

4.1.3 THE PARENT AS A STRONG TIE

Strong ties may be crucial to promoting the spin-off's early performance. Spin-offs can have strong ties with a variety of organisations but the relationship with their parent organisation is among the most obvious. Spin-offs enjoy a close relationship with their parent organisation, or, more specifically with the research group they emerged from. This section discusses the role of the parent organisation as a strong tie in providing the spin-off with support and the role of relatedness between the parent organisation and its spin-off.

TANGIBLE AND INTANGIBLE SUPPORT BY THE PARENT

The close relationship between a spin-off and its parent organisation may provide opportunities for the spin-off in terms of cost reductions e.g. access to laboratory and expensive equipment (Kogut, 1988) and learning possibilities (Hansen, 1999; Pennings *et al*., 1994). In the literature on alliances it is found that the partner can directly provide information, knowledge and complementary resources for the start-up (Cohen and Levinthal, 1990; Hagedoorn, 1993; Hamel, Doz and Prahalad, 1989; Teece, 1987). Compared to incumbents, technological start-ups are less resource-rich firms that generally

seek technical, managerial and financial resources through alliances with established market firms (Hitt *et al*., 2000).

Parent organisations can provide the spin-off with both tangible and intangible support. Tangible support refers to the "touchable" assets, such as finance, licencees and patents, equipment and personal. Spin-off can make use of these types of tangible support below market price (Star and MacMillan, 1990) and, as a result, enjoy cost reductions (Kogut, 1988). Furthermore, a strong relationship with the parent organisation makes it easier to attract finance from either the parent organisation or others such as informal or "angel" investors (Steier and Greenwood, 2000). The linkage with the parent organisation can include the transfer of intellectual property or licences. Support from the parent organisation with intellectual property helps spin-offs to better understand the resources and capabilities they need, provide opportunities for learning and can improve the spin-off's new product-development cycle (Hsu and Bernstein, 1997).

Intangible support reflects guidance and advice by the parent organisation. The parent can relieve the spin-off of administrative and legal tasks and help it in focusing on its major activities (Allen and McCluskey, 1990). Furthermore, the parent can assist the spin-off in negotiations when setting up business contracts. Moreover, the technological expertise within the parent organisation can help spin-offs to translate their research findings into commercial products (Jensen *et al*., 2003; Murray, 2004). Consequently, if spin-offs receive support from their parent organisation, they can enjoy a competitive advantage (Flynn, 1991; Stuart *et al*., 1999).

The provision of tangible and intangible support by the parent organisation may alleviate the liabilities of smallness and newness that spin-offs face in their initial years. Consequently two hypotheses regarding the parent support can be formulated:

Hypothesis 1d. *The more tangible the support by the parent organisation the faster the spin-off's early growth will be.*

Hypothesis 1e. *The more intangible the support by the parent organisation the faster the spin-off's early growth will be.*

RELATEDNESS TO THE PARENT ORGANISATION

Various scholars have argued that if an actor's partner in a network enjoys considerable status, then the actor may derive legitimacy or status through affiliation with that actor (Baum *et al*., 2000; Podolny, 1994; Stuart *et al*., 1999). Regarding entrepreneurial firms, it has been observed that collaborative strategies with established firms can increase performance (Deeds and Hill, 1996; Powell *et al*., 1996; Yli-Renko *et al*., 2001). Alliances with prestigious firms were found to be more beneficial to new and small firms compared to alliances with less prestigious firms (Stuart 1998; Stuart *et al*., 1999). Also Baum and Oliver (1992) found that a tie with a legitimate institutional actor, such as a church or governmental entity, was beneficial to the survival of day-care centres. Previous research that analysed the effects of the parent involvement on spin-off performance did not explicitly mention the relatedness between parent and spin-off (Feeser and Willard, 1989; Pitts and Hopkins, 1982; Sykes, 1986; Woo *et al*., 1992).

Research on corporate spin-offs suggests that spin-offs can find endorsement from being related to a reputed and established organisation (Stuart, 2000; Higgins and Gulati, 2003). In general, relatedness is defined as the extent to which a new venture and an established business have comparable activities, markets or strategies. In their study, Sorrentino and Williams (1995) analysed the influence of relatedness on the performance of a new firm and concluded that the degree of relatedness does not explain, by itself, new firm performance, but in combination with the support of an established firm it increases a new firm's performance. Thornhill and Amit (2000) examined how the relatedness between a new firm and an established company could explain the new firm's success. Their argument was that a tight fit provides the new firm with access to the parent's resources and subsequently increases performance. This line of thought for corporate venturing can be adapted to spin-off venturing. Spin-offs that are closely related to their parent organisation are likely to make more use of the resources and support provided by the parent organisation. In addition to these resources and support, spin-offs that are closely related to the parent organisation are also likely to take advantage of the network contacts of the parent. Hite and Hesterly (2001) argue that new firms are embedded in their identity networks: the social network from which they draw their initial resources. For spin-offs, the identity network is the network of the parent organisation. Despite new firms' lack of a track record, their identity network may serve as a reference framework for the credibility of their business. In this way, the relatedness between spin-off and parent organisation may influence the early growth of the spin-off. We therefore state the following hypothesis[9].

Hypothesis 1f. *The more relatedness between the spin-off and its parent organisation, the faster the spin-off's early growth will be.*

4.2 HYPOTHESES REGARDING THE RESOURCE-BASED VIEW

The resource-based view emphasises the role of key resources and capabilities controlled by a firm to explain its early growth (Barney, 1991, 2001; Wernerfelt, 1984). By implementing value-creating strategies based on these resources and capabilities, firms can achieve a competitive advantage (Teece *et al*., 1997). Section 3.3.4 indicated that key resources and capabilities of a spin-off firm can be ascribed to the team's prior experience, diversity of experience and to the cohesion of the team and their entrepreneurial orientation. This section develops hypotheses regarding the role of resources and capabilities in the early growth of spin-offs. Analysing these hypotheses addresses the second part of the first theoretical research question. This first theoretical research question is stated as follows: *To what extent can the social capital theory and the resource-based view explain the early growth of academic spin-offs?*

[9] We also analysed the non-linear effect of relatedness and the interactions with the parent support variables on the early growth of academic spin-offs. In paragraph 6.3.2 we discuss the results in detail.

4.2.1 RESOURCES

Prior experience is the cognition one has accumulated through experience and skills from previous activities. Having prior experience in relevant knowledge and skills makes it easier to start a business since one can draw upon that prior expertise. According to Roberts (1991) and Shane (2000), many high-technology starters start their business with a technology and/or in a market that they are familiar with. Since spin-offs are founded with little more than the technology and expertise of their founders, this research focuses on the intangible resources, see Section 3.3.4. Four types of resources have been found to be important in the resource base of spin-off firms: management-, research-, industry- and start-up experience.

MANAGEMENT EXPERIENCE

Management experience refers to the methods of organising business activities, such as marketing and logistics. Previous studies on entrepreneurial firms have shown that management experience is an important factor in explaining a new firm's performance. Firms that are founded by individuals with management experience are better-suited to converting the firm's resources into value-generating activities (Castanias and Helfat, 2001). Also, various other scholars have found management experience as important to the development and management of the start-up (Chandler and Hanks, 1994; Chandler and Jansen, 1992). Westhead *et al*., (2001) indicate that management experience is important for firms to develop export channels. Their management experience helps them to set up contracts and undertake negotiations. Furthermore, spin-offs that are founded by entrepreneurs who have management know-how may be able to introduce better human-resource practices, carry out more effective administrative procedures, better control and monitor the work process and undertake more promising competitive-strategy tasks (Romanelli, 1989; Romanelli and Schoonhoven, 2001).

RESEARCH EXPERIENCE

Prior research experience among the founding team members is viewed as beneficial to the early start of the spin-off (Shane, 2000, 2004). Spin-offs are based on a technological finding that needs further adaptation to the market before it can be exploited commercially. Teams with members who have worked on the technology before have the advantage of experience and skills with the intellectual property. The experience is critical for translating and developing the knowledge into a commercial product or service. Especially when it concerns complex knowledge with tacit components, the translation requires a common language and frequent face-to-face interaction (von Hippel, 1994; Cohen and Levinthal, 1990). Recent studies have found evidence that successful spin-offs are founded by star scientists. The benefits result from the fact that star scientists operate at the forefront of their research field, are more embedded in scientific networks that provide better access to expertise, and engage in frequent collaboration (Murray, 2004). Vohora *et al*. (2004) observed among successful UK spin-offs that they were founded by academic inventors who had a strong position in their research field and have created valuable know-how. More experienced scientists are in the best position to conduct radical innovations, which are more risky but also highly valuable (Corolleur *et al*., 2004). Shane (2003) indicated that

scientists who created a spin-off in a field they are not experts in, encountered particular problems with obtaining strong intellectual property protection.

INDUSTRY EXPERIENCE

Another type of experience that is often mentioned as facilitating a start-up is prior knowledge of the industry. Industry experience makes it easier to adapt to the habits of that industry (Chandler, 1996; Fiet, 1996). Spin-off founders who have experience in the same industry in which the spin-off will operate, have the benefit of knowing the competitive conditions and specific technologies in the industry (Kor, 2003). Industry experience allows entrepreneurs to identify emerging opportunities and position new products and services accordingly (Castanias and Helfat, 2001; Kor, 2003). In a study of 78 MBA students, Shepherd and DeTienne (2005) observed that prior knowledge of the market was positively associated with the number of opportunities identified. And in a large survey of 1600 small firms and 105 large firms, Siegel, *et al*. (1993) found that substantial industry experience was important for both high- and low-growth ventures to be profitable. Industry experience also helps firms to find ways to export their products (Westhead *et al*., 2001) and to facilitate spin-offs in going public (Shane and Stuart, 2002). Hence, teams that possess substantial industry experience tend to perform above average.

START-UP EXPERIENCE.

The fourth type of experience that determines the early growth of new firms is the extent of start-up experience among its founders. Start-up experience refers to the knowledge related to a start-up firm. Start-ups need to overcome specific junctures before they become a fledging firm (Vohora *et al*., 2004). During the start-up process, the members of a team need to convince financiers, suppliers and customers of their abilities even though they lack a track record. Furthermore, the role and composition of the members in the team will change over time. Teams with experience in start-ups and growing firms will recognise that creating and building a new venture is a dynamic process and they will understand the context in which their emerging firm will operate (Cooper *et al*., 1994). Duschenau and Gartner (1990) found that successful start-ups could plan the growth of their start-up better if they had considerable start-up experience. Chandler (1996) found evidence that pre-ownership was positively related to venture performance, if the new business was connected to the experience gained in the entrepreneur's previous firm. Goslin (1987) found previous start-up experience to be the main characteristic of successful high-tech start-up firms. Hence, spin-offs that are founded by teams that include individuals with start-up experience are better-suited to the changes and difficulties that have to be overcome during the start-up process. The arguments above stress that the four types of prior experiences, namely management-, industry-, research-, and start-up experience, can affect the early growth of spin-offs:

Hypothesis 2a: *The more management experience there is among the members of the spin-off team, the faster the spin-off's early growth will be.*

Hypothesis 2b: *The more industry experience there is among the members of the spin-off team, the faster the spin-off's early growth will be.*

Hypothesis 2c: The more research experience there is among the members of the spin-off team, the faster the spin-off's early growth will be.

Hypothesis 2d: The more start-up experience there is among the members of the spin-off team, the faster the spin-off's early growth will be.

4.2.2 CAPABILITIES

The resources of the spin-off are discussed in terms of accumulated experience, but diversity among the experiences of team members is also identified as affecting team performance (Shane, 2004). Spin-off teams with diverse experience can complement each other, which can result in more effective decision-making (Roberts, 1991). In that way the diversity among the team members is a proxy for the capabilities of the spin-off.

DIVERSITY OF PRIOR EXPERIENCE

Based on a theoretical discussion of team demographics of upper echelons, R&D and project teams and entrepreneurial teams, Section 3.3.4 stresses that team diversity is important to the early performance of spin-offs. Diversity among team members is often perceived as increasing task conflict (Simons *et al*., 1999; Pelled *et al*., 1999). Diverse team members tap into the knowledge and the experience they have obtained from a variety of information domains. The perceptions of work-related tasks are then differently assessed and evaluated. Priorities and assumptions about the future and actions to be taken (Hambrick and Mason, 1984) can diverge and necessitate constructive debate before a common understanding is reached (Simons *et al*., 1999). The diversity may then represent a potential for more thoughtful decision-making. Evidence of the role of functional diversity is provided by several studies on upper-echelon teams (Simons *et al*., 1999; Keck, 1997; Pelled *et al*., 1999).

Three types of diversity can be distinguished: tenure, function and industry. Tenure diversity expresses the difference in lengths of time that each member of the team is associated with the team. Functional diversity expresses the difference in the previous functions or positions of the team members, and industry diversity expresses the difference in experience in various sectors of industry.

TENURE DIVERSITY

Tenure diversity, the diversity of moments that team members entered the spin-off is important to strategic actions. Not constrained by previous thoughts or experiences, new members bring new views and perspectives to the discussion on strategic actions. They are more likely to question the strategic plan and to deviate from initial schedules or business plans. Ancona and Caldwell (1992a: 325) found that "*members who have entered the organisation at different times know a different set of people and often have different technical skills and different perspectives on the organisation's history*." Research on the role of tenure diversity in large firms shows that the more diverse teams are with respect to tenure, the more willing they are to undertake strategic change (Boeker, 1997; Simons *et al*., 1997). Keck (1997) found that short-tenured teams are better-suited to facing environmental complexities, while in stable environments, diversity in tenure was

negatively associated with higher performance. Also, research on R&D teams shows that tenure diversity is positively associated with productive and innovative teams (Reagans and Zuckerman, 2001; Ancona and Caldwell, 1992a).

FUNCTIONAL DIVERSITY

Regarding functional diversity, team members that span more and different functions, for example members who have worked in finance, marketing and technical areas, can be complementary. Diversity of function makes the execution of the various tasks at hand more efficient. Especially in R&D teams and project teams (Ancona and Caldwell, 1992a; Pinto *et al*., 1993) and in entrepreneurial teams (Roure and Madique, 1986; Ucbasaran *et al*., 2003) the functional diversity is associated with higher team productivity and larger sales growth.

INDUSTRY DIVERSITY

The third type of diversity is industry diversity (see Section 3.3.4). Industry diversity reflects the differences in the industries that team members have worked in before joining the spin-off. Diversity in the industries results in different opinions and beliefs as to how to act, to compete and to approach business partners. In addition, diversity of industrial experience can be beneficial in identifying alternative opportunities in different industries (Castanian and Helfat, 2001; Shephard and DeTienne, 2005), which in turn allows the team to choose the most attractive. In formal terms, the three types of diversity are stated in the following hypotheses:

Hypothesis 2e: *The more tenure diversity there is among the members of the spin-off team, the faster the spin-off's early growth will be.*

Hypothesis 2f: *The more functional diversity there is among members of the spin-off team, the faster the spin-off's early growth will be.*

Hypothesis 2g: *The more industry diversity there is among members of the spin-off team, the faster the spin-off's early growth will be.*

TEAM COHESION

Team diversity is a multifaceted concept that interacts with the team process (debate) to shape performance in different ways (Simons *et al*., 1999). The negative side of diversity, in general, is that the efficiency of communication and the coordination of activities within a team are constrained by diversity among team members. If team members lack a common mind-set or linguistic commonality, communication will be less efficient and more costly in terms of time (Dearborn and Simon, 1958). For teams that deal with complex knowledge and knowledge with a low level of codification (Zander and Kogut, 1995), communication is hampered by difficult articulation. Communication in teams is related to team cohesion and teams that exhibit a strong degree of cohesion manifest higher levels of affinity and trust for one another, and experience more satisfaction with the group as a whole (O'Reilly *et al*., 1989). Team cohesiveness describes the close links between like-minded persons, in an entrepreneurial team. Cohesive teams are closer to each other and share common beliefs and understandings which make the distribution of information smoother. The cohesion-

performance effect has proven positive in several group studies (Ensley *et al*., 2002). In a study among CEOs and management-team members, Amason and Sapienza (1997) found that, among teams in the food-processing industry, the more open teams, i.e. teams that were more willing to discuss and encourage opinions, had more work-related discussions and less personal conflict. Team cohesion was found to be related to venture performance (Smith *et al*., 1994) and new venture growth (Ensley *et al*., 2001). Cohesive teams are also more successful in implementing strategic decisions (Elron, 1997). In a study among 222 R&D teams, Zucker and Reagans (2001) observed that cohesive teams had more frequent communication among members and achieved higher productivity. Communication that cuts across demographic diversity enriches the research process and promotes greater productivity. Regarding high-tech start-ups, Roure and Madique (1986) found that teams of successful start-ups had more prior experience working together. Consequently our hypothesis[10] is stated as follows:

Hypothesis 2h: The more cohesion there is among the members of the spin-off's starters team, the faster the early spin-off's growth will be.

ENTREPRENEURIAL ORIENTATION

Entrepreneurial orientation is often suggested as an important aspect in determining growth and success (Birch, 1987; Brown and Eisenhardt, 1995). In the present study, the entrepreneurial orientation of a firm is defined as "*a process, by which individuals – either on their own or inside organisations – pursue opportunities without regard of the resources they currently control"* Stevenson *et al*. (1989). This definition covers the dimensions of entrepreneurial orientation described by Miller (1983): innovativeness, risk taking, and proactiveness. The concept of entrepreneurial orientation by Miller (1983) and Covin and Slevin (1989) resulted in numerous studies that found evidence for the role of entrepreneurial orientation (see table 3.8). Innovative firms are more apt to create and produce new products and technologies (Brown and Eisenhardt, 1995). And to capitalise on these innovations, proactive firms focus on premium market segments and move in before others do (Zahra and Covin, 1995). They are more willing to allocate resources to these new innovations (McGrath, 2001). Research on spin-offs has also shown that entrepreneurial orientation is critical to early growth. Vohora *et al*. (2004) stress that opportunity recognition and entrepreneurial commitment are critical junctures during spin-off growth. Opportunity recognition is associated with efforts to innovate and pursue commercialisation, while entrepreneurial commitment refers to the willingness to devote time and resources to the entrepreneurial activity. Consequently our hypothesis is formulated as follows:

Hypothesis 2i: The more entrepreneurial orientation there is among the members of the spin-off team, the faster the spin-off's growth will be.

[10] In this research we also analysed the interaction effect of team cohesion and team diversity on the early growth of academic spin-offs. The findings are presented in chapter 6.

4.3 CONCLUDING REMARKS

This chapter formulated the theoretical discussion of the previous chapter in hypotheses based on the social capital theory and the resource-based view. Based on the social capital theory, an elaboration of the role of structural embeddedness on the early growth of spin-offs resulted in two rival hypotheses. One stresses the role of dense networks, while the alternative focuses on the role of structural holes. Both these hypotheses discuss redundancy in the external network based on inter-connectedness between alters. Redundancy may also result from similar backgrounds. Based on the notion of background-based redundancy, a hypothesis that pleads for heterogeneity in the network was formulated. Network benefits may also occur from relational characteristics. In that respect, the relational embeddedness of a spin-off was formulated in several hypotheses. Again, two alternative hypotheses were formulated regarding the role of tie strength. One alter in the spin-off network occupies a specific position in the spin-off network: the parent organisation. This study discusses the parent organisation as a strong tie that may provide the spin-off with certain benefits for early growth. These benefits were formulated in three hypotheses, based on tangible support, intangible support and parent relatedness.

After elaborating the hypotheses based on the social capital theory, this chapter continued with an elaboration of the hypotheses based on the resource-based view. The resources of the spin-off were discussed in terms of prior experience e.g. management-, business-, research- and start-up experience. For each type of experience, hypotheses were formulated. Besides the role of spin-off resources in early spin-off growth, the spin-off capabilities as possessed by the members of the spin-off team were also postulated in hypotheses. Five hypotheses reviewed the capabilities that flow from diversity among team members, team cohesion and the entrepreneurial orientation of teams. Regarding team diversity, diversity was discussed in terms of tenure diversity among team members, diversity in terms of previous functions team members occupied, and diversity in the industries team members previously worked in.

CHAPTER 5 STUDY DESIGN

This chapter provides insight into the methodology of the empirical study. The empirical study employed both case studies and surveys in order to increase the understanding of academic spin-offs. The statistical findings that result from the survey could be interpreted more meaningful with the observations from the case study. The case study design is based on concepts from the social capital theory and the resource-based view and aided in the design of the survey questionnaire. The theoretical concepts are then translated into constructs. Section 5.1 discusses data collection and the uniformity of the study population. A database of spin-off entrepreneurs was built up. With case studies, these entrepreneurs were interviewed in order to gain insight knowledge into academic spin-offs. In section 5.2 the design of these case studies is discussed. Section 5.3 addresses the design of the survey by discussing the measurement instruments of the constructs. A literature review is applied to formulate the questions regarding the resources, skills and the network of a spin-off. The review resulted in a variety of types of constructs: formative, reflective and network constructs. The three types of constructs need different assessments techniques to analyse their reliability and validity, and each is discussed in detail in Section 5.3. The chapter concludes with a discussion of the tools used for analysing the empirical data.

5.1 STUDY POPULATION AND DATA COLLECTION

To gather empirical data on the indicators of the early growth of academic spin-offs, three steps are followed. First, the study population was established. Research on spin-off activity within the Netherlands is fragmented and a database of spin-off activities is not readily available. Universities and knowledge institutions differ greatly in their efforts to keep track of their spin-offs. Although the University of Twente is an exception and keeps well-maintained records of their spin-off activities, at many universities and knowledge institutions spin-offs are less visible and records are kept only on spin-offs in which there is a specific interest. Nevertheless, a spin-off database was established from a variety of sources. The second step was to develop a questionnaire that covered the important factors that could explain the early growth of spin-offs. Information from experts, such as licence officers and managers in universities, was collected during interviews in an effort to identify the convergence of common themes and patterns (Miles and Huberman, 1994; Yin, 1994). The specific knowledge from the experts was brought together in general start-up concepts (Eisenhardt, 1989). These general concepts are based on past literature, and with the support of knowledge from experts, were brought together into an initial questionnaire. During a pilot study, eighteen spin-off founders from different knowledge institutions were given the initial questionnaire. The pilot study resulted in a structured questionnaire that met this research project's goals of simplicity and completeness. The third step was to develop a structured questionnaire. Finally, in the fourth step, data was collected from the spin-offs. Data collection was done by a survey among 297 Dutch academic spin-offs. The questionnaires were sent in two batches and were addressed to the principle entrepreneur. The data gathering took 6 months and resulted in 89 responses total some. The triangular approach of using interviews, pilot studies and structured questionnaires allows for the establishment of factors that helps to explain the early growth of spin-offs (Yin, 1994).

5.1.1 STUDY POPULATION

The sampling design shows how the database of spin-offs was developed for this research. The spin-off population is not different from that of other start-up firms, except in their origin. Building a database of Dutch academic spin-offs is quite difficult because the origin of the start-up, which is one of the selection criteria, is generally not available in databases of start-ups. Consequently, detailed analyses of start-ups named in university newspapers and on websites, funding programmes such as Biopartner, business-plan competitions and other media sources were essential to build up a database of academic spin-offs. Two criteria had to be met for start-ups to be included in the sample as academic spin-offs:

1) Origin — In this research, a spin-off company is an autonomous company that is based on a research activity that has been carried out in a university or research institute. The company must have been founded or co-founded by an individual who has worked on the specific research topic at the university or research institute.

2) Founding — Academic spin-offs are included in the analysis if they were founded after 1996. The founding date is defined as the moment that the team or individual officially founded a legal autonomous company. Some spin-offs

may have started their activities within the university long before 1996. The moment that spin-offs started their activities is, however, not taken as the founding date because they were not operating as a separate legal entity at that time.[11]

To collect the empirical data, a database of Dutch academic spin-off companies that started since 1996 was built up. The approach was as follows: In the first step, the websites of the holding company of each university were investigated. Many of these websites provide an overview of spin-offs in which the knowledge institution is involved through support activities. The problem with this overview is that spin-offs with no involvement by the parent organisation are not included. The second step was then to find those spin-offs that do not have explicit parent involvement. A search of university publications, sector-oriented and specialist journals and national newspapers provided more information about spin-offs that had started with no or relatively little parent involvement. Besides the secondary literature, the spin-off founders themselves and experts in the parent organisation also served as sources for finding other spin-offs. Through this snowball effect 297 potential spin-offs that had started between 1996 and 2003 at Dutch academic knowledge institutions were identified.

5.1.2 DEVELOPING CASE STUDIES AND THE SURVEY QUESTIONNAIRE

The present study adopts a multi-method approach of case studies and structured questionnaires to test the empirical model and examines the network and parent involvement of individual spin-offs (Yin, 1994). These methods permit a more thorough investigation of the sometimes ambiguous and sensitive aspects of spin-off venturing.[12] The case studies served the research in two ways. First, they are used to discuss the topics important for the early growth of spin-offs. The discussion with spin-off founders helped to translate existing concepts based on the resource-based view and the social capital theory into concepts that are relevant to spin-off starters. Second, the interviews were important for formulating the questions in the questionnaire, especially those regarding entrepreneurial activities and external networks. It was crucial that respondents could easily understand these questions. A balance in the depth, means, simplicity and efficiency of questioning proved to be vital. Accordingly, respondents were asked to evaluate the relative importance of their entrepreneurial activities. Then the respondents were asked to identify those people in their networks, who they consulted concerning these activities. The identification of the spin-off's external network is based on the name-generator (McCallister and Fischer, 1978). The name generator is based on Burt's questionnaire,[13] which identifies some 20 alters that can be named in a matrix. In this matrix each

[11] Among the spin-offs that are included in our sample, we identified the founding date and the date that the business idea emerged. We found differences between the two dates and our interviews revealed that some spin-offs started their business activities within the parent organisation before being founded. The average date of the idea was 5.6 years while the founding date was 4.2 years. During the model estimation (see Chapter 6), we also analysed a model in which we considered the idea date stead as the moment the spin-off was initiated, but we found few differences on the regression coefficients.

[12] In Section 1.1 we discussed the contribution of this research. This elaboration showed the various actors that were interested in the spin-off, their sometimes divergent views on objectives and how to accomplish them, and consequently the variety of factors that have an impact on the early growth of spin-offs.

[13] An example of a questionnaire that is based on the name generator can be found on Burt's homepage: http://gsbwww.uchicago.edu/fac/ronald.burt/research/QUEST.pdf.

respondent is asked to indicate who is related to who and how close the relationship is. The questionnaire also used a resource-matrix to identify the resources that network contacts provide access to. The inclusion of the resource-matrix in the questionnaire connects the contacts to certain resources. Recently, Van der Gaag and Snijders (2005)[14] developed the resource-generator to connect resources directly to network contacts. During our interviews and based on findings in previous literature,[15] we decided that seven alters would be satisfactory for mapping the external business discussion networks of a spin-off. Moreover, the interviews were helpful in investigating the different demographic backgrounds of the alters and in building a scale for tie strength.

5.1.3 METHODS OF DATA COLLECTION

The present study employs both qualitative and quantitative methods. The qualitative method is based on structured interviews in case studies and is followed by the questionnaire that was sent out in the survey among spin-offs. The previous section mentioned that the structured interviews were important in developing the questionnaire for the quantitative survey. To initiate the interviews, the principle entrepreneur was sent a letter and asked for his/her cooperation. One week later, the letter was followed up by a telephone call to see if an appointment for an interview could be made. If the entrepreneur responded positively, a date for an interview was set and confirmed by a letter or email. The interviews took between one and one and a half hours, were tape-recorded and then transcribed. The interview protocol included the use of tables to record data (Miles and Huberman, 1984). These ensured that the interviews were focused, covered all relevant information and were identical for all entrepreneurs. Using this protocol, we were able to build up qualitative case studies that proved helpful in developing the survey questionnaire. The reliability of the questionnaire was then established through the structured approach of interviewing, and construct validity was established by multiple sources of experts, such as entrepreneurs, licence officers and managers in academia (Yin, 1994). In the end, 18 spin-off founders and 5 managers in knowledge institutions were interviewed over a total of 35 hours.

After the qualitative data had been collected, quantitative data collection commenced by sending a questionnaire to the principle entrepreneurs. The questionnaire uses constructs that apply to the firm level. Team members worked closely together and during the interviews a notable overlap in their activities was found. Therefore, it was expected that the principle entrepreneurs would be able to fill out the background characteristics of all of their team members. Also asking the principle entrepreneur about the dyadic relationships between the members of the spin-off team and the external network seemed sufficient.

[14] The resource generator is a measurement instrument that has recently been developed by Tom Snijders and Martin van der Gaag at Groningen University. The resource generator measures the type of connections through which certain resources are available. At the time we sent out our questionnaire the instrument had not yet been published. As a result, our instrument is based on the name generator with characteristics concerning resources that are closely related to the resource generator. We thus refer to our instrument as a name generator that includes elements from the resource generator.

[15] Renzulli *et al*. (2001) and McEvily and Zaheer (1999) found that there was not a bias towards listing five contacts. In their studies, the mean number of contacts reached 3.5 and 4.8 respectively. When using the 20 alters as in Burt's questionnaire, a respondent can asses up to 190 relations, saying whether they are related and to what extent. Since we also asked the respondent to indicate what information was discussed with each contact and from what demographic background the contacts came, we found it inconvenient and unnecessary to ask about more than seven contacts.

Within the management teams of small firms, it is no secret as to who maintains contact with whom.

The questionnaire was sent in two batches over a period of four months. The rationale for this was purely practical. Sampling the population, i.e. reading back issues of newspapers and surfing the Internet took up a lot of time, and the interviews were also used to gain more names. The respondents were able to help by pointing to other spin-offs. Sending out questionnaires in two batches allowed for a sampling of the population and at the same time started the data-collection process. Sending out the questionnaire in two batches also helped to increase the response rate and completeness of the questionnaires. Entrepreneurs were contacted for their non-response or were asked for additional information if they sent incomplete questionnaires. The gap of four months is believed not to have influenced the data collection because the first wave was sent just before the summer while the second wave was mailed in September. In each batch, the questionnaire was mailed with a brief letter that outlined the research. About four weeks after the initial mailing, letters of reminder and more questionnaires were sent off.

5.2 THE CASE STUDIES

The case studies serve this research in two ways. First, they were used to improve information about academic spin-offs. The qualitative approach allows a discussion of multiple facets that influence the early growth of spin-offs. Besides the factors that are relevant to the early growth of spin-offs, the broader context of spin-off venturing is also discussed. To that end, the case studies are based on interviews with spin-off entrepreneurs and with officials in universities that support or back the spin-off during its initial years. Second, the case studies were helpful to in developing the structured questionnaire. The interviews with spin-off founders assisted in the development of a questionnaire based on the theoretical framework that was efficient and comprehensible.

The case studies in this research served as exploratory studies and as pilot studies. In exploratory case studies, fieldwork and data collection may be undertaken prior to definition of the research questions and hypotheses (Yin, 1994). The goal of the exploratory case studies was to obtain more knowledge about the arena in which spin-offs operate. The early growth of spin-offs is dependent on the behaviour of others outside the spin-off as well. Interviews with officials in knowledge institutions and spin-off entrepreneurs were thus important to understand the factors relevant to the early growth of spin-offs. The next reason for the case studies was to serve as pilot studies. Discussions with spin-off entrepreneurs and officials in knowledge institutions were used to determine the final protocols that would be used. Survey questions could be dropped or added based on the outcome of the pilot study.

5.2.1 CASE STUDY DESIGN

For the design of the case study, the five steps put forward by Yin (2003) were followed. First, the research questions had to be formulated. The research questions in the pilot study were similar to those used in the complete research. The second step concerned the formulation of propositions. According to Yin (2003), propositions must direct attention to

the issues under study. Based on the theoretical research questions, propositions were formulated regarding structural and relational embeddedness, the resources and capabilities of the team, and the parent involvement. These propositions are similar to the hypotheses that were formulated in Chapter 4. The third step involved establishing the unit of analysis (Yin, 2003). This step is particularly important because the interviews were held with entrepreneurs in spin-offs and with officials in knowledge institutions that support the entrepreneur during the start-up phase. The unit of analysis needs special attention when interviewing individuals in different organisations that have different viewpoints on spin-offs. Chapter 3 discussed that the unit of analysis in this research is at the firm level. Although the questions are addressed to the individual, they concern the early growth of spin-offs. Besides the unit of analysis, the selection of cases is also relevant to the collection of data. The data for the case studies were collected with spin-offs in the three sectors that are mostly represented: life sciences, ICT/Media and consulting and with the knowledge institutions. Collecting data at both the parent organisation and the spin-off is a selection that offers the opportunity to maximize what can be learned Stake (1995). Next, the respondents were selected by the extent to which they could provide relevant information, knowing that there were time limitations. Spin-off founders and officials in knowledge institutions at different universities and knowledge institutions were selected to be interviewed. The fourth and fifth steps concerned the logic of linking the data to propositions and interpreting the findings. The linking of data to propositions describes the method by which the data was to be analysed. The suggestions by Miles and Huberman (1984) were followed to analyse the data that was collected through interviews.

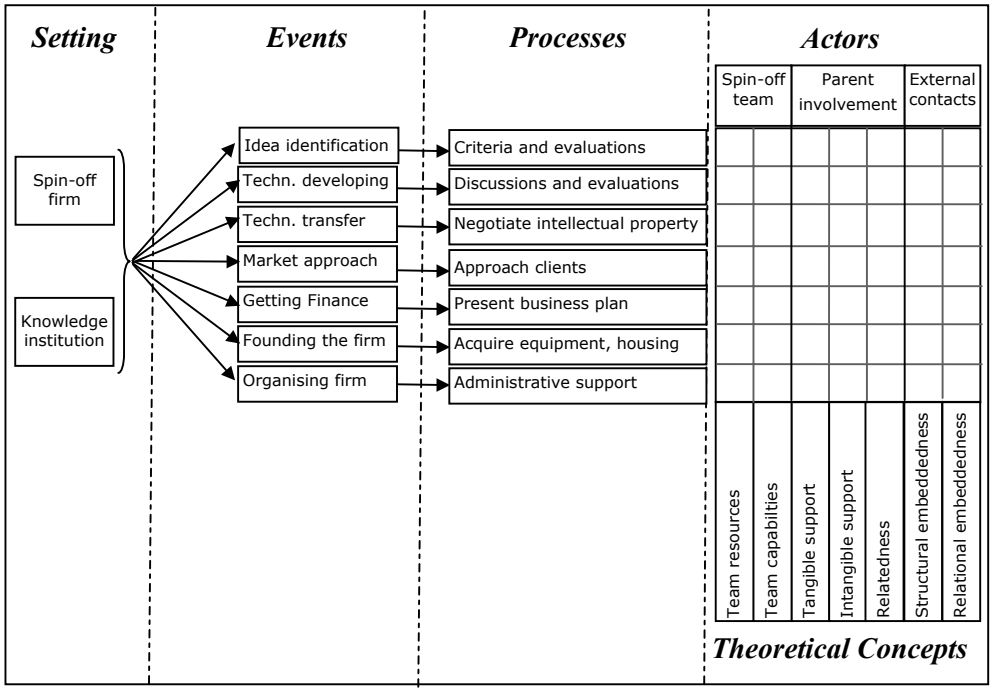
5.2.2 DATA COLLECTION

Data were collected from in-depth interviews with spin-off entrepreneurs and officials in knowledge institutions that were involved in the spin-off process. These interviews were qualitative and semi-structured. Miles and Huberman (1984) describe explicit and systematic methods for drawing conclusions from qualitative research and testing for them carefully. They set up procedures for analysing data during its collection in order to keep interviews focused and to simultaneously provide learning opportunities. In terms of the methods by Miles and Huberman this would be a cross-site analysis for the interviews with spin-off entrepreneurs and officials from knowledge institutions. For data analysis, a multi-site sampling method was used, as outlined by Miles and Huberman (1984: 41). This multi-site sampling method is presented in Figure 5.1.

The method involves four parameters: settings, actors, events and processes and Miles and Huberman (1984) stress that the sequence of the parameters can be researcher-specific. In these case studies, the settings are the sites at which the interviews took place. Interviews at the spin-off firms were held with the entrepreneur and interviews at the knowledge institution were conducted with officials were involved in the spin-off process. These officials were often managers of new-business development, scientific directors, business managers and spin-off programme managers. All have different views on the spin-off process. Making the distinction is then important to understanding the answers provided in the interviews, and benefits the validity of the study. The case studies are focused on the early growth of spin-offs. Therefore, several events and processes were identified that

entrepreneurs have to deal with when founding a spin-off. These events and processes are based on the entrepreneurial activities outlined by Reynolds (1994), Gatewood *et al*. (1995), Elfring and Hulsink (2003) and Shane (2004). The activities are linked with the actors. In the founding of a spin-off, three actors are basically involved (Roberts and Malone, 1996). First of all, the starters team performs the start-up activities. Second, during the early growth the parent organisation can be involved. It may not be directly involved in the spin-off but can help the entrepreneurs in their activities. Besides the parent organisation, contacts in an external network may help spin-off entrepreneurs perform the activities. Such contacts are the third set of actors. These three types of actors refer to the two organisational theories. The variables of these theories are presented in Figure 5.1 as theoretical concepts. The reliability of the interviews was established by cross-checking interviews. Attempts were made as far as possible to interview officials that were involved in the spin-off who had been interviewed. In this way it was possible to obtain information from both the spin-off entrepreneur and the official in the parent organisation.

Figure 5.1 Multi-site sampling method (Based on: Miles and Huberman, 1984)



5.3 THE SURVEY

The survey uses measures that relate to the concepts of the social capital theory and resource-based view. Previous studies were used to provide the initial measures for the theoretical concepts and they were discussed during in-depth interviews with spin-off entrepreneurs and officers in parent organisations. The approach warranted the creation of validated and reliable scales. Different types of measures, such as summated scales, network analysis and the analytical hierarchical process were employed. The first set of measures is objective, such as the background of contacts or the type of experiences, but entrepreneurs were asked their opinion on several issues using Likert scales.

A second set of measures employs dichotomous or binary data. The concepts that measure the prior experience of individuals in founding teams required 'yes or no' answers. The data were used in equations to attain an indicator of the degree of the team's experience or diversity in experience (Kendall and Stuart, 1977). These equations are based on calculations of the mean. Network measures were based on ego-centred networks that consist of a focal actor, termed ego, and a set of alters who have ties to the ego (Wasserman and Faust, 1994). The measures are then focused on the ties among these alters and ego, and the characteristics of alters. Our ego-centred network measures use binary data, which are then calculated into network variables.

A third set of measures uses the Analytical Hierarchical Process (AHP) as developed by Saaty (1980). The AHP technique identifies the importance of certain types of entrepreneurial activities. These activities were used to identify the entrepreneurial orientation of the spin-off and to find out the "tie content". The AHP combines the rating and ranking of the activities. The rating requires each respondent to assign a value or rating to each activity. Complete ranking requires each respondent to rank the activities to all other activities. The rating scale gives respondents the possibility to rate a number of activities with similar values, while the ranking does not indicate the distance between the importance levels. The AHP can provide both the rating and value.

5.3.1 CONSTRUCTS IN THE SOCIAL CAPITAL THEORY [16]

External network analysis of the spin-off is based on two dimensions: structural and relational embeddedness. Structural embeddedness is based on complete set of contacts, while relational embeddedness refers to the dyadic relationship between the ego and alters.

Network data are gathered using the name-generator technique. The name-generator asks ego to name individuals with whom certain topics were discussed. This ego-centred network measurement instrument is designed and developed specifically for use in the small-firm context (Aldrich *et al*., 1986). Respondents (ego) are asked to give the seven most important external sources of advice (alters) they relied upon and discussed important issues with during the start-up phase. Two reasons underlie the rationale for this approach.

[16] Most measurement techniques in social network analysis require the group to be defined as a finite set of actors who are treated as a finite set of individuals on which network measurement are made. The finite set necessitates the use of social-network analysis software such as Ucinet, Egonet or Pajek. However, for the measures we applied and the small size of the groups, some easy calculations were satisfactorily in a spreadsheet program such as Microsoft Excel.

First, the respondents are forced to provide names of important individuals and not those of everyone they have talked to. Second, previous research has shown that when important contacts regarding business were considered, the average size of an external network is approximately five contacts. In a study among starters, Renzulli *et al*. (2001) found that respondents indicated on average 4.8 contacts. And in a study of 227 job shop manufacturers located in the USA, McEvily and Zaheer (2001) found that using the name generator, respondents indicated on average 3.5 external contacts.

STRUCTURAL EMBEDDEDNESS

Structural embeddedness is based on the structural position of alters in the network. Knowing the position of all alters in the network provides information on their overlap or redundancy. Two approaches were used here to indicate the redundancy in the ego's network. First redundancy is based on the structural position of contacts. For this type of redundancy the measures of density and structural holes are often applied. The second type of redundancy focuses on the demographic background of the contacts, because when contacts come from similar backgrounds they are believed to expose redundancy. This type of redundancy is often referred to as heterogeneity.

STRUCTURAL EMBEDDEDNESS: DENSITY

Network density indicates the average strength of ties between contacts. The density measure is often used in research studies to understand how firms acquire competitive capabilities (McEvily and Zaheer, 2000) or to understand differences among industrial sectors (Rowley *et al*., 2000). Based on this previous research, this research measured density using a matrix of the ties, see Appendix A2. Density is computed with the following equation:

$$Density = existing\ ties\ /\ potential\ ties \qquad (5.1)$$

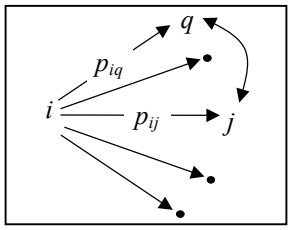
In Equation 5.1, the existing ties reflect the number of ties that actually exist among contacts in the spin-off network. The potential ties reflect the maximum number of ties in the spin-off network if every one is connected to each other, thus excluding the ego. The values for this variable can range between 0 and 1. Low numbers indicate low redundancy and high numbers indicate high redundancy. If all contacts know each other, the density score is 1, meaning complete redundancy in the network. On the other hand, if no ties exist among the contacts, the number of existing ties is zero and the equation equals zero, meaning that there is no overlap among network contacts. The density is measured using question 56 in the questionnaire (see appendix A1).

STRUCTURAL EMBEDDEDNESS: STRUCTURAL HOLE

To identify the number of structural holes in the spin-off network Burt's measure of structural holes that is based on the concept of constraint (Burt, 1992) was used. Constraint measures the extent to which a person's network is concentrated in redundant contacts (Burt, 1992). The constraint measure integrates the proportion of both the respondent's network time and energy invested in a relationship combined with the structural position of the contact among the respondent's contacts. In other words, constraint refers to how much room one has to negotiate or exploit structural holes in a network. The constraint is high if

the contacts are directly connected to each other. For each contact, the constraint is calculated based on their ties to other contacts. Appendix A3 explains the calculation of the constraint measure in more detail. From Appendix A3 it can be seen that constrain (C_{ij}) between ego *i* and contact *j* is a product of direct investment in the contact by ego (P_{ij}) and indirect investment through other contacts *q* ($\sum_q P_{iq}P_{qj}$), see Figure 5.2. If indirect investment equals zero, meaning that no other contact *q* has invested in a relationship with contact j (Burt, 1992), contact *j* represents a structural hole to other contacts. The constraint measure has been adopted by several studies. Burt *et al*. (2000) applied the constraint to measure the social capital of French and American managers and its relation to performance in terms of information and control benefits. Also Walker *et al*. (1997) measured the social capital of biotechnology start-ups and analysed how industrial networks emerge. In a study on the content of network contacts, Podolny and Baron (1997) used the constraint measure to investigate job mobility. In previous studies on structural holes, the constraint measure has been used to indicate the structural hole connection. Several studies that have used the constraint measure to indicate the number of structural hole connections in an ego's network provided evidence that people with more bridges do better (Burt *et al*., 2000). The number of structural holes is measured using question 56 in the questionnaire (Appendix A1).

Figure 5.2 Hole conditions of constraint (Burt, 1992)



STRUCTURAL EMBEDDEDNESS: HETEROGENEITY

To calculate structural embeddedness based on heterogeneity, the respondents were asked to mention the background of each of their contacts. Background is based on demographic background, for example the contact could be a family member or co-worker (Renzulli *et al*., 2000). Four demographic backgrounds were differentiated: private environment, former-work environment, academic environment, and business environment. Contacts within a former-work environment are those with previous colleagues or officials in the knowledge institution, and academic contacts are all colleagues at other knowledge institutions. Non-academic contacts can come from the private environment, such as friends and family, or from the business environment such as advisors, financiers and other businessmen. When two contacts come from the same demographic background, it is assumed that they are homogenous. This technique allows the proportion of redundancy or homophily in the external network to be calculated. Appendix A4 explains in detail the heterogeneity measure in the external network which is calculated by Equation 5.2.

$$Heterogeneity = 1 - \left[\left(\frac{\#\, private_i}{total} \right)^2 + \left(\frac{\#\, former..work_i}{total} \right)^2 + \left(\frac{\#\, academic_i}{total} \right)^2 + \left(\frac{\#\, bu\sin ess_i}{total} \right)^2 \right] \qquad (5.2)$$

In Equation 5.2 for each type of demographic background e.g. private, former-work, academic and business, the proportion of alters that come from that background is

calculated. A high proportion – meaning many alters come from the same background – implies a high level of homogeneity and thus high levels of redundancy. When the amount of homogeneity is subtracted from 1, the equation gives the measure of heterogeneity. Question 51 measures the amount of heterogeneity in the spin-off network.

RELATIONAL EMBEDDEDNESS

Relational embeddedness is based on relations between ego and alters. Section 3.2.3 discussed how relational embeddedness can be expressed in tie strength and tie content. Tie strength reflects the social proximity in a dyadic relationship (Granovetter, 1973; Marsden and Campbell, 1984), while the tie content conveys the topics and importance of the topics discussed in a dyadic relationship (Podolny and Baron, 1997; Provan and Milward, 1995). Emphasis is also put on the parent organisation as a single strong tie. Spin-offs emerge from the parent organisation and, as a result, have a specific relationship with their parent. For this particular strong tie some specific relational characteristics are analysed, such as the commitment to uphold the relationship and the relatedness in the activities of both the spin-off and the parent organisation.

RELATIONAL EMBEDDEDNESS: TIE STRENGTH

In 1973, Granovetter developed the concept of tie strength to measure the strength of the relationship between friends in ego networks. Granovetter (1973:1361) suggested that "*the strength of a tie is a (probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services, which characterise the tie"*. While proposing the measure of tie strength, Granovetter also indicated that the operational measures and the weights attached to these measures should be explored. Marsden and Campbell (1984) addressed the problem of measuring tie strength by analysing the operational measures and weights for friendship ties. Data of friendship ties were collected in three cities, two in the US and one in Germany. Using structural equation modelling, they found that for friendship ties a measure of closeness or intensity was the best indicator of strength, whereas frequency and duration were weaker predictors. Furthermore, they showed that the predictive powers of several independent variables of friendship ties (e.g. kinship, neighbours) were weak. Hansen (1999) applied the strength measure in work-related ties and found that frequency and closeness did correlate very highly (0.83) and thus represented the same underlying construct. He explained this anomaly as being due to differences in the networks under study. Hansen employed a work-related definition of closeness, while Marsden and Campbell employed an affective definition of closeness. Although spin-off entrepreneurs may consult friendship and business ties to gain information about starting up their spin-off, we specifically focus here on the business network, which involves applying the work-related definition of tie strength. Consequently, this research follows the initial measure of tie strength as proposed by Granovetter, who used the indicators of frequency, duration and closeness. Based on our interviews during the case studies, the scales for these indicators have been adapted and made applicable to the business environment in which spin-offs occur. Ranging from weak to strong, frequency is measured on a three-point scale 'once every 6 months', 'monthly' and 'weekly'. Duration is measured in a similar trend as the number of years the

relationship has existed. The distribution of duration appeared to be very skewed and has therefore been tri-chotomised into 'less than two years', 'between two and four years' and 'more than five years'. Finally, the indicator for closeness is measured with the three categories 'very little', 'to some extent' and 'very good'. For all three indicators, the least strong tie was coded as 0, the middle one as 0.5 and the strong tie as 1. The strength of the tie was constructed by a linear summation of the three indicators (Granovettter, 1973). The tie strength is measured using questions 52, 53 and 54 in the questionnaire.

Relational Embeddedness: Tangible and Intangible Support from the Parent

The parent organisation can be seen as a strong tie to the spin-off (see Section 3.2.3). Strong ties are beneficial in providing the spin-off with support and referrals. This section describes the measures for parent support and relatedness. The support is distinguished as support with tangible and intangible assets (Dierickx and Cool, 1989). Tangible assets are those resources provided to the spin-off that can be easily observed. Four types of indicators describe the tangible support: provision of finance; the use of intellectual property right(s); launching orders by the parent; and providing accommodation and equipment. The intangible assets are more difficult to measure since they refer to resources that cannot be physically touched, but are largely carried within people (Itami, 1987). Again, four types of indicators are used to describe the intangible support: legal issues; organisational issues; technological expertise; and administrative tasks. These tangible and intangible assets are common in the support of spin-off ventures (Doutriaux, 1987; Steffensen *et al*., 1999). The indicators of parent support were measured on a categorical scale that included two questions. The first asks whether the spin-off received support, and the second looks at whether this support was necessary for the early growth of the spin-off.

The possible answers were as follows:

No, we did not receive support but we should have
No, we did not receive support but it could have made things easier
No, we did not receive support but it was not necessary
Yes, we not receive support but it was not necessary
Yes, we not receive support and it made things easier for us
Yes, we not receive support and it was crucial

This measure allowed us not only to see whether support was provided but also the extant to which the spin-off needed the support. Questions 28 up to 35 measure the amount of support by the parent organisation.

Relational Embeddedness: Relatedness

Relatedness is a multidimensional construct that refers to both the external and internal fit with the parent organisation. In a study of corporate spin-offs, Thornhill and Amit (2000) derived two drivers that describe the internal fit between the parent organisation and the corporate venture. They identified, first, the economic drivers based on the resources of the parent and second, the relational drivers flowing from the structure and culture of the parent. Sorrentino and Williams (1995) used three aspects to define the relatedness construct. First, the degree to which the new venture shares production resources with the parent firm, second, the degree to which it shares marketing programmes with the parent, and third, the degree to which the new venture shares immediate customers with the parent

organisation. Other studies consider a venture related to the parent if they both sell to the same set of customers, both sell similar lines of products or services, or apply similar production techniques (Feeser and Willard, 1989; Woo *et al*., 1992). Relatedness was measured at two levels: first, relatedness based on knowledge or intellectual capital and second, relatedness regarding the market environment in which both operate. For each type of relatedness, the respondent assessed two statements on a 7-point Likert scale (questions 23 until 26 in the questionnaire).

Relational Embeddedness: Tie Content

The tie content reflects the issues and start-up activities that are discussed with contacts. The discussion can result in new or combined information that is relevant for early spin-off growth. This research focuses on generic activities that almost all high-tech start-ups are confronted with. We first look here at activities for start-ups in general. Reynolds (1994) investigated the activities that involved the gestation of new ventures among a large sample of nascent entrepreneurs. Activities that were most reported were searching for accommodation (75%), saving to invest (68%), and organising the start-up team (58%). Among 142 nascent entrepreneurs Gatewood *et al*. (1995) identified 29 activities involved in starting a business that could be categorised as market activities, operations and organising the company. Elfring and Hulsink (2003) investigated the processes of a start-up that take place in the network. Three processes were most important: the discovery of opportunities, mobilising resources, and securing legitimacy with business partners and financial institutions. Based on the observations of start-up processes by Elfring and Hulsink (2003), two activities for each process are distinguished.

The first process is the discovery of an opportunity. The discovery of an opportunity involves two steps. The first is the identification of an idea that leads to an opportunity (Singh *et al*., 1999). The idea emerges from new knowledge that in the case of spin-offs, has been developed in an academic setting. Research activities such as effecting the technology and carrying out the development process are important for ideas to emerge. The initial idea is often not ready to serve market needs. Further development is needed and gained through a thorough evaluation of market demands and an evaluation of the feasibility of the initial idea. Potential customers and competitors must be investigated and experts have to be consulted before the business plan can be written. This evaluation of ideas is the second step: recognising the opportunity. The activities that will be done to this end are collecting information about markets, their suppliers, customers and competitors.

The second process is the mobilising of resources to get the start-up organised. In general, start-ups are not sufficiently endowed with resources. Therefore, one of the first objectives when starting a new business is gaining access to resources that could help to transfer the opportunity into profitable returns. Important resources can be specific equipment, personnel or accommodation. Before the new venture can be considered a legal entity the organisation must be registered and procedures and administrative tasks have to be set up to ascertain continuity.

The third process focuses on securing legitimisation. Legitimisation is an external concept and is the result of evaluation of the spin-off by other business partners. Previous studies (Baum *et al*., 2000; Stuart *et al*., 1999; Shane and Cable, 2002) have shown that cooperation is an important mechanism for starters to increase their credibility. In general,

start-ups lack a track record, making it difficult to convince potential partners that their business is robust and reliable. Following alliances with existing or reputable partners can substitute for a lack of track record by signalling to other business partners that the start-up is attractive and can realise what it promises. Another activity that can secure the spin-off legitimacy is establishing a strong financial backbone. Start-ups with sufficient financial resources show solvency and a greater potential to last. For business partners, this may ease uncertainty when setting up business contracts. Consequently, the two main activities associated with securing legitimacy are entering into cooperation with business partners and assessing finance.

Table 5.1 illustrates the three processes and the corresponding activities that start-ups will engage in. Respondents were asked to indicate, for each of the contacts they mentioned in their business discussion network, the activities that they discussed. Because the structural and relational characteristics of each contact are known, the tie content questions provide additional information about the topics discussed with each contact. The importance of tie content is measured using questions 36 up to 50 and tie content related to contacts is measured using question 55 in the questionnaire (see Appendix A1).

Table 5.1 Start-up processes and corresponding activities
(Adapted from: Elfring and Hulsink, 2003; Shane, 2004; Reynolds, 1994; and Gatewood 1995)

Start-up process	Corresponding activity
Discovery of opportunities	• Collecting information on the market, customers and competitors • Effecting the technology and the development process
Mobilising resources	• Effecting organisational, legal and administrative procedures. • Organising personnel, housing and equipment
Securing legitimacy	• Entering into cooperation with business partners • Getting access to finance.

5.3.2 CONSTRUCTS IN THE RESOURCE-BASED VIEW

Section 3.3.4 discussed the concepts of the resource-based view and stressed the importance of the start-up team's resources and capabilities. Before explaining the measures we first elaborate on our definition of the team. In previous research, the founding team is often not clearly defined, apparently assuming it is self-evident (Doutriaux, 1992). In studies that provided a definition of the founding team, the definitions varied a great deal. Eisenhardt and Schoonhoven (1990) defined the founding team as the individuals who occupied an executive position in the firm when it began. Others have defined the founding team as those individuals who either work in the firm, invest in the firm, and/or are entitled to receive profits from the firm (Cooper and Bruno, 1977). During the case studies in this research, it was observed that some team members were working part-time for the spin-off. We therefore follow the definition by Cooper and Bruno and defined the founding team as the individuals who were directly involved in the start-up activities of the spin-off, by working, investing and receiving profit from the spin-off.

TEAM RESOURCES

The most frequently mentioned resources of the spin-off team members are prior management experience, prior research experience, prior start-up experience and prior

industry experience. For each member, the extent of these prior experiences was measured. The total of one type of experience is the summation of that experience among the founding team members (Westhead *et al*., 2001; Shane and Stuart, 2002). The measure is cumulative, meaning that the more members there are with experience, the more prior experience the team has. An average measure was not employed since that would lead to inconsistencies. For example, a team of two members both with experience in management would result in a total experience of *one individual*. This would be the same amount of experience if a single entrepreneur had management experience and it would result in less experience compared to a team of four members in which three members had management experience. A cumulative measure was therefore used. Regarding the example, this denotes a 1 count experience in management for the single entrepreneur, 2 counts for the two-member team, and 3 counts for the four-member team. From our interviews we deduced that we had to set the criterion for duration at two years' experience because people believe that after two years one starts to accumulate experience and knows how things work in that field. Questions 3, 4, 5, and 6 measure the experience in the spin-off team.

TEAM CAPABILITIES

The capabilities of a firm are described by its capacity to deploy resources using organisational processes (Amit and Schoemaker, 1993). As discussed in Section 3.3.4, teams with more diversity in their experience can complement each other, develop better organisational processes, and are more suited to coping with changes in the environment. We therefore focus on the diversity of the team based on three types of diversities: tenure, function and industry. To measure differences in tenure, respondents were asked to fill out the date (month/year) when each member joined the spin-off. Although the tenure diversity for new ventures cannot be expected to have a very wide range, we argue that the activities of the new venture change frequently as they manoeuvre through the phases of their early growth. During interviews, we observed that spin-offs go through several phases in a relatively short period of time. When new persons join the entrepreneurial team in a later phase, they will not have the experiences of the previous phase(s). Members that join the spin-off at different times with a difference of at least 6 months are believed to have different experiences and have, as a result, different views regarding the current issues that they have to deal with. Therefore, when members of the entrepreneurial team had more than 6 months difference in their tenure, they were designated as different (=1), while members with less than 6 months were designated as not being different (=0). For the two other types of difference, functional and sector, respondents were asked to indicate their previous job function and the previous sector in which they had worked. Functional diversity indicates the diversity of previous job functions, e.g. manager, researcher, etc. Industry diversity reflects the differences regarding the type of industry or sector in which people worked. Again, when the functions and sectors differed for two members it was indicated with a 1 and if they were similar they are appointed as 0. For both the function and the sector, the criterion was set at two years working in that function or sector. The team capabilities are measured using questions 2, 3, and 5.

For each measure we composed a square matrix that consisted of pair-wise comparisons of members *i* and *j*. If member *i* is different from member *j,* we addressed their relationship with a 1. If they are similar they were given 0. The total diversity in a team is then

calculated by pair-wise comparisons for all members. The calculation is based on the method used by Reagans and Zuckerman (2001), which is the Gini coefficient of mean difference, see Equation 5.3 (CMD, Kendall and Stuart 1977: 48).

In Equation 5.3, t_{ik} and t_{jk} indicate individual i's and j's tenure in the organization and N_k is the number of individuals in the management team. In the current equation, the diversity reflects the average difference in tenure between team members. The same equation can be applied to functional and sector diversities.

$$CMD = \frac{1}{n(n-1)} \sum_{i=1}^{n} \sum_{j=1}^{n} |t_i - t_j|, \; j \neq i \qquad (5.3)$$

CAPABILITIES: ENTREPRENEURIAL ORIENTATION

Entrepreneurial orientation was measured using the opportunity approach developed by Stevenson (Stevenson, 1983; Stevenson and Gumpert, 1985; Stevenson and Jarillo, 1990; 1990). The opportunity approach makes a distinction in entrepreneurial-oriented and managerial-oriented firms. Entrepreneurial-orientated firms seek opportunities regardless of resources currently controlled, while the aim of managerial-oriented firms is to make use of resources that they control. According to Stevenson and Gumpert (1985), entrepreneurial-oriented firms are managed by a promoter type of manager who feels confident of his or her ability to seize opportunities, expects surprises, and adapts and capitalises on changes. The managerial-oriented firms are managed by the trustee type of manager. In contrast to the promoter type, the trustee type of manager feels threatened by change and the unknown, and relies on the states quo. Predictability fosters effective management of existing resources, while unpredictability endangers them. To separate the promoter type from the trustee type of manager, the opportunity approach is based on six dimensions: s*trategic orientation, commitment to opportunity, commitment to resources, control of resources, management structure and reward philosophy.* Promoter type of managers have a strategic orientation focused on opportunities, and show commitment to them by taking action to seize them. On the other hand, the trustee type of manager focuses on planning, controlling resources, and building an organisational structure and reward systems to reduce risks. These six dimensions have been adapted into six questions that reflect actions that entrepreneurs may pursue, these dimensions are measured using questions 36 until 50.

The first action is that of collecting information about the market, such as the needs and behaviour of customers and competitors. This action is related to strategic orientation and higher scores indicate more focus on opportunities. The next concerns the technology and development process and is particularly applicable for spin-offs. If the action scores highly, it indicates that the spin-off (still) has a strong technological orientation. This either indicates that the spin-off is not yet willing to show commitment to the opportunity or that the team is still uncertain about its commercial exploitation. The third action is that of cooperating with business partners and shows that the team is not only committed to taking action but also to trying to get access to resources. The fourth and fifth actions are concerned with administrative and legal issues, and with organising the firm's structure through finding accommodation, personnel and equipment. These actions refer to the control of resources, the management structure and the reward philosophy. The sixth action resolves around finding finance.

To find out the entrepreneurial orientation of spin-offs, we calculated the importance levels for the activities of 1) collecting information on the market, customers and competitors, 2) cooperating with business partners, and 3) finding financial capital. Orientation towards managerial tasks was measured by accumulating the calculated importance levels for 1) effecting the technology and development process, 2) effecting organisational, legal and administrative procedures, and 3) organising personal, housing and equipment.

A difficulty in measuring the importance of these activities is that ranking does not indicate1 anything about the difference in importance between the activities. And using Likert scales may result in all activities being equally important. To overcome these problems, the Analytical Hierarchical Process (AHP) technique is applied. The AHP technique (Saaty, 1980) assesses the relative importance of the six activities simultaneously through pair-wise comparisons (see Appendix A5 for more details). The AHP is a scoring model that relies on multiple criteria. Inputs are converted into scores used to prioritise a list of activities. The AHP not only rank-orders the activities but also quantifies the distance between the importance levels of the activities.

CAPABILITIES: INTERNAL COHESION

The internal cohesion of the spin-off team is measured with a cohesiveness measure. Bollen and Hoyle (1990) define cohesion as the perception of team members regarding the individual's sense of belonging to a particular group and his or her feelings of morale associated with membership of that group. Ensley *et al*. (2001) used the cohesion measure based on belonging and morale in new ventures and showed a positive relation between cohesion of a top management team and the new venture's growth. During our tests of this measure in interviews, we found that the teams work closely with each other. As a result, the feeling of morale was quite high among team members and proved to be an indicator that provided little difference. As a result, we focused on the sense of belonging to a group. Although in interviews, the members indicated a strong sense of belonging, we analysed the belonging to the group based on the extent that members had contact with each other before the start-up of the spin-off. If people had had contact with each other before the start-up, we considered them as showing high levels of cohesion. Members who had worked together before had learned how to get along and communicate with each other. Aggregating all spin-off members indicated the level of internal team cohesion. Question 7 measures the cohesion (see Appendix A1).

5.3.3 CONTROL VARIABLES

For the control variables, a distinction was made between control variables that apply to the main theoretical model and those that apply to the model of parent involvement in particular. The control variables for the main theoretical model are the degree of exploration, the level of investment required, the spin-off's size and itsage. Control variables regarding parent involvement are the relatedness between the parent and spin-off activities and the commitment both parties have to upholding their relationship.

DEGREE OF EXPLORATION: NEWNESS TO TEAM/ NEWNESS TO MARKET

The degree of exploration of the spin-off was measured in terms of newness of the spin-off activity to the team and newness of the spin-off activity to the market. For both measures the operationalisation by McGrath (2001) was used which explains the newness of the firm based on the main business activity. In this research, the main business activity is the commercial exploitation of a technological finding.

Two dimensions measure newness related to the team: the level of newness of the technology and the level of newness of the market. In other words, this is the extent that the team is familiar with the technology or with the market in which it will operate. Four statements were formulated regarding the newness to which the respondent could agree or disagree on a seven-point Likert scale. Questions 12 until 18 measure the newness to team and to market.

SPIN-OFF SIZE AND AGE

The firm size measure, question 57 in the questionnaire, was included as a control variable. Firm size is a contingency variable and may effect the resources and networking of a firm. Regarding resources, the size can affect the ability of an organisation to learn. During recent years, an extensive discussion has begun as to whether small firms do grow faster than larger firms (Phillips and Kirchhoff, 1989; Sutton, 1997; Cabral and Mata, 2003). The discussion has been inspired by "Gibrat's Legacy", which can be interpreted as an "*expected value of the increment firm's size in each period is proportional to the current size of the firm*" Sutton (1997: 40). The arguments consider the role of the industrial context in which the start-up is founded (Evans, 1987; Hart and Oulton, 1996). Regarding high-tech industries, recent studies have indicated that there is a positive relation between firms' initial size and their probability of survival (Colombo *et al*., 2004; Audretsch *et al*., 2004; Lotti *et al*., 2001; Almus and Nerlinger, 2000).

The age of the firm, question eight in the questionnaire, was also included as a control variable. Survival is more critical for young firms than for older firms. Older firms can rely on previous activities and contacts since they have already developed extensive networks. Hite and Hesterly (2001) suggest that as firms emerge, their networks shift from more dense and strong ties to sparse networks that exploit structural holes. In a more recent study, Hite (2005) suggests that relational embedded network ties evolve over time as firms emerge.

LEVEL OF CAPITAL INVESTMENT

The measure for the level of capital investment is based on the industry variety construct by Miles *et al*. (1993). The measure for the level of capital intensity indicates the extent to which high levels of marketing efforts, R&D expenses or capital intensity are crucial during the start-up of a spin-off. Respondents were asked to indicate how far they agreed with six statements regarding these aspects of industry variety. All statements are measured on a seven-point Likert scale and presents a scale for the total level of capital investment needed by the spin-off.

5.3.4 PERFORMANCE: EARLY GROWTH

As discussed in Section 3.5 the dependent variable in this study is the early growth of the spin-off. Growth was measured in terms of the number of employees. Our rational for choosing this dependent variable was based on the observation that successful spin-offs do not necessarily have to make a profit in their early stages of growth. Spin-offs in the life sciences in particular have to make large investments before revenues appear. Consequently, most traditional measures are not suitable. The growth measure was calculated accordingly to the difference between the number of employees in 2001 and the number of employees at the end of 2003. Some particularities have to be taken in account when using the employee growth measure. Spin-offs, especially those in the life sciences, may start large, which has an effect on the dependent variable. Also larger firms may grow faster in absolute terms whereas small firms may grow faster in relative terms. To correct these influences and make small and large firms comparable, we developed the growth-index based on the Birch index (Birch, 1981):

$$Early\ growth = (E_{2003} - E_{2001})^{0.5} \cdot (E_{2003} / E_{2001}) \qquad (5.4)$$

In Equation 5.4, E_{2001} is the number of full-time employees in the spin-off in 2001 and E_{2003} is the number of full-time employees in 2003. In this equation, the absolute growth of large firms will decrease disproportionally with that of small firms and at the same time the relative growth of small firms is less emphasised. Question 57 measures the spin-off growth. The measure is explained in more detail in Appendix A.6

5.4 DISCUSSION ABOUT MEASUREMENT

This section discusses whether the measures used in this study were appropriate. Three types of measures were employed: reflective, formative and network constructs. For each type the conceptual definition, the construction of summated scales, the reliability and the validity of the scales are discussed.

5.4.1 DEFINITION, RELIABILITY AND VALIDITY

The conceptual definition of the scales is based on the theoretical applicability of the variable in the field of research. The conceptual definition is often discussed in terms of the content or face validity. The content and face validity assess the correspondence between the (individual) item(s) and the concept one is attempting to measure. Content validity considers whether the measure captures all the elements that the construct represents. Face validity assesses how respondents interpret the measure. The assessments of both face and content validity are performed by consulting literature, experts, and applying pre-test questionnaires to the targeted population. The face and content validity are followed by checks of reliability and statistical validity checks Measurement instruments are reliable if they provide repetitive scores, and are valid if they measure what they are intended to measure. A violation regarding reliability is based on random errors, while violation regarding validity is based on systematic errors. Both can be present without the other. For instance, a measurement can be valid but still provide different scores due to its

unreliability. Also, measures can be reliable in that their random error is small, but still not measure the topic the measure was designed for.

In the discussion of statistical validity, three aspects are often investigated when sets of different variables are elaborated on convergent validity, discriminant validity and nomological validity. Convergent validity determines the degree to which the items of a concept correlate, and thus measure the same concept. Discriminant validity reflects the extent that two conceptually different concepts are distinct. Again correlations are important but here they should be low to demonstrate that the concept is different from other concepts. The third type of validity, which is often mentioned for discussing sets of variables, is nomological validity. Nomological validity reflects the extent to which a construct makes accurate predictions of the dependent variable in a theoretical model. In other words, it shows how far a construct is associated with other constructs.

While validity assesses the extent that the measurement instrument captures the concept one is attempting to measure, the reliability check assesses the extent that the measurement instrument provides repetitive answers. In other words, the reliability of a measure reflects the extent of the variation of a score that is attributable to random or chance errors. A perfectly reliable measure has zero random effect in its scores. The Cronbach Alpha analyses the reliability of summated scales.

5.4.2 REFLECTIVE AND FORMATIVE INDICATOR CONSTRUCTS

A summated scale is composed of a number of indicators or items (i.e. observed variables). Two types of summated scales exist: reflective and formative construct scales (Diamantopoulos and Winklhofer, 2001). In general, the construct being measured is a latent variable and cannot be measured directly but is computed from one or more indicators or items. For the reflective indicator constructs, it is assumed that the observed variables or indicators (Y_i) are dependent on the latent variable (η). This is represented by the following equation: $Y_i = \lambda_i \cdot \eta + \varepsilon_i$. (*Eq. 5.5*). In this equation, η is the latent variable and Y_i represents the indicators. The standardised loading coefficient of each expected effect of latent variable (η) on its indicators (Y_i) is given by λ_i. The formative construct, in contrast, reflects the notion that "*in many cases the indicators could be viewed as causing rather than being caused by the latent variable measured by the indicators*" (MacCallum and Browne, 1993: 533). Stated differently, the formative construct is a composite measure based on explanatory indicators. According to Bollen (1989), formative constructs should be applied when constructs are conceived as explanatory combinations of indicators (e.g. indicators of a marketing mix). If the construct is reflected by a "perception" or "attitude", reflective constructs are appropriate. Formative constructs directly reflect the operational definition and strictly speaking the "*concept becomes its measure and has no meaning beyond that measure...*" (Bagozzi, 1984: 15). In a single-item measure, the latent variable (η) is equal to the empirical measure or the indicator (x): $\eta = x$. If the formative construct is composed of several indicators, the formative construct is specified by the following relationship: $\eta = \gamma_1 x_1 + \gamma_2 x_{2 + \ldots +} \gamma_n x_n$ (*Eq. 5.6*). In this equation, parameter γ_i reflects the contribution of x_i to the latent variable η, and ζ is the disturbance term. Both reflective and formative constructs are shown in Figures 5.3a and 5.3b.

Figure 5.3a Reflective construct

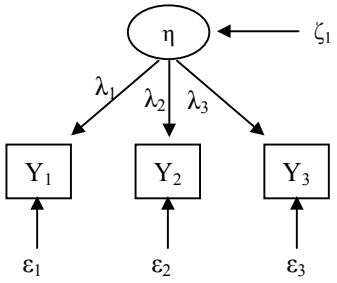
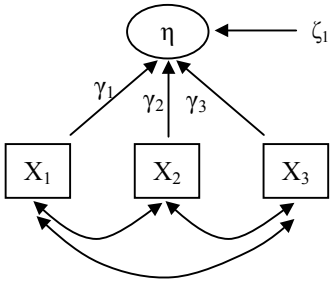


Figure 5.3b Formative construct



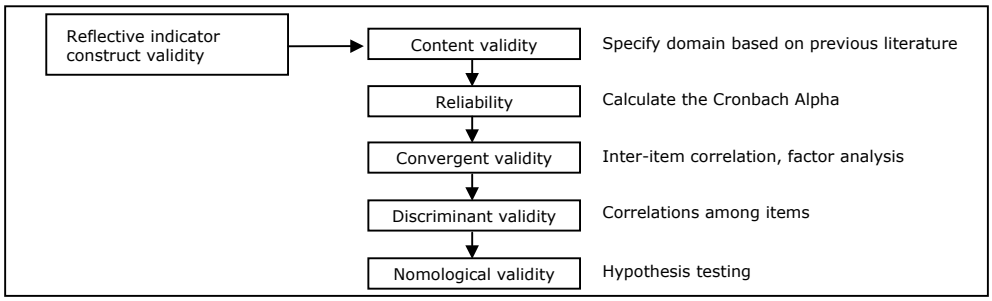
Equations 5.4 and 5.5, which represent the formative and reflective constructs, invoke several properties of the constructs. Fornell *et al*. (1991) identified up to six properties that distinguish formative constructs from reflective ones, two of which we consider sufficiently important to this research to discuss here[17]. Basically, reflective indicators are interchangeable. The fundamental principle of the underlying construct does not change if one of the items is removed. By contrast, with formative constructs "*omitting an indicator is omitting a part of the construct*" (Bollen and Lennox, 1991: 308). The second property elaborated on here is the fact is that the measurement model cannot explain correlations among formative indicators. In Figure 5.5b it can be seen that the indicators are explained exogenously. This property infers difficulties regarding the validity assessment of the formative construct. Consequently the reliability and validity of formative and reflective indicator constructs must be assessed differently. In Section 5.3.1 in addition to content validity, the nomological, the convergent, discriminant and nomological validities were discussed. The validation procedure for the reflective construct is based on these validity assessments. Figure 5.4 describes this validation procedure.

REFLECTIVE CONSTRUCT VALIDATION PROCEDURE

The procedure for the reliability and validity of the reflective indicator constructs commences with *content validity*. Content validity assesses the degree of correspondence between the items selected to constitute the construct (Hair *et al*., 1998). Stated differently, content validity refers to the extent to which the measure reflects the domain of the concept. Previous literature is important to increase the content validity of a measure (Churchill, 1979). Content validity is supported when the measurement instrument has performed well in related studies. Less-related studies that used a similar concept can also be employed to adapt the measure to our study. In addition to a literature search, a pilot study with spin-off entrepreneurs and interviews with experts was able to inform us how well the measure held in our study.

[17] For a more extensive comparison between formative and reflective indicators, see Fornell, Rhee and Yi (1991) or Diamantopoulous and Winklhofer (2001).

Figure 5.4 Validation procedure for the reflective indicator constructs



The *reliability* of the reflective indicator constructs refers to the extent that a set of indicators is consistent with what it is intended to measure. Cronbach's Alpha assesses the reliability of the construct. Furthermore, several other measures are related to reliability, such as the variance extracted, item-to-total correlation, and inter-item correlation. The item-to-total correlation shows the correlation of the item to the summated scale score and the inter-item correlation reflects the correlation among items. Threshold values are 0.50 for the item-to-total correlation and the inter-item correlation should exceed 0.30. For the Cronbach's Alpha, the measure ranges between 0 and 1 but the threshold value is generally 0.70 and 0.60 for exploratory scales (Hair *et al*., 1998).

The *convergent validity* discusses the extent to which the measure correlates with other methods designed to measure the same construct (Churchill, 1979). We assessed the convergent validity with inter-item correlations and exploratory factor analysis. The inter-item correlates display the correlation of one item of the construct with the other items of that construct. To obtain convergent validity, the threshold value for the correlation is often set at 0.3 and is significant at 95%. If the correlation does not exceed the threshold, the item has insufficient variance shared with the other items of the construct. The item is then assumed not to be indicative of the construct and should be removed. The technique of exploratory factor analysis is used to assess the extent that all items in a collective load on the right factor. The factor is the linear combination of the original variables. The factor represents the underlying dimensions (constructs) that summarise or account for the original set of observed variables (Hair *et al*., 1998). The factor loading is the correlation between the original variables and the factors. The total of all squared loadings represents the amount of total explained variance in an original variable that is explained by the distracted factors. For the factor loadings, it is important that their values exceed 0.60 and the total explained variance should be more than 60% for a measure to meet convergent validity.

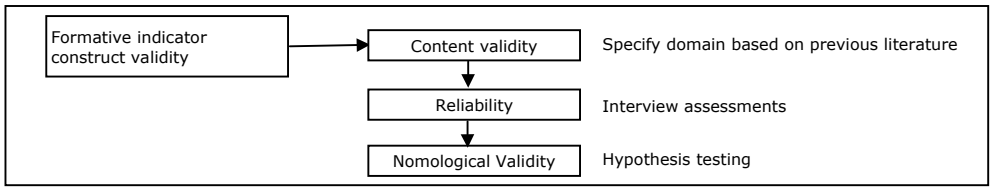
The *discriminant validity* reports the extent that an item is indeed novel and not a reflection of some other variable (Churchill, 1979). If the correlation between two conceptually different items is too high they may be measuring the same, rather than different, constructs. Discriminant validity is achieved when low correlation exists between the item of interest and other items that are supposedly not measuring the same variable (Heeler and Ray, 1972). The threshold for correlations between two items that belong to different theoretical concepts should not exceed 0.30.

Although items may all be related to the same construct, it does not prove that they relate to the specific construct that motivated the research in the first place (Churchill, 1979). According to Churchill, the measure should be tested to check whether it behaves as expected in relation to other constructs. This type of validity is labelled *nomological or criterion validity*. The criterion is assessed by empirical data. In our research we checked nomological validity by testing the hypotheses we formulated. The t-values show the extent to which hypotheses are supported.

FORMATIVE CONSTRUCT VALIDATION PROCEDURE

The test for reliability and validity of the formative indicators constructs is based on different criteria than those discussed for reflective constructs. In assessing formative constructs, the unidimensionality, reliability and convergent validity cannot be determined statistically. Formative constructs are based on items that represent a separate dimension of the concept. As a result, the items do not necessarily correlate. Consequently assessments of unidimensionality, convergent and discriminant validity are not discussed here. The content validity, reliability and nomological validity, however, can be assessed and they make up the validation procedure. Figure 5.5 illustrates this validation procedure. Similar to the procedure for reflective constructs, *content validity* is the initial check.

Figure 5.5 Validation procedure for the formative indicator constructs



Although the approach is no different from that of the reflective construct, it is important to note that the formative constructs are directly represented by their items (Bagozzi, 1984). The operational definitions used, therefore, have an impact on the breadth of the measure. If the scale does not contain a specific aspect, it may not cover the complete construct: leaving out an item is like displaying only part of a construct.

The *reliability* in formative constructs is similar to the content validity assessed by the search for items used in previous studies and the assessment of the items during interviews and pilot studies. If respondents consistently understand the meaning of items, the reliability of the construct has been met. Suppose, for example, that respondents have to guess at the meaning of a item due an imprecise specification or a misfit with the current context, responses will then tend to be more inconsistent (Churchill, 1979). Because the assessment of the interpretation of items by respondents was done during interviews, we consider the reliability of formative constructs as part of the content validity.

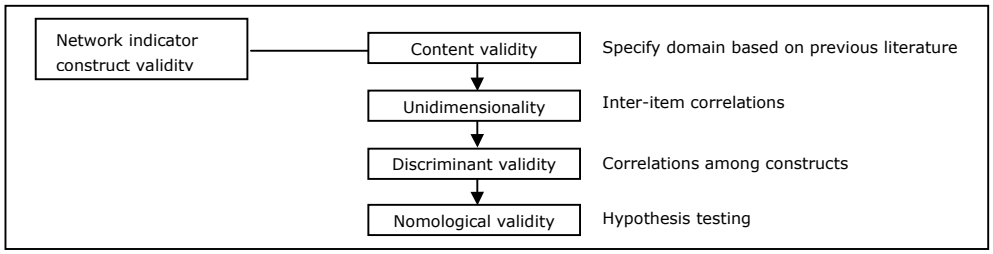
A check of *nomological validity* is done during model estimation. The extent that hypotheses hold informs us about their nomological validity.

5.4.3 NETWORK CONSTRUCTS

To determine the reliability and validity of the network measures, we followed the same approach as we did for the reflective and formative constructs, although some aspects were assessed differently (see Figure 5.6). Regarding the content validity of all network constructs, we again used the previous studies that employed similar operationalisation of the network in combination with expert opinions and respondent knowledge.

The unidimensionality could only be assessed for the tie strength measure in global terms. The directions of all tie strength items are similar but strong correlations are not necessary. The structural hole and density measures, however, are based on single or binary questions that do not allow for testing reliability and unidimensionality statistically. The data for the network measures are obtained by asking the entrepreneur (ego) to identify a set of alters connected to ego. We then asked the entrepreneur to indicate several aspects of the dyadic relations with these alters and among alters. The validity and reliability of the network measures is to a large extent dependent on the ego's ability to assess accurately these relational aspects with and between alters (Krackhardt, 1996; Marsden, 1993). During our interviews, we were able to gain some insight into the validity of the network measures. Assessment of the reliability of network measures in previous studies proved to be fairly consistent and the accuracy was determined to be well within the range of generally acceptable measurement accuracy.

Figure 5.6 Validation procedure for the network indicator constructs



For network constructs, it is important that they do not reflect similar measures. Therefore, we employed the *discriminant validity* that reports an whether the measure is indeed novel and not a reflection of some other variable (Churchill, 1979). If the correlation between two conceptually different measures is too high they may be measuring the same, rather than different, constructs. Again the threshold for correlations between two supposed concepts should not exceed 0.80. The *nomological validity* of the network constructs is again checked during model estimation. The extent that the hypotheses hold demonstrates their nomological validity.

5.5 QUANTITATIVE METHODS FOR DATA ANALYSIS

Chapter 3 discussed the theoretical models and the concepts we used to establish these models. Based on a literature review, we discussed the relationship between the concepts in Chapter 4. In Chapter 5 we discuss the measurement of the concepts. In the measurement of several constructs, we used quantitative methods to establish the construct, and for the network variables we used social-network analysis. The social-analysis techniques are based on Burt (1992), Marsden and Campbell (1984), Wasserman and Faust (1994) and Wasserman and Galaskiewicz (1994). The analytical hierarchical process, based on Saaty (1980), assesses the entrepreneurial orientation and the tie content. The concepts are then estimated in the theoretical model using multiple regression. The next sections discuss these methods in detail.

5.5.1 ANALYTICAL HIERARCHICAL PROCESS

Entrepreneurial orientation and the content of network discussions are measured by analysing the issues that entrepreneurial teams consult others over and how much relative importance they attach to these issues. During our interviews, we asked respondents to indicate issues they viewed as important to the start-up of their spin-off. To find out the relative importance of these issues, we introduced a pair-wise comparison of all issues. Based on the interviews, the technique of pair-wise comparisons proved to be satisfactory enough to apply it to the survey. In the pair-wise comparison, respondents were asked to indicate which activity was more important. Simultaneously, we asked the respondent to what extent the prioritised activity was more important compared the other activity. The method used to analyse the relative importance between the activities is the Analytical Hierarchical Process (Saaty, 1980). The pair-wise comparisons result in a matrix $A = (a_{ij})$, where each element a_{ij} gives the relative importance of activity i compared to activity j. When the respondent has made the pair-wise comparisons with complete consistency, the unknown weights of each activity can be calculated based on two characteristics of matrix A_{ij}. A consistency check is important to validate the AHP-based measures. In Appendix A4, there is further elaboration of the calculations and consistency check of the AHP.

5.5.2 SOCIAL NETWORK ANALYSIS

Many different types of social networks can be studied. In this research we use the ego-centred network design. According to Wasserman and Faust (1994: 42), "*an ego-centered network consists of a focal actor, termed ego, as set of alters who have ties to ego, and measurements on the ties among these alters*". These data are relational and display the social environment surrounding individuals. Wasserman and Faust (1994), state that the ego-centred design is often used to study social support, which refers to social relationships that aid the health or well-being of an individual. To gather the data in ego-centred networks, the name-generator technique is often used (McCallister and Fischer, 1978). This technique identifies relevant alters by asking respondents who they discussed specific issues with. For example: "*Looking back over the last six months – who are the people with whom you discussed matters important to you?*" (Burt, 1984: 119). Consequently, the respondent is asked to provide specific information on the dyadic relationship between ego

and alter and on relations among alters. Respondents' answers are often processed in a computer program, such as Uci-net. These software programs can perform a wide variety of network measures and allow for complex calculations in large networks. In our study we are interested in density, constrain, structural hole and tie strength measures. Furthermore, we aimed to analyse the content of discussions. As a result, the Uci-net program did not completely fulfil our requirements and we copied the algorithms we needed into Microsoft Excel and adapted them to our needs.

5.5.3 MULTIPLE REGRESSION

Model specification is performed with linear regression. This estimates the coefficients of the linear equation, involving one or more independent variables that best predict the value of the dependent variable. Multiple regression is based on the least squares procedure. This procedure aims to estimate the regression coefficients so as to minimise the total sum of the squares (the residuals). Each independent variable is weighted by the regression analysis procedure to ensure maximal prediction from the set of independent variables. The relative contribution of each independent variable to the overall prediction is denoted by the weights (regression coefficient: β). The set of weighted independent variables forms the regression variate, a linear combination of the independent variables that best predict the dependent variable. The regression variate is also referred to as the regression equation: $Y = \beta_o + \beta_1X_1 + \beta_2X_2 + \ldots + \beta_kX_k + \varepsilon$. In the equation, β_o represents the intercept, β_k the partial regression coefficients and ε the residual or error term. Seldom will predictions be perfect and errors will occur. It is assumed that this error is an estimate of true random error in the population (ε), and not due to error in prediction for our sample (e). Analysis of the error term allows a better understanding of the estimated variate.

When performing regression analysis, it is possible to use additional statistics and tests. The analysis calculates the number of valid cases, the mean, and standard deviation for each variable. These baseline statistics provide information on the distribution of the variables included.

Regarding the estimated model, the technique provides the regression coefficients, correlation matrix, R^2, adjusted R^2. The regression coefficient indicates the numerical value of the parameter estimate directly associated with an independent variable. The parameter represents the amount of change in the dependent variable due to a one-unit change in the independent variable. In a multiple variate, the regression coefficients are partial coefficients. Each coefficient not only represents the relationship between Y and X_1 and between Y and X_2, but also between X_1 and X_2. The correlation matrix then provides insight into the strength and direction (+ or –) of the association between any two metric variables. Values range from +1 to –1, where +1 indicates a perfect positive relationship and –1 a perfect negative, while 0 indicates no relationship. R^2 denotes the coefficient of determination that measures the proportion of variance of the dependent variable about its mean, which is explained by the independent variables. The coefficient varies between 0 and 1, and the higher its value, the greater the explanatory power of the regression equation. In other words, R^2 indicates how well the dependent variable has been predicted. The adjusted R^2 is a modified coefficient of determination that takes into account the number of independent variables. The determination coefficient increases with more variables but, if

adjusted, the value may decrease due to added independent variables that have little explanatory power. Statistical significance is provided by the *t* values. The t-values assess the confidence interval around any predicted value.

Is so required, the regression technique produces additional information such as partial correlations, change in R^2, the variance inflation factor, tolerance, and residuals and distance measures (Mahalanobis, Cook, and leverage values) (Hair *et al*., 1998). Furthermore, some insight into the distribution can be plotted with scatter plots, partial plots, histograms, and normal probability plots. Partial correlations display the strength of the relationship between a dependent variable and a single independent variable in the model if the effects of all other independent variables are held constant. The change in R^2 indicates the increase due to including or excluding an independent variable in the model estimation. The change provides information us about the increase of the explanatory power of the model by changing the number of variables. The variation inflation factor (VIF) indicates the effect that the other independent variables have on the standard error of a regression coefficient. The VIF is directly related to the tolerance value ($VIF_i = 1/TOL_i$). Large values of VIF indicate that the variable is more influenced by the other independent variables. This is also referred to as collinearity or multicollinearity. The residuals and distance measures can be used for advanced diagnosis and indicate the difference between the actual and the predicted values of the dependent variable. These residuals can demonstrate whether the underlying assumptions of regression analyses have been met and can serve as a diagnostic tool in identifying outliers and influential observations. Distance measures, such as Mahalanobis, Cook and leverage point, indicate whether a single observation has substantial impact on regression results. And DFBETA and DFFIT denote the change in the regression coefficient and change in overall model fit due to omitting a particular observation from model estimation.

5.6 CONCLUDING REMARKS

This chapter discussed the population this research addressed. The sampling of the population resulted in specific criteria for inclusion of firms as spin-offs. Furthermore, it elaborated on the questionnaire design and how preliminary interviews during case studies helped to develop this questionnaire. A discussion of measurement constructs explained how the raw data were collected and translated into constructs. Table 5.2 provides a brief overview of these measurement instruments, the operational definition used and the sources of previous studies that employed the measure. Two types of constructs are used, namely reflective and formative constructs. The procedure for reliability and validity checks for reflective constructs differs from that of formative constructs. We elaborated on the procedure for reliability and validity for each construct in this chapter. Finally, the mathematical and statistical methods we used to analyse the data were introduced. Part 3 of this manuscript presents the results of the empirical analysis.

Table 5.2 Measurement Items, their operational definition and source

Construct	Operational definition	Source	Question(s)
Growth	Difference in employee numbers between 2001 and 2003.	Birch, 1981	57
Spin-off network (social capital theory)			
Structural holes	Number of bridging ties between unconnected alters	Burt, 1992	56
Density	Average strength of connection between alters	Burt, 1992	56
Heterogeneity	Diversity of demographic backgrounds among alters	Renzulli *et al*., 2000	51
Tie strength	Strength in the dyadic relationship between ego and alter	Granovetter, 1973	52-54
Tie content	Subjects discussed with contacts	Adapted from Elfring and Hulsink, 2003; Shane, 2004	55, 36-50
Parent Involvement (social capital theory)			
Tangible support ^{F}	The level of support by the parent through tangible assets	Adapted from Allen and McCluskey, 1990; Jensen *et al*., 2003; Murray, 2004	28-31
Intangible support ^{F}	The level of support by the parent through intangible assets	Adapted from Allen and McCluskey, 1990; Jensen *et al.,* 2003; Murray, 2004	32-35
Relatedness ^{R}	The level of relatedness between the parent and the spin-off venture	Adapted from Sorrentino and Williams, 1995; Thornhill and Amit, 2000	23-26
Team resources and capabilities (resource-based view)			
Team size	The number of individuals associated in the starters team	-	1
Management experience	Number of individuals in starters team with more than 3 years' work experience in management	Adapted from Westhead *et al*., 2001; Shane and Stuart, 2002	3
Business experience	Number of individuals in starters team with more than 3 years' work experience in business environment	Adapted from Westhead *et al*., 2001; Shane and Stuart, 2002	4
Research experience	Number of individuals in starters team with more than 3 years' work experience in research environment	Adapted from Westhead *et al*., 2001; Shane and Stuart, 2002	5
Starters experience	Number of individuals in starters team with more than 3 years' work experience in another start-up venture	Adapted from Westhead *et al*., 2001; Shane and Stuart, 2002	6
Tenure diversity	Average score of team members with more than 6 months difference in being part of the spin-off starters team	Adapted from Ancona and Caldwell, 1992a; Reagans and Zuckerman, 2001	2
Functional diversity	Average score of team members with different functional experiences	Adapted from Ancona and Caldwell, 1992a; Reagans and Zuckerman, 2001	3
Industry diversity	Average score of team members with different industry experiences	Adapted from Ancona and Caldwell, 1992a; Reagans and Zuckerman, 2001	5
Team cohesion	Average score of team members that knew each other before being part of the starters team	Adapted from Ensley *et al*. (2002)	7
Entrepreneurial orientation ^{F}	Teams orientation to market activities, partnerships and financial support	Adapted from Stevenson and Gumpert (1985)	36-50
Control			
Newness to the team ^{R}	Level of newness of the market and activities to the spin-off team members	Adapted from McGrawth, 2001	12-15
Newness to the market ^{R}	Level of newness of activities to the market in which the spin-off operates	Adapted from McGrawth, 2001	16-18
Capital Intensity^{R}	Level of investments needed	Adapted from Miles *et al*., 1993	19-22
Age	Number of years since the spin-off started	-	8
Size	Number of employees (fte) in the spin-off company	-	57

(Constructs market with an ^{F} are formative constructs and constructs marked with a ^{R} are reflective constructs)

CHAPTER 6 EMPIRICAL RESULTS

This chapter presents the results of the case studies and the survey. The case studies were conducted with spin-off entrepreneurs and officials at knowledge institutions. The case studies serve to provide a better understanding of the factors that influence the early growth of spin-offs and to develop a survey questionnaire applicable to academic spin-offs. The results of the case studies are presented in Section 6.1 and those of the survey in Section 6.2. This section starts with a preliminary evaluation of the study sample followed by a baseline description of the spin-offs that responded to the questionnaire. Observations regarding the age and size of the firms, their performance levels and the role of the sector they operate in are discussed here. Next, a response analysis explains which organisations responded to the questionnaire and whether non-respondents would pose a problem in evaluating the data.

The constructs are evaluated in Section 6.3. The questionnaire uses formative, reflective, and network constructs that need different methods to assess their validity and reliability. Section 6.4 presents the estimated model that explains the early growth of the spin-off based on the theoretical framework. The model indicates the role of networks and resources on the early growth of spin-offs. Finally, in Section 6.5, the network of spin-offs is further explored. This section investigates the network typologies that are used to discuss certain topics, such as technological development or market information, and the importance of these topics.

6.1 CASE STUDY RESULTS

The case studies were conducted with spin-off entrepreneurs and officials in knowledge institutions. Data were collected from eighteen spin-off entrepreneurs and five officials at knowledge institutions. Table 6.1 provides the baseline description of the eighteen spin-offs.

Table 6.1 Characteristics of the spin-offs in the case studies

Sector	Start date	Size 2003	Team size	Parent[1]	Autonomy
Consulting	1997	8	2	RUG-UMCG	66
Life Sciences	1997	20	2	WUR-ATO	100
Life Sciences	1997	24	4	WUR-IDL	10
Life Sciences	1997	25	6	RUG	100
ICT/ the media	1997	37	4	WUR-PRI	0
Consulting	1999	1	1	WUR-PRI	100
Life Sciences	1999	4	3	WUR-IDL	100
ICT/ the media	1999	6	2	RUG	70
Consulting	1999	7	3	RUG	0
Life Sciences	2000	11	2	RUG	64
Life Sciences	2000	15	4	WUR	90
Life Sciences	2000	20	5	WUR-IDL	0
Consulting	2001	1	1	WUR-PRI	100
ICT/ the media	2001	2	3	RUG	100
Life Sciences	2001	3	1	WUR	0
Life Sciences	2001	6	4	WUR-PRI	0
Consulting	2001	12	3	RUG-UMCG	67
Life Sciences	2001	25	4	VUmc	20

1WUR = Wageningen Universiteit and Researchcentrum; VUmc = Vrije Universiteit Medisch Centrum; WUR-IDL = WUR ID Lelystad; WUR-PRI = WUR Plant Research International; WUR-ATO = WUR Agrotechnologisch Onderzoeksinstituut; RUG = Rijks Universiteit Groningen; RUG-UMCG = RUG Universitair Medisch Centrum Groningen.

The baseline descriptions in Table 6.1 show that 10 spin-offs are operating in the life sciences, 5 in consulting and 3 in ICT/media. The spin-offs started between 1997 and 2001, and range in size from 1 employee to 37 employees. The spin-offs in the life sciences are bigger and have larger management teams compared to the other spin-offs, with the exception of a single case in the ICT/media. Autonomy refers to the extent to which the starter's team owns the shares in its spin-off. The table shows that there are wide differences in the percentage of shares owned by entrepreneurs. External parties more often own shares in the spin-offs in the life sciences, compared to the spin-offs in ICT/media and consulting. This is probably because spin-offs in the life sciences are more dependent on external funding to get their spin-off founded initially.

6.1.2 SPIN-OFF ENTREPRENEURS

The spin-off entrepreneurs were asked about their start-up activities. Questions addressed the importance of these activities during start-up and with whom these activities were discussed. The findings from the interviews for each activity are discussed below.

IDENTIFICATION OF THE IDEA

For many spin-offs, the stepping stone to starting a new venture was the identification of the business idea. Indicating the exact moment of identification proved to be difficult. Because the idea had emerged from research activities, the scientists had often been thinking about the possibilities over a long period of time. In some cases, the scientists were already performing the business activity within the parent organisation before the spin-off was founded. As a result, the spin-off founders often indicated that they did most of the "idea identification" themselves. In other words, the resources and capabilities of the scientists were important. They also indicated that the idea was discussed with colleagues within the knowledge institution. They discussed with family members whether it would be wise to quit their jobs as scientists and become self-employed.

TECHNOLOGY DEVELOPMENT

Questions concerning the development of technology were aimed at evaluating technological options. The spin-offs had to make choices with respect to the types of technologies available to work out in more detail which technologies to use and to capitalize on. However the case studies clearly revealed that the importance of technological development is dependent on the degree of exploration. Entrepreneurs in consulting spin-offs indicated that further research was not necessary. Some consulting firms even stated that the knowledge they had developed during this research was too complex for customers, and they simply did not need such expertise. Several spin-offs in the life sciences indicated that they needed a strong relationship with the parent organisation to develop technological knowledge, but also the parent's help to find a large buyer. One entrepreneur indicated that the parent was crucial to opening doors to large pharmaceutical firms. He stated: "*we may have the knowledge but not the managerial capabilities to run the clinical tests*". The spin-offs that act as a mediator between the knowledge institution and the industry are performing contract research for industry. Spin-offs in ICT/media mentioned that technology development was not important. Often the existing technology was adapted but this was part of the order they received from customers.

TECHNOLOGY TRANSFER, NEGOTIATING IP

Negotiating the transfer or licensing of intellectual property rights was done with officials from the knowledge institution. Some entrepreneurs indicated that the negotiations were difficult, and they had little experience handling such talks. As one entrepreneur put it: "*if you don't want to become a puppet, you need an independent counsellor who can do the negotiations for you*".

MARKET APPROACH

"Market approach" addresses how the market opportunities were evaluated and how initial customers were approached. There are large differences between the sectors. ICT/media and consulting spin-offs explained that they evaluated the market with business contacts and approached customers themselves. Several spin-offs in the life sciences were still developing their technology and had attracted finance to cover their R&D activities. One had just begun sending samples to potential clients. Other spin-offs in the life sciences were

more active in selling their products to customers, and indicated that referring to their roots in a knowledge institution was often beneficial in convincing potential customers of their capabilities. One spin-off entrepreneur indicated that the parent was very helpful in setting up a contract stating the terms of delivery. But many spin-offs indicated that selling their business proved difficult. When starting the spin-off, they knew very little about the demands of customers or how competition works. As an entrepreneur said: "*To become acquainted with the techniques of selling involves a lot of energy and probably we will never learn them. Attracting a real salesman is crucial*."

ATTRACTING FINANCIAL BACKING

Attracting financial backing was not important for all spin-offs. Some were already operating their business within the parent organisation and received income from the first day onwards. However, many spin-offs in the life sciences are heavily dependent on the development of technology, and it may take a longer period of time before financial returns can be expected. As a result, they need financial resources. The case studies revealed several important issues regarding the involvement of the parent organisation. The long period of development not only required initial and often substantial investment but also good planning and management. In such cases, investors typically do not want others to be involved as this may hinder product development. In one case, the initial parental investment in the spin-off later turned out to be crucial in attracting private investors to invest. The private investors were reassured about the credibility of the spin-off.

OBTAINING EQUIPMENT, OFFICE AND LABORATORY SPACE.

Many spin-offs said that getting equipment, ofifce and laboratory space was not a problem or a necessity. Regarding equipment, spin-off firms in the life sciences indicated that they were allowed to use the equipment of the parent organisation, but that as soon they had been officially set up, the Mibiton Foundation was a good source of assistance. Mibiton provides investments and equipment for start-ups in the life sciences. Some spin-offs in consulting also mentioned that their parent organisation's equipment was often too specific or too sophisticated. As one spin-off entrepreneur in consulting explained: "*many tools can be easily bought on the market, but if we need something special we can always go back to the university and borrow it*."

ORGANISING THE FIRM VAND ESTABLISHING ADMINISTRATIVE SUPPORT

Several spin-offs indicated that the organisation of the firm was a time-consuming task. Dealing with tax, legal and personnel issues was often seen as an obligation that did not contribute in material terms to the spin-off. As a matter of fact, many spin-offs indicated they were neither good at such matters nor interested in them. Contacts from the business environment were often approached to deal with these issues. Other spin-offs, especially those in the life sciences, could benefit from the knowledge available within the parent organisation. Spin-offs that are operating as a mediator between the knowledge institution and the business environment typically outsourced their administrative tasks to their parent organisation.

6.1.3 KNOWLEDGE INSTITUTIONS

The interviews with knowledge institutions were done with five officials; two were heading a research group, two were new-business development (NBD) managers and one was a programme manager of the spin-off programme.

IDENTIFICATION OF THE IDEA

The respondents at knowledge institution indicated that the identification of the business idea basically lies within the research group. They are better equipped to assess whether a finding is appropriate for a spin-off. Respondents indicated, however, that these groups were not actively searching for spin-off possibilities but focus more on contract research and licensing to existing companies. They are confident that these companies are able to commercialise the intellectual property rights without the help of a knowledge institution, and that the knowledge institution could expect financial returns in a relatively short period of time.

TECHNOLOGY DEVELOPMENT

The new-business development managers indicate that radical innovations are not a primary source for spin-offs. These activities are at a stage where it is too early for a company to run a viable business based on them. Furthermore, they noted that it is important to keep spin-off activities separate from the primary process that takes place in a knowledge institution. After all, as one of the new business development managers indicated: "*a spin-off remains a side effect of the daily activities at our research institution*".

TECHNOLOGY TRANSFER AND NEGOTIATING IP

The new-business development managers indicated that, in principle, existing firms are invited to be involved in technology transfer. Sometimes a finding is made that lies outside the field of interest of a knowledge institution. Then it is difficult to find an appropriate firm and a patent-broker is often involved since they know the market and can make contact with firms that are outside the knowledge institution's immediate network

MARKET APPROACH

The managers in the research groups indicated that it was not their task to conduct market activities for a spin-off. But the interviews revealed that they were often involved in such activities. They help spin-offs to put together contracts or passed orders to the spin-off. In other cases, managers were helpful in referring spin-offs to individuals in the business environment who could help them break into the market. Teams of spin-offs that were funded by external parties were frequently reinforced with a salesman or experienced entrepreneur who had contacts in the business environment and could promote the business.

ATTRACTING FINANCIAL BACKING

Being involved in spin-offs and finding finance were tasks that new-business development managers were reluctant to becaome involved in. A research group that is financially involved and actively participating in a spin-off can easily face conflicting interests. They strongly advise setting up a spin-off activity that is separate from the other activities in their

research institution. Also spin-off programme managers indicated that spin-offs could learn from experience and discuss this when they meet each other. Network meetings are therefore often helpful. At these meetings entrepreneurs can exchange experiences and meet others interested in spin-off activities. Regarding the attracting of finance, university officials explained that it was neither their goal nor their duty to invest in private firms. And a head of a research group explained that finding financial backing from outside the parent organisation is a good indicator of the viability of the spin-off. Moreover, one of the NBD managers explained that spin-offs based on experimental projects have to perform too many explorative activities and are unlikely to capitalise on their knowledge, within a reasonable time span. To attract finance, spin-offs need to exploit their activities and generate cash flow in the short run and, at the same time, explore activities that will offer potential in the long run.

OBTAINING EQUIPMENT, OFFICE AND LABORATORY SPACE

The managers of research groups and new-business development managers were adamant that they had to justify their expenses and that being financially involved in spin-offs or providing them with office space or equipment could not be at the expense of other activities. If spin-offs were able to pay for the equipment, there was no problem. One manager explained that spin-offs could make use of equipment at operating cost but only when the research group was not using the equipment. Although they mostly operate in this way, some managers were aware that internal competition for resources could be a cause of spin-off failure.

ORGANISING ADMINISTRATIVE SUPPORT

Scientists are not allowed to work in a spin-off during working hours. Nascent entrepreneurs were often appointed by their employer as an entrepreneur and no longer as a scientist. They were paid but their wages were in fact loans they had to pay back later. Helping a spin-off in its organisational activities such as administrative tasks or with legal issues was not a problem. But as one NBD manager and its spin-off programme manager explained: "*we don't want to pamper them too much, it must be the entrepreneur who drives the spin-off and soon we will know if he or she is capable enough*".

6.1.4 EVALUATION OF CASE STUDIES

The case studies offered insight into the role that important actors play in several start-up activities and provided knowledge about the two organisational theories that explain the early growth of academic spin-offs. The case studies show that spin-off entrepreneurs are good at conducting research activities. Setting up a firm and selling its products or services were more complicated and the social capital of the team was important in substituting for any deficiencies. Spin-offs in the life sciences in particular needed capabilities they had to find in their network. To work out technological leads, the filing of patents and making choices about markets to approach, spin-offs often needed expert knowledge. This knowledge had to be found either in the parent organisation or in their business environment. The consulting and ICT spin-offs were less dependent on expert knowledge. The capabilities they needed to run their businesses were less diverse and often already

present in the start-up team. A systematic discussion of the external network was time-consuming; discussions were often focused on the role of the parent organisation. If the parent did not contribute, the spin-off entrepreneurs mentioned that they did the work themselves. Follow-up questions revealed that contacts outside the parent network were also important. The entrepreneurs often blamed the parent for not doing enough but frequently they expected too much from the parent, in our view`.

6.2 SURVEY RESULTS: PRELIMINARY EVALUATION

In 2003, 279 firms were mailed and 89 responses were received (see Table 6.2). However, eight of the start-ups that did reply could not be considered as an academic spin-off according to our definition (see Section 5.1.1) because they were not based on scientific research. This may be due to the fact that students who had not participated in academic research programmes had started these firms, or they were organised by scientists who started a company in an area that was unrelated to their previous research efforts. Alternatively, the universities may have been open to external start-ups. The number of eligible spin-offs was 81, making an effective response rate of 29%. Ten spin-offs did not return a completed questionnaire, primarily due to the fact that this research project focused on start-ups and some started in 2002 or later. For these young spin-offs we could not establish the pace of their early growth, which was calculated from the difference in employee numbers between 2001 and 2003. Calculation of early growth takes into account the influences of growth for small and large firms (see Section 5.3.4). Small firms grow faster in percentage than in absolute terms, while large firms grow faster in absolute terms. The correction applies only to spin-offs that grow: firms that have shrunk in size have not been included.[18]

Table 6.2 Summary of survey response

	First batch March 2003	Second batch October 2003	Total
Mailed	**88**	**191**	**279**
Responded directly	**18**	**23**	**41**
Not a spin-off	-	2	2
Total eligible	18	21	**39**
Missing data	2	3	5
Decreased in size	1	2	3
usable	**15**	**16**	**31**
Responded after reminder	**15**	**33**	**48**
Not a spin-off	1	5	6
Total eligible	**14**	28	**42**
Missing data	1	4	5
Decreased in size	1	2	3
usable	**12**	**22**	**34**
Total responded	**33**	**56**	89
Total eligible	**3**2	**49**	81
Total usable	**27**	**38**	**65**

[18] In the estimation we included the 6 firms that were shrinking in size and set their growth index at zero. The regression results displayed smaller parameters and less significance for the variables, but the 6 firms did not influence our conclusions of the model estimation.

Section 6.2.2 analyses the effect of the non-response analysis. This analysis investigates the companies that did not reply to the questionnaire by assessing the differences between the 16 spin-offs that were dropped for estimation and the 65 that were eventually used. Furthermore, the questionnaire was sent in two batches, one in March 2003 and the other in October 2003. The data are also assessed for differences in the first and second batch and for differences in those who responded directly and those who responded after a reminder was sent. Section 6.2.3 discusses the formulation of constructs and their validity and reliability for the data of the 65 responses.

6.2.1 BASELINE DESCRIPTION OF SPIN-OFFS

A baseline description is given in Table 6.3 for all the spin-offs that responded to the questionnaire. The baseline description includes figures about the size and age of the spin-off, its autonomy and the size of its management team and its external network. Table 6.3 presents the average and standard deviation of these figures for the total data set and for the spin-offs in life sciences, ICT/the media and consulting practices, separately.

Table 6.3 Characteristics of the spin-offs in sample

	Number of spin-offs	Spin-off size	Spin-off age	> 50% autonomy***	Management team size	Network size
	count	mean (SD*)	mean (SD)	count (perc.)	mean (SD)	mean (SD)
	n	Fte**	years	n	fte	n, alters
Life sciences	31	10,6 (11,4)	2,6 (1,7)	14 (45%)	3,2 (1,5)	3,9 (1,5)
ICT/the media	21	4,8 (3,9)	3,0 (1,4)	19 (90%)	3,0 (1,3)	3,4 (1,8)
Consulting	29	6,1 (6,4)	3,9 (2,1)	23 (79%)	2,6 (1,2)	4,1 (1,2)
Total	81	7,5 (8,6)	3,2 (1,9)	56 (69%)	2,9 (1,4)	3,8 (1,5)

*SD = Standard Deviation, **fte = full-time employees, *** >50% autonomy = majority of shares are held by the management team

Table 6.3 shows that of the 81 respondents, 31 (38%) spin-offs are active in the life sciences, 21 (26%) are spin-offs in ICT/media and 29 (36%) are involved in consulting practices. Regarding the spin-off's size, age and autonomy, the table shows large differences between the biotech/life sciences, and ICT/the media and consulting spin-offs. The table shows that life science spin-offs are much larger (having more full-time employees) than the ICT/the media or consulting spin-offs. Furthermore, compared to the ICT/the media and the consulting spin-offs, the life science spin-offs are younger. Spin-offs in the life sciences already start off on a larger scale with more employees, right from the beginning. Most spin-offs in the life sciences are not owned by the own management team: only in 45% of the cases (n=14) does the starters' team hold a majority of the shares. For ICT spin-offs, 90% have more than 50% of the shares in their spin-off, and in consulting spin-offs this applies to almost 80% of the spin-offs. Regarding the management team size and the number of important contacts in their network, spin-offs in the life sciences have the largest teams, while ICT/media spin-offs have the smallest number of important network contacts.

The differences between the sectors were analysed using the analysis of variance technique. The findings show that regarding the size of the spin-off, spin-offs in ICT/the media

(p=0.02) and consulting (p=0.05) are significantly smaller than those in the life sciences. Regarding the age of the spin-off, the findings show that consulting spin-offs have existed significantly (p=0.05) far longer than spin-offs in the life-sciences and slightly longer (p=0.08) than ICT/the media spin-offs. Analysis of the autonomy of spin-offs reveals that both ICT/the media (p=0.03) and consulting (p=0.04) spin-offs differ significantly from life-science spin-offs. Finally, the analysis indicates that the management teams in spin-offs in the life sciences are larger (p=0.03) than those in consulting.

The extent to which parent involvement varies for the three sectors is was also analysed. Life-science spin-offs are most closely related to their parent, which differs significantly from ICT spin-offs (p=0.00) and consulting spin-offs (p=0.01). For the two types of support, life-science spin-offs and consulting spin-offs received significantly more tangible support (both p=0.00) and more intangible support (also both p=0.00).

For network variables, sector comparisons only indicated significant differences for network heterogeneity and not for the number of structural holes in the network or the tie strength. Both the spin-offs in the life sciences (p=0.00) and in consulting (p=0.03) have more heterogeneous networks.

Regarding the resources and capabilities of the team, the analyses of variance indicate that the spin-offs in the life sciences have the highest average of research experience with 2.3 individuals, while ICT have 1.9 individuals and consulting 1.6. The difference between the life sciences and consulting is significant (p=0.03). Furthermore, spin-offs in ICT have significantly more industry experience in the team compared to the other spin-offs (p=0.02 for both the life sciences and consulting). The ICT spin-offs also had more sector diversity in their teams (again p=0.02 for both the life sciences and consulting). On the other hand, the ICT spin-offs showed significantly less entrepreneurial orientation compared to consulting (p=0.02) and to life sciences (p=0.07). Finally, the spin-offs in ICT (p=0.05) and consulting (p=0.01) were significantly more cohesive than spin-offs in the life sciences. In other words, the team members of life-science spin-offs were less familiar with each other before the spin-off was set up. For the other variables of team resources (management and starters experience) and for the teams' tenure and function diversity no significant differences were found.

6.2.2 Analysis of Response, Non-Response Bias and Informant Selection

Analysis of the responses provides insight in how well the research sample represents Dutch academic spin-offs. Table 6.3 has already shown that the responses were quite balanced regarding the sectors. The percentage of spin-offs from each sector is between 26% and 38%, so no single sector represents the majority of spin-offs. Although many spin-offs start in the life sciences or ICT, their absolute number is not striking. In other spin-offs studies, the life-science spin-offs and the ICT/media spin-offs are also very much present (Thornburn, 2000; Nicolaou and Birley, 2003b). Thornburn (2000) found that Australian spin-offs in life sciences accounted for almost 40% of the total number of spin-offs founded between 1971 and 2000. Nicolaou and Birley (2003b) categorised the spin-offs in Cambridge, UK, regarding their technological backgrounds: in biotechnology, software/ICT and new techniques in medicine such as diagnostics and instrumentation. And in the US, Shane (2004) found that in biotechnology spin-offs are the dominant type of

start-up. In our sample, besides the life sciences and ICT/the media, other spin-offs are mainly active in consulting. Consulting practices and activities in ICT/the media may require relatively low investment when compared to the high level of investment needed for laboratories, equipment and long periods of time before revenue appears as it generally does in the life sciences. As a result, the estimation of the model focuses more on the level of investment than on the sector that spin-offs operate in.[19]

Comparing the spin-offs used for model estimation and those excluded from the analysis shows that the excluded spin-offs are smaller and operate more autonomously. The excluded spin-offs are those that started after 2003 or that shrunk in size (see Table 6.2). Using t-tests, the significant differences are not large for the baseline description.[20] A non-response analysis addresses the impact on the estimated model of the spin-offs that did not reply to our questionnaire. To analyse the non-response, the extrapolation method was used (Armstrong and Overton, 1977). The method assumes that respondents who returned the questionnaire after the reminder were less prepared to complete it and can therefore be considered as close to non-respondents. The extrapolation method compares the baseline description and some main constructs used in the model estimation of the early respondents with those of the late respondents. Again parametric (t-test) and non-parametric tests (Mann-Whitney test) were used to assess the differences between early and late respondents (see Table 6.4). The 48 late respondents, which are considered to be close to non-respondents, do not significantly differentiate (95% significance level) for any of the constructs. Regarding the baseline description, it can be seen that the early and late respondents differ on firm size and firm age. But only age is weakly significant, meaning that young spin-offs that are growing quickly were more eager to fill out the questionnaire. As an overall conclusion, it appears that non-response bias does not pose a significant problem in this research.

Table 6.4 Analysis of spin-offs that responded directly and after reminder

	Number of spin-offs	Spin-off size	Spin-off age	> 50% autonomy	Team size	Network size
	count	mean (SD)	mean (SD)	count (perc.)	mean (SD)	mean (SD)
Spin-offs …	n	fte	years	n	fte	n, alters
responded directly	41	9.2 (10.1)	2.8 (1.5)	26 (63%)	3.0 (1.5)	3.9 (1.5)
responded after reminder	48	5.8 (6.2)	3.6 (2.2)	36 (75%)	2.8 (2.6)	3.7 (1.6)
significance test	-	0.084	0.048	0.265	0.374	0.702

The quality of the response was dependent on the respondent who filled out the questionnaire. The questionnaire was sent to the main entrepreneur: the founder, owner or chief executive officer of the spin-off. This individual was believed to be the best person to provide the relevant data on the spin-off and the person most likely to know the important network contacts that existed at the firm level. The use of the main entrepreneur as the

[19] In the regression analyses we captured the various sectors by the level of investment. We also ran models with sector as a dummy but could not confirm any significant influences of these sectors on the early growth of spin-offs.
[20] Parametric tests (t-test) and non-parametric tests (Mann-Whitney test) were also applied to the variables but did not show significant differences.

informant is in common with other entrepreneurial studies that have analysed firm resources and networks (e.g. Renzulli *et al*., 2001; Shane 2000; Brüderl *et al*., 1992). We therefore feel confident that our respondents were sufficiently knowledgeable to provide information about the resources and the external network of the spin-off. Since we only asked one single person in the spin-off to provide us with data, we checked the dependent variable of the study, growth rate, with secondary sources. We used the Reach database and the sector reports by Biopartner[21] to assess the size of the firms and no anomalies were found when the data were compared.

6.2.3 RELIABILITY AND VALIDITY OF CONSTRUCTS

This study uses three types of constructs: reflective, formative and network constructs. Each type of construct needs a different approach to assess its reliability and validity. In the reflective constructs indicators are interchangeable as was discussed in Section 5.4.2. On the other hand, formative indicators reflect different dimensions of the underlying construct. As stated before, leaving out one item/dimension is to leave out a part of the construct. Furthermore, the network constructs are based on a single indicator. Each type of indicator needs a different approach to assess its reliability and validity. This section discusses the reliability and validity of each type of indicator.

REFLECTIVE INDICATORS

In this research, reflective indicators are present among the control variables. These reflective indicators are the *newness to the team*, the *newness to the market*, and the *level of capital intensity*. Assessment of the validity and the reliability of these constructs is based on the procedure outlined in Figure 5.4. The *content validity*, or face validity of the constructs is based on a literature review and is elaborated on in Chapters 3 and 4. The extensive literature discussions in the second chapter form the basis of the content validity. The constructs for newness to the team and newness to the market are based on the work of McGrath (2001). During the interviews respondent were asked to reflect on these questions. The questions were adapted to the context of spin-offs so that our scale was able to measure both types of newness. In a similar way, we adapted the scales for level of capital investment based on industry variety (Miles *et al*., 1993). The interviews indicated that the construct captured the level of investment well enough to validate the content of the measure. Finally, the construct of relatedness is based on Sorrentino and Williams (1995), Thornhill and Amit (2000) and Sapienza *et al*. (2004). Since the first two articles focused on industrial spin-offs, we adapted the items during our interviews to our setting of academic spin-offs. Thus, the content validity of the reflective constructs has been verified.

Prior to the assessment of the reliability and validity of the constructs, a factor analysis on all the items was performed to find a way to condense the information that was presented by a number of variables into a smaller set of composite dimensions, with a minimum loss of information (Hair *et al*., 1998). Factor analysis based on principal component analysis and varimax rotation for extracting the factors was used (see Table 6.5). For sample sizes

[21] The Reach Database is a database containing statistics of 328.000 Dutch companies: http://reach.bvdep.com. Biopartner was until 2005 a Dutch organisation set up by the national government to facilitate start-ups in the life sciences. Every year Biopartner produced a sector rapport of the Dutch life-science industry: www.biopartner.nl.

less than 100, the lowest loading to be considered significant would, in most instances, be 0.30 (Hair *et al*., 1998). Loadings that exceed 0.70 account for 0.50 per cent of the variance of the item. The five factors that are extracted cover 75% of total variance in all items and are consistent with our supposed constructs (see Table 6.5).

The items that load on the same factor define the construct. For the items of each respondent, factor analysis calculates a new factor score. The composed construct is then based on the factor score multiplied by the average of corresponding items. The level of capital investment is constructed by summating the composed constructs for investment in the market and investment in R&D. The *reliability* of each construct reflects its internal consistency and is assessed with Cronbach's Alpha. Table 6.5 shows the calculated coefficients of reliability. Although the construct of newness to market is an exception, all the other constructs showed coefficient values above the threshold of 0.60 for explorative research (Hair *et al*., 1998).

Table 6.5 Principal component factor analysis, loadings > 0.6 (n=65)

Item	Factor loadings					Composed Construct	Cronbach Alpha	Item total correlation
Development process was new to us	**.85**	-.02	-.14	.23	-.09	Newness to team	0.83	0.68
Technological expertise was new to us	**.74**	.01	-.06	.11	-.15			0.57
Customers' demands were new to us	**.89**	-.12	.08	-.10	.05			0.80
Competitor behaviour was new to us	**.74**	-.05	.35	-.14	.13			0.60
We started with simple innovation	-.29	**.73**	-.11	-.03	.13	Newness to market	0.62	0.38
We could do more than market asked	.16	**.81**	.00	.18	.01			0.47
Exploitation of expertise after a while	-.08	**.62**	-.24	.25	-.26			0.43
High investments in marketing	.07	-.16	**.88**	-.14	-.18	Investment market	0.80	0.66
High investments in client approach	.00	-.07	**.89**	.11	.04			0.66
High investments in R&D	.12	.14	-.02	**.89**	-.03	Investment R&D	0.80	0.67
Many people will stay in R&D	-.02	.15	.00	**.87**	.02			0.67
Customers are similar to parent's	.15	-.09	-.00	-.16	**.82**	Relatedness	0.85	0.67
Business partners are similar to parent's	.06	.12	-.12	-.11	**.84**			0.68
We supplement parent's activities	-.13	-.08	-.02	.06	**.88**			0.79
Knowledge field is similar to parent's	-.18	.01	.03	.18	**.76**			0.61

The *convergent validity* assesses the extent that indicators of a construct, which theoretically should be related to each other, are empirically related. The item total correlations for all item pairings were checked and all pairings scored above the threshold of 0.3. This confirms the convergent validity of the reflective constructs. The test for *discriminant validity* shows the extent to which measures that should not be related are in reality not related. Correlation analyses of all items were not significant (no values were above the threshold of 0.3), and they confirmed that discriminant validity was established. The *nomological validity* is determined by the estimation of the regression coefficients. The significance of constructs in the model demonstrates that the measures are valid in nomological terms.

FORMATIVE INDICATORS

The present study uses several formative indicators. Concerning the social capital variables, the levels of tangible and intangible support are formative indicators. And regarding the resource-based view, the measures for the amount of experience and diversity, and the entrepreneurial orientation are formative indicators. The formative indicators are based on summated scales; each item has an equal weight (linear summation) to the overall construct. As explained earlier, formative indicators need another approach to determine their construct validity. To establish construct validity, we analysed the *content validity,* the *reliability* and the *nomological validity* to assess the scores for the validity of the formative indicators.

FORMATIVE INDICATORS: PARENT INVOLVEMENT CONSTRUCTS

The degrees of tangible and intangible support are both constructs that refer to parent involvement. *Content validity* is based on previous studies of business incubation (Allen and McCluskey, 1990; Rice, 2002). The reference to similar or equivalent spin-off support activities by numerous studies (Chan and Lau, 2004; Mian, 1997; Rice, 2002) indicates that content validity of our tangible and intangible support constructs is satisfactory. The *reliability* of the parent support constructs is assessed during the interviews in the case studies. Interviews were held with spin-off entrepreneurs and with officials in universities and research institutions to cover the important aspects of spin-off support and the extent to which respondents viewed the types of support in a similar way. As Churchill (1979) explained, when respondents perceive the questions in the same way as others do, the inconsistency of the measure will be less. The estimation of the model assesses *nomological validity*. The final model (Table 6.7) shows significant effects of the tangible and intangible support variables on the dependent early growth variable, and thereby establishes the nomological validity.

FORMATIVE INDICATORS: TEAM RESOURCE AND CAPABILITY CONSTRUCTS

The resource constructs, for example the experience and capabilities of founding teams, have a history of wide acceptance in business literature, especially regarding studies in start-ups and entrepreneurship (Brüderl *et al*., 1992; Chandler and Hanks, 1994; Westhead *et al*., 2001). Based on previous empirical studies, the resource constructs were introduced in a similar way, thereby substantiating the *content validity* of our constructs. During the case studies, spin-off entrepreneurs were asked about important skills and resources, and officials in knowledge institutions were consulted about the resources they found important in individuals when starting a spin-off. Resources that were indicated as important were research-, management-, business- and start-up experience, and important capabilities included tenure-, function- and industry diversity, cohesion in the team, and entrepreneurial orientation. These resources and capabilities were tested during interview to see whether spin-off founders could differentiate the types of experience and capabilities. The findings proved the *reliability* of the formative constructs. The *nomological validity* of the team resources and capability constructs was assessed by multiple regression analysis. Several resources proved to be significant and as a result verify nomological validity. Concerning team capabilities however, no significant regression coefficients were found, but we believe that the nomological validity is not under debate.

NETWORK INDICATORS

The network constructs density, structural holes, heterogeneity, tie strength and tie content are basically all formative constructs. Therefore, the validity procedure for formative constructs was followed. In addition, a check for discriminant validity was done because the network variables were conceptually closely related. Discriminant validity shows the discrepancy of the concepts. The network indicators of density, heterogeneity and structural holes refer to structural embeddedness, while tie strength and the content of the tie refer to relational embeddedness.

The *content validity* of the constructs is based on numerous studies that applied the instruments in various fields of research. Many literature reviews discuss the conceptual meaning of social capital and the applications of the various instruments (Nahapiet and Ghoshal, 1998; Adler and Kwon, 2000; Burt, 2000; Borgatti and Foster, 2003). Moreover, many books are dedicated to the concept of social capital and have explained the methods and applications of the various instruments (Leenders and Gabbay, 1999; Wasserman and Faust, 1994; Wasserman and Galaskiewicz, 1994). Some studies have focused on a single instrument (Marsden and Campbell, 1984; Burt, 1992). Burt (1985, 1992) uses the network density and the number of structural holes in a variety of settings. The tie strength measure by Granovetter (1973) is also deployed in numerous studies and in various contexts. Concerning the value of ties, we analysed studies that focused on start-up activities (Reynolds, 1994; Gatewood *et al*., 1995) to show that our network measures were suitable in terms of content validity.

The reliability of the network variables was analysed in the same way as the formative constructs. Based on the interviews with spin-off founders, the network questions were adapted until respondents clearly understood the purpose and meaning of each question. Especially the questions concerning the value of the tie, which were compiled with the analytical hierarchical process (AHP), needed careful formulation. The reliability of the AHP measure was obtained by using the inconsistency check (see Appendix A4). To secure the internal inconsistency of the AHP measure, we followed the procedure presented by Winston (1997). This is based on a 9-point scale to measure a respondent's preferences. During our interviews we realised that the 9-points scale would be too exhaustive in combination with the other questions on the questionnaire. As a result, we turned the 9-point scale into a 5-point scale. The reduced scale did not prove to be inferior in terms of the information we obtained and in addition reduced the likelihood of confusion. But the chances of inconsistency increased due to the smaller scale. Consequently we had to establish a new value for the random index to calculate the inconsistency (see Appendix A4). We ran 120 simulations for random inconsistency and attained a new value to check the random consistency of our measure. We calculated the consistency index for all the respondents and found that consistency was violated in 8% of the cases at a 10% level. Hence, the reliability of our network-related measures was achieved.

Analysing the association between density, structural holes, heterogeneity and tie strength assesses the *discriminant validity* of the network variables. As mentioned in Section 3.2.2, network density, the number of structural holes, network heterogeneity and tie strength are logically distinct variables. Network density reflects the overall inter-connectedness among contacts, while heterogeneity shows the extent of the interaction across demographic

boundaries. Furthermore, the number of structural holes indicates the number of bridges between previously disconnected contacts that the spin-off has, while the strength of tie captures the frequency or proximity of interaction between ego and alters. Although the variables are conceptually different, in an empirical setting they may be correlated. In our sample, we found correlations between the variables up to 0.69. If we follow the threshold value of 0.8, it can be seen that although significant relations exist, *discriminant validity* can be established.

The extent that hypotheses are supported demonstrates the *nomological* validity. By estimating the different models, we obtained several regression coefficients that were significant. We also analysed the network variables in more detail and found that answers were given to the complete range of each measure. The fact that the network measures show us much insight in the network activities proves their importance.

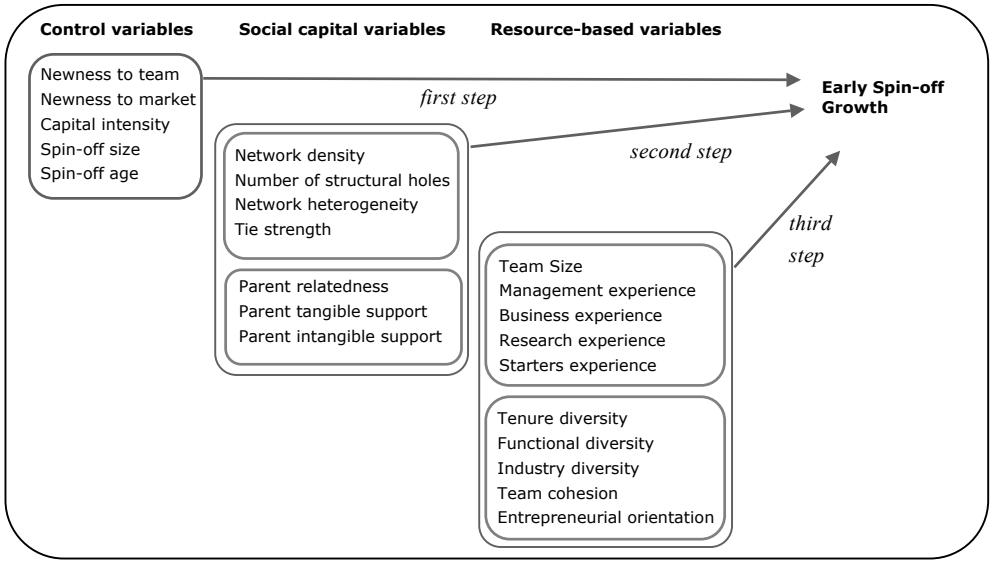
EARLY GROWTH OF SPIN-OFFS.

The early growth of the spin-off is the dependent variable in this research. We used two items to calculate the early growth of spin-offs: the number of full-time employees in 2001 and in 2003. The construct of early growth was calculated with the Birch's formula (1981), which corrects for the effect of the percentage growth in small firms compared to that of larger firms and the effect of the absolute growth in large firms compared to that of small firms (see Section 5.3.4). The content validity of the early growth of a spin-off based on the number of employees is underlined by many studies on entrepreneurship and high-tech start-ups (Baum *et al*., 2000; Wiklund and Shephard, 2003). Brush and Vanderwerf (1992) compared methods and sources for obtaining estimates of new-venture performance and found the owner to be a reliable source of information on the objective measure of employee growth for recent as well as past years. Data for the dependent variable, however, were gathered from a single respondent making it possible that common method bias exits. Comparing the number of employees at a spin-off using secondary literature assesses the common method bias. In reports such as the Biopartner Sector Report and the Reach Database, we were able to find the 65 of the spin-offs from our sample. The number of employees indicated by the respondents in our sample was compared to the numbers that were given in these reports.

6.3 EARLY SPIN-OFF GROWTH

The early growth of spin-offs is estimated based on the integrative theoretical model that was presented in Section 3.4. In a slightly different form, the integrative theoretical model recurs in Figure 6.1. This figure presents the integrative model as a set of control variables, a set of social capital variables and a set of resource-based variables. These sets of variables refer directly to the research questions in this study. To recapitulate the research questions, the first theoretical research question was formulated as follows: "*To what extent can a combination of the social capital theory and the resource-based view explain early growth?"* As Figure 6.1 shows, by dividing the analysis into several steps, the contribution of each theory can be assessed independently before they are combined. The second theoretical research question addressed the social capital theory in more detail: "*What types of social relations are favourable or and what types are unfavourable to the early growth of spin-offs?"* Each set of variables was analysed in a multiple regression on the dependent variable. In the first step we analysed the control variables, which would constitute the base model. The second step analysed the social capital variables regarding the role of network variables and the role of a special strong tie: the parent organisation. The contribution of the resource-based view in terms of team resources and team capabilities was assessed in the third step. The fourth step provided the complete model for all the independent variables that showed a significant relationship with the dependent variable in the previous three steps. First, we discuss the bi-variate correlations of the variables in Section 6.3.1.

Figure 6.1 Causal Model: The role of the Social Capital Theory and Resource-based View in Early Spin-off Growth



6.3.1 BASELINE DESCRIPTION

The baseline descriptions describe the variables that were used in estimating the model of early spin-off growth. For each variable, the mean, standard deviation and the correlations with other variables were calculated and shown in Table 6.6.

DESCRIPTIVES

Table 6.6 shows that between 2001 and 2003 the average growth index among the 65 spin-offs was 3.3. A growth index of 3.3 indicates that a small firm grows from 3 to 6, a middle-sized firm from 12 to 17, and a large firm from 20 to 26 employees. Appendix A5 elaborates further on the growth index. The means of the concepts of newness to the team and to the market and that of capital intensity are based on factor scores. Higher values indicate higher average scores for that concept (more newness to the team and to the market and more capital intense on 7-point scale). What is remarkable is that, on average, the newness of the spin-off activity is indicated as marginal for both the starters' team and the market they are targeting. In other words, most spin-offs develop incremental innovations. The average size of the spin-off is eight employees, but the high standard deviation indicates quite a big variance in spin-off size. The smallest in our sample had 1 employee while the largest spin-off employed 37 individuals. The average age of the spin-offs was about 4.2 years. The density measure showed that, on average, contacts in a spin-off's network were about 25% redundant. Note that density could range from 0 (open networks) to 1 (completely closed networks). The average number of structural holes among external contacts reached 1.2 while the average size of the networks was 3.7 contacts (see Table 6.3). Redundancy based on heterogeneity showed a low average (0.4), indicating that networks tend to be homogeneous regarding their demographic background. The relational embeddedness of spin-offs is displayed by the average strength of tie. On average, spin-off networks based on strong ties (66%). Regarding the internal team variables of the spin-off, the average team size is three members. Moreover, each spin-off has 1.3 members with management experience, 1.6 members with some business experience, 2 members with research experience, and 0.6 members with start-up experience. In other words, academic spin-offs are endowed with extensive research experience but with little start-up experience, which is not unexpected for new firms that are based on a scientific finding. Further analysis was carried out for all 196 spin-off team members. Among all team members in all the spin-offs, about 43% have management experience and slightly more, 53%, have business experience. The highest score is for research experience with about 67% having prior experience in research, and the lowest score is for start-up experience (20%). Among the 108 members that have management experience, 20 members have gained management experience in a research environment, 30 in a business environment and 37 in both research and business.

CORRELATION

Several independent variables show significant associations with the dependent variable: the early growth of spin-offs. Among the control variables, spin-off size and capital intensity are positively associated with early growth. Age is negatively correlated with growth. It seems that if firms survive their initial years, their rate of growth decreases. Concerning the social capital variables, we found a direct positive effect of the number of

structural holes. The early growth of a spin-off increases with more structural holes that are bridged by the spin-off. Start-up experience refers to the resource-based theory and displays a significant positive association with early growth. More experience with start-up benefits the early growth of a spin-off.

Among the independent variables we can observe some correlations that are interesting. Regarding the variables based of the social capital theory, the number of structural holes is negatively correlated with newness to the team and positively correlated with newness to the market. Apparently, spin-offs that operate in markets new to them bridge more structural holes compared to spin-offs that operate in familiar markets. Although the other network variables do not show strong relations with the early growth of the spin-off, we do find significant correlations among the network variables. The variables that measure structural embeddedness (density, structural holes and heterogeneity) are conceptually related, hence the sign of the relations should be consistent. Theoretically all these variables refer to redundancy, but describe it different in operational terms. We can confirm consistency, and density is negatively associated with structural holes and heterogeneity, while heterogeneity is positively related to structural holes. Regarding the relational embeddedness, strong ties are positively associated with dense networks and slightly negatively with structural holes. We realise that these are based on averages of measures on external network contacts, and do not necessarily indicate that all contacts that bridge structural holes have to be weak ties. In Section 6.3 a detailed discussion on these network measures is presented.

Tangible support, such as finance and accommodation, is present in spin-offs and decreases as spin-offs age. Remarkably, they show little direct association with early growth. This is also the case with intangible support. The mutual relation between the two types of support is large. The parent may also advise spin-offs that benefit from accommodation or finance assistance.

Regarding the variables based on the resource-based view, we notice that, with the exception of research experience, the various types of experience are positively associated with each other. Research experience is only slightly associated with management experience but not with business or start-up experience.

Table 6.6 Baseline descriptions and correlation matrix of spin-off sample (n=65)

	Mean	S.D.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
1. Early growth	3.3	4.5																							
2. Newness to team	2.9	1.2	-.10																						
3. Newness to market	2.9	1.0	.14	-.14																					
4. Spin-off size	8.1	8.5	.41**	-.18	.00																				
5. Spin-off age	4.1	1.5	-.22†	.14	-.04	.28*																			
6. Capital intensity	2.2	0.9	.24†	.01	.07	.19	.03																		
7. Network size	3.7	1.4	.17	.00	.10	.11	.04	.05																	
8. Density	1.2	1.5	-.05	.06	-.20	.09	.09	.04	-.38**																
9. Structural holes	0.3	0.2	.33**	-.12	.27*	-.02	-.08	.06	.27*	-.69**															
10. Heterogeneity	0.4	0.3	.18	-.06	.15	.19	-.01	.12	.42**	-.62**	.50**														
11. Tie Strength	0.7	0.2	-.09	-.05	.12	-.06	.11	-.03	.01	.28*	-.23†	-.20													
12. Tangible support	0.4	0.3	.06	-.12	.06	.35**	-.19	-.08	-.01	-.05	.03	.18	-.25*												
13. Intangible support	0.3	0.4	.06	-.02	-.15	.18	-.09	-.02	.06	.01	-.17	.17	-.33**	.58**											
14. Relatedness	2.7	1.5	.10	-.05	-.04	.23	-.20	-.09	.18	.02	.04	.19	-.19	.54**	.40**										
15. Team size	3.0	1.3	.20	.08	.07	.18	-.08	.30*	.11	.13	-.07	.03	.06	.12	.07	-.01									
16. Management exp.	1.3	1.1	.00	-.27*	.14	.14	-.03	.03	.07	-.04	.08	.04	.03	-.02	-.09	-.22†	.43**								
17. Business exp.	1.6	1.3	.05	.06	.12	-.08	-.16	.25	-.03	.15	.01	-.19	.23†	-.21†	-.37**	-.26*	.48**	.41**							
18. Research exp.	2.0	1.2	.08	.18	.02	.39**	.04	.19	-.01	.19	-.12	-.00	-.17	.25*	.23†	.11	.59**	.31*	.11						
19. Start-up exp.	0.6	1.0	.20	.06	-.05	-.07	-.17	.07	-.05	-.09	.20	.04	.08	-.07	-.16	-.10	.42**	.50**	.45**	.17					
20. Tenure diversity	0.3	0.4	.16	.16	.00	.35**	.13	.24*	.09	.12	-.09	.12	-.14	.12	.08	.14	.53**	.17	.27*	.36**	.13				
21. Functional diversity	0.2	0.2	-.03	.10	.16	.04	.13	.23†	.12	-.15	.15	.36**	.03	.17	.27*	.15	.25*	.08	.06	.10	.01	.37**			
22. Sector diversity	0.1	0.2	.09	-.04	.19	-.13	-.11	-.01	.00	-.08	.15	-.04	.11	-.06	-.05	-.27*	.19	.21†	.33**	-.02	.15	.13	-.05**		
23. Cohesion	0.7	0.4	-.32**	-.13	-.21†	-.38**	.06	-.41**	.07	-.11	.02	-.14	.13	-.18	-.13	.01	-.49**	-.26*	-.37**	-.42**	-.25*	-.53**	-.13**	-.23**	
24. Entrepr. orientation	0.5	0.1	.02	.15	-.07	-.24	-.26*	-.23†	.19	-.26*	.30*	.05	-.22†	.07	-.03	.04	.10	.10	.00	.16	.14	-.11	-.14**	-.09**	.06**

**p<0.01 *p<0.05 †p<0.1

exp = experience

The gray areas are variables in the domain of the external network, the parent support and the team's resources and capabilities.

6.3.2 ANALYSIS OF THE MODEL

The model was estimated using multiple regression based on a '*theory-driven*' all-possible subset (APS) approach. The all-possible subset approach as advocated by Thompson (1995) is a *setwise* multiple regression technique that uses all possible models involving a certain set of variables. Models with different variables are estimated and reconfigured until the best subset of independent variables has been identified. For each model, the inclusion of the independent variables is based on theoretical arguments. The criterion for the final subset is then based on statistical criteria such as the maximum proportion of variance explained (R^2), (Onwuegbuzie and Daniel, 2003). It should be noted that the technique is particularly useful for exploratory modelling, as opposed to model testing (Tabachnick and Fidell, 1996).

Table 6.7 shows the results of model estimation based on the all possible subset approach. In all models, the dependent variable is the early growth of the spin-off. In each step, we assessed the contribution of a theoretical approach by using a subset of independent variables in several models. The right-hand column of Table 6.7 gives the final model. The independent variables that show significance recur in a collective and allow elaborating on our research questions. It should be noted that, for each model, the same sample was used for estimation.

BASE MODEL

The first step of the all-possible subset approach analyses the base model. The base model aims to assess the contribution of control variables. These may explain part of the dependent variable although they do not refer explicitly to either the social capital theory or the resource-based view. Table 6.7 presents the results of the estimated base model, which is significant and shows that the early growth of a spin-off can be explained for 27% (adj.R^2). The statistic F ratio of the base model is 5.66 ($p<.00$). Significance tests show that firm size ($p<.00$) and firm age ($p<.00$) are significant predictors of early growth. The positive effect of firm size on the early growth of a spin-off is an inherent effect when both independent and dependent variable are based on the number of employees in the spin-off. The effect of spin-off age is negative, apparently starters grow more quickly when they have just started. The growth-index that we used to control for firm size increased understanding, but effects of differences in firm size were not completely rectified.

SOCIAL CAPITAL MODEL

The second step of the all-possible subset approach is related to the social capital theory and involves Models 2a to 2d. The first three models determine the contribution of both the structural and relational embeddedness and the fourth model determines the role of the parent organisation as strong tie. For the first three models in this second step, we include the number of contacts in the external network, which is basically a control variable for the network variables.

In Model 2a we introduce the network density measure and the tie strength measure. The density measure is a redundancy measure based on Coleman's closure argument (see Section 3.2.2) and refers to the structural embeddedness of the spin-off. The relational

embeddedness of the spin-off is displayed by the tie strength measure. Although the model shows significance ($p<.00$), the contribution of density is nil ($p>.10$), and the adjusted R^2 changes very little ($\Delta adj.R^2$=-.02) compared to the base model.

Table 6.7 Results of the all-possible subset regression analysis

Model	1	2a	2b	2c	2d	3a	3b	4
Subset	Base model	Closure argument	Structural holes	Hetero-geneity	Parent Invol-vement	Resources	Capa-bilities	Final Model
Newness to team	-.01	-.02	.08	-.01	-.01	-.02	-.04	-.01
Newness to market	.14	.13	.04	.13	.17	.19†	.12	.14
Spin-off size	.46**	.44**	.50**	.44**	.58**	.55**	.47**	.63**
Spin-off age	-.35**	-.34**	-.36**	-.34**	-.43**	-.31*	-.29*	-.38**
Capital investment	.15	.15	.15	.15	.11	.12	.18	.11
Network size		.12	.03	.11				
Density		.02						
Structural holes			.33**					.30**
Heterogeneity				.01				
Tie strength		-.04	.06	-.03				
Tangible support					-.30*			-.37**
Intangible support					.13			.21*
Relatedness					-.04			
Team size						.20	.03	
Management exp.						-.24*		-.25*
Industry exp.						-.11		
Research exp.						-.24†		
Start-up exp.						.31**		.26*
Tenure diversity							-.00	
Functional diversity							-.04	
Sector diversity							.09	
Cohesion							-.01	
Ent. Orientation							.13	
R^2	0.32	0.34	0.42	0.34	0.38	0.44	0.35	0.54
Adj. R^2	0.27	0.25	0.34	0.24	0.29	0.33	0.21	0.45
F (df)	5.7 (59)	3.6 (56)	5.1 (56)	3.6 (56)	4.3 (56)	4.2 (54)	2.6 (53)	6.2 (54)
p	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
ΔAdj. R^2	-	-0.02	+0.07*	-0.03	+0.02	+0.06*	-0.06	+0.18**
ΔF (p)	– (–)	0.4 (.74)	3.1* (.04)	0.4 (.75)	1.6 (.12)	2.2* (.07)	0.3 (.94)	4.9**(.00)

**p<0.01 *p<0.05 †p<0.1

Model 2b contrasts Coleman's closure argument to Burt's structural hole argument. In this model, the independent variable that measures the number of structural holes shows a significant effect ($\beta=.33$, $p<.01$) in explaining the variance of early growth. Furthermore, the model is significant ($p<.00$) and explains 34% of the variance in the dependent ($\Delta adj.R^2=.07$).

The indicator of structural embeddedness or redundancy among external contacts is in Model 2c given by the demographic heterogeneity. The influence of redundancy based on

demographic attributes does not show a significant effect (*p>.10*) on the early growth of a spin-off. The explained variance decreases compared to the base model (*Δadj.R^2=-.03*). It is interesting that in Models 2a, 2b and 2c relational embeddedness does not show significant predictability (*p>.10*) for the early growth of spin-offs.

Model 2d analyses the role of the parent organisation as a single strong tie on the early growth of the spin-off. Results indicate that relatedness[22] does not seem to affect the early growth of spin-offs (*p>.10*). What is interesting is that tangible support, such as finance and accommodation, has a significant negative effect (*β=-.30, p<.05*) on the early growth of spin-offs, while the influence of intangible support, such as technology and organisational advice, is absent (*p>.10*). Compared to the base model, the explained variance due to the inclusion of parent involvement does increase slightly (*Δadj.R^2=.02*).

RESOURCE-BASED MODEL

The third step of the all-possible subset approach involves two models (Models 3a and 3b) that analyse the role of team resources and capabilities in accordance with the resource-based view. For both models, team size is introduced as a control variable. Model 3a presents management and starters' experience, and, although to a lesser extent, research experience, as relevant predictors of early growth. Management experience is significant and has a negative effect (*β=-.24, p<.05*) on the early growth of the spin-off. Start-up experience, on the other hand, has a strong positive effect *(β=.32, p<.01)* on early growth. Business experience does not affect the early growth of spin-offs, and research experience is just significant (*p<.10*). The model for the resource-based view is significant (*p<.00*), with an adjusted R^2 that increases by 7% compared to the base model with a total of 33%, and the statistic F reaches 4.04. Model 3b displays the team capabilities. None of the team's capabilities are significant (*p>.10*) and the adjusted R^2 and F statistics decrease due to the larger number of variables included in the regression.

FINAL REGRESSION MODEL

The fourth and final step is presented by Model 4. It shows the collective model in which all the control variables and all significant *(p<.05)* independent variables from previous models recur. The criteria for including the variables are based on an assessment of the standardised coefficients and the structure coefficients (Courville and Thompson, 1985; Onwuegbuzie and Daniel, 2003, see Appendix B.1). In this final model, we again started by including the variables from the base model (Model 1). For the structural and relational network variables of the social capital theory, we included the significant indicator of structural holes, which we found in Model 2b. Regarding parent involvement, we included both types of parent support, i.e. tangible and intangible support. Tangible support showed significance in Model 2d. Our reason including intangible support is based on the theoretical consideration that both types of support may affect the early growth of a spin-off. The next two variables we included are based on the significance *(p<.05)* that was exposed in Model 3a. These two variables are management experience and start-up experience and belong to the resource-based view. Research experience was not included

[22] Relatedness was furthermore analysed as a variable that has an inverted U-shape relationship with the early growth. The standardised coefficient did increase but did not reach a significant level. Also interactions effects between relatedness and parent support did not prove to be significant in this research.

because its significance was below the 95% level. Moreover, its effect disappeared in the final model and because we were striving for model parsimony the variable was omitted.

The final model displays a significant *(p<.00)* increase in the F statistics with *ΔF=4.91*. The explained variance of the model is 45% (adj. R^2=.45) and has increased by 18% compared to the base model. Concerning the control variables, we see that few changes occur. The effects presented by previous models do still occur but the variables spin-off size *(β=.63, p<.05)* and spin-off age *(β= -.38, p<.00)* are still significant predictors of the early growth of a spin-off.

Regarding the social capital variables, we found that the variable of structural hole in the final model also positively affects the early growth of the spin-off (*β=0.30, p<.01*). As for the parent support, we found a strong negative effect of tangible support (*β= –0.37, p<.01*) and a significant positive effect of intangible support (*β=0.21, p<.05*). The increase of the effect of tangible and intangible support is due to suppressor effects. In The suppressor effects are explained in more detail in Appendix B1.

Regarding the variables of the resource-based view, both management experience and start-up experience significantly affect the early growth of the spin-off. Furthermore, these two variables also display some suppressing effects (see Appendix B1). Management experience among the team members negatively affects early growth (*β=–0.25, p<.01)*, while start-up experience was a positive influence (*β=0.26, p<.01*) on a spin-off's early growth.

6.4 ANALYSIS OF THE SPIN-OFF NETWORK

In the previous section, regression analysis showed that the number of structural holes, in particular, proved to be a good predictor of the early growth of a spin-off. Although the other network variables are correlated with the structural hole variable (see Table 6.7), they do not show significant influence in the regression analyses. This part of the research explores the spin-off network in more detail. The objective is to understand the types of network contacts that are used to obtain certain types of information or to carry out different activities. In other words, the analysis aims at the interaction of network relationships and the content they provide. Analysis is at the alter level and concerns the characteristics of each alter and the type of connection to the spin-off. In the next sections, the analysis is focused on 1) the alters with whom the spin-off bridges a structural hole; 2) the demographic background of the all network alters; 3) the strength of the ties with alters; and 4) the types of information and number of activities that were discussed with each alter. The 65 spin-offs that were analysed mentioned a total of 266 contacts in their business networks. The respondents designated these contacts as individuals who were important or contributed to the start-up of the spin-off although they were not part of the spin-off team itself. The network measures are based on questions 51 up to 56 and the topics and activities are measured by questions 36 up to 50 in the questionnaire (Appendix A1). The questions about the topics and activities are calculated using the AHP to analyse their importance levels (see Appendix A5).

6.4.1 STRUCTURAL HOLES

Among the 266 alters mentioned by the respondents, 97 were identified as contacts with whom the spin-off bridges a structural hole. In other words, the alter has no contact with any of the other relations of the spin-off management team (see Appendix A1). Identification of these alters is based on the density measure. The 97 contacts that provide the opportunity to broker across a structural hole represent 37% of all spin-off contacts. Analysis of these 97 ties provides information about the demographic background of these ties, the strength of the ties and the type of information discussed with them.

DEMOGRAPHIC BACKGROUND AND TIE STRENGTH OF STRUCTURAL HOLES

Table 6.8 presents the network characteristics of the structural hole ties among the 65 spin-offs. In the complete network, 83 contacts come from personal networks. Among these 83 contacts, 29 are structural hole ties, which represents 35% of the 83 contacts. In a similar way, the relative share of structural hole ties in a previous work background (24%), in an academic network (53%), and in a business network (50%) were calculated. The academic network is represented by a small number of people (15). Column III shows that most structural hole ties are in the business network (n=37). The fourth column shows the percentage of structural hole ties that come from certain demographic backgrounds.

Table 6.8 Network characteristics of structural hole (SH) ties

I	II	III	IV	V	VI
Demographic background	All alters in network	# structural holes	Percentage of SH from that background	# strong ties	# weak ties
	(n = 266)	(n=97)	(III/II)*100	(n = 55)	(n = 42)
Personal	83	29	35%	28	1
Previous work	94	23	24%	14	9
Other academia	15	8	53%	3	5
Business	74	37	50%	10	27

Among the 97 structural hole ties, 55 have strong ties, leaving 42 with weak ties. Column V shows that almost all structural hole ties in a personal network are strong ties. Furthermore, in a previous work network there are 14 strong ties versus 9 weak ties, and among the structural holes with academia the table indicates that 3 are strong ties versus 5 weak ties. Apparently, some spin-offs go to other knowledge institutions that they do not have strong ties with. The structural hole ties to the business network are mostly weak ties. As expected, the structural hole ties in a personal network are mostly strong while in a business network they are weak. In a personal network, contacts are friends and family that one has known for a long time but who are not familiar with the other ties, and the structural hole ties to the business network, on the other hand, are probably recent contacts who are new to the spin-off network.

INFORMATION CONDUIT IN STRUCTURAL HOLES

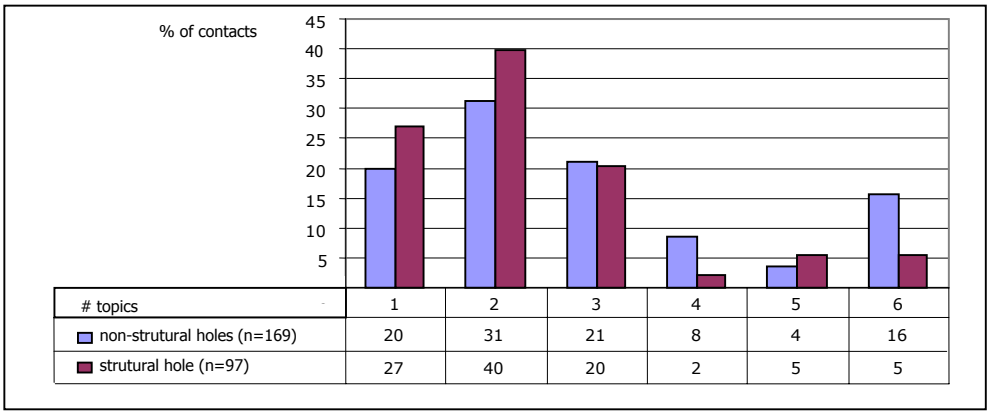
According to the structural hole argument, a spin-off that bridges a structural hole may benefit from novel information that flows to the spin-off. This section aims to underpin the information that flows through structural hole ties and non-structural hole ties. First, the

number of topics discussed in structural hole ties is compared to non-structural hole ties. Second, the kinds of topics are analysed and their importance for the spin-off is discussed.

NUMBER OF TOPICS DISCUSSED IN STRUCTURAL HOLE TIES

Figure 6.5 shows that ties fewer topics are discussed in structural hole than in non-structural hole ties. Among all non-structural hole ties, 20% discussed 1 topic, 31% discussed 2 topics and so on, while in structural hole ties, 27% discussed a single topic and 40% discussed two topics. Comparison shows that a single topic is more often discussed in structural hole ties (27%) than in non-structural hole ties (20%). For the two-topic group a similar distribution can be seen: the majority of the structural hole ties (40%) discuss two topics compared to the non-structural hole ties (31%). The three-topic group shows comparable percentiles and when more than 3 topics are discussed, non-structural hole ties occur more often. On average, 2.3 topics are discussed in structural hole ties and 2.9 topics are discussed in non-structural hole ties. The number of topics is significantly different for the two types of ties (t=3.106, df=260, p=0.001, one-tailed and equal variances not assumed).

Figure 6.2 Distribution of number of topics among non-structural hole and structural hole ties



# topics	1	2	3	4	5	6
non-strutural holes (n=169)	20	31	21	8	4	16
strutural hole (n=97)	27	40	20	2	5	5

TYPES OF TOPICS DISCUSSED IN STRUCTURAL HOLE TIES

This research has distinguished six types of activities that spin-off entrepreneurs discuss regarding their start-up. These activities are based on three start-up processes (Elfring and Hulsink, 2003). The first start-up process is the discovery of opportunities and concerns activities such as collecting information about the market, customers and competitors and concerning technology and development processes. Evaluations of market potential and technological feasibility are important to the spin-off. The next start-up process is the mobilising of resources, which deals with effecting organisational, legal and administrative procedures and gaining access to personnel, office and laboratory space, and equipment. The third start-up activity is securing legitimacy, which can be established by cooperating with business partners or mobilising finance. More details of these start-up activities can be found in Section 5.3.1 and Table 5.1. The next sections cover these start-up activities as topics discussed in the network. The distribution of topics discussed with structural hole ties and non structural hole ties is presented by Table 6.9.

In absolute terms, Table 6.9 shows in the first column that market potential is most discussed in non-structural hole ties (108 non-structural hole ties versus 54 structural hole ties). The 108 non-structural ties represent 64% of all non-structural holes ties. Comparing the non-structural hole ties with structural hole ties (Columns III and V) shows that in 64% of all non-structural hole ties the market is discussed, compared to 57% of all structural hole ties. Significant differences were found for technology (t=1.253, df=260, p=0.012, one-tailed); for organisation (t=3.093, df=260, p=0.001, one-tailed); and for resources (t=1.878, df=260, p=0.027, one-tailed, variances are unequal). The data tend to suggest that with structural hole ties more specific information on topics is discussed compared to non-structural hole ties. Including the level of importance of the topics for the individual respondents may clarify this.

Table 6.9 Distribution of topics discussed with structural hole (SH) and non-structural hole ties

I	II	III	IV	V
Topic	Non-structural hole ties	Percentage of non-structural hole ties	Structural hole ties	Percentage of structural hole ties
Discussions and evaluation of	(n = 169)	(II/169)	(n=97)	(IV/97)
Market (collecting information about the market, customers and competitors)	108	64%	54	57%
Technology (effecting the technology and development process)	91	54%	38	40%
Collaboration (entering into co-operation with business partners)	63	37%	37	39%
Organisation (effecting organisational, legal and administrative procedures)	98	58%	36	38%
Resources (locating personnel, housing and equipment)	61	36%	24	25%
Finance (accessing finance)	65	38%	30	32%

IMPORTANCE OF TOPICS DISCUSSED IN STRUCTURAL HOLE TIES

The importance of topics is determined by the analytical hierarchical process (AHP) technique (Saaty, 1980). The AHP technique does not only provide a ranking order of activities but also presents distances between the ranks. To understand the importance of topics discussed in structural hole ties compared to non-structural hole ties, the following five-step procedure was employed. First, the AHP used pair-wise comparisons for the six activities to present a distribution of relative importance for all six activities for each spin-off. In the second step, respondents were asked to indicate for each alter the types of activities they discussed with the alter. This procedure indicates the relative importance of each activity for a spin-off and the information is used to compare the importance of activities discussed with structural hole or non-structural hole ties (see Table 6.10).

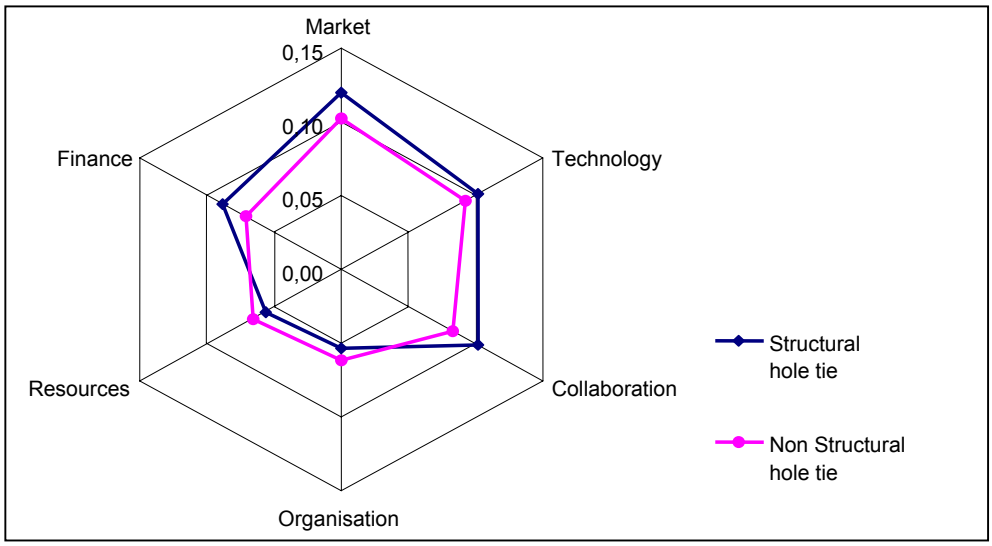
The table is based on the following procedure. First, a selection was made of all alters that were consulted regarding a certain topic, for example, the market. Second, the average weight of a certain topic was calculated separately for structural hole ties and non-structural hole ties. Regarding market-related topics, the table shows that in discussions with structural hole ties the market was more important (12%) than in discussions with non-

structural hole ties (10%). The differences between the average weight topics discussed with structural hole and non-structural hole ties are small. The table indicates that technological development, collaboration, and financial activities are discussed with structural hole ties, while organisation and resources were common in talks with non-structural hole ties. The importance of the last two activities were significantly different (t=3.244, df= 256, p=0.000 one-tailed for organisation and t=2.136, df= 256, p=0.017 one-tailed for the resources). In other words, the resource mobilisation process (setting up the organisation and finding resources, see Table 5.1) is significantly more frequent with non-structural hole ties. Figure 6.3 illustrates the table.

Table 6.10 Distribution of structural hole average weight assigned to the topics discussed

I	II		III		IV		V		VI		VII	
Tie strength	Market		Technology		Collaboration		Organisation		Resources		Finance	
	Weight	n	Weight	n	Weight	n	Weight	n	Weight	n	Weight	n
Structural hole tie	0.12	52	0.10	36	0.10	36	0.05	34	0.06	24	0.09	26
Non structural hole tie	0.10	108	0.09	91	0.09	63	0.06	96	0.07	61	0.07	65

Figure 6.3 Radar distribution of relative weight addressed to the topics discussed in structural hole and non-structural hole ties



6.4.2 DEMOGRAPHIC BACKGROUND

The demographic attributes of alters provides information about the distribution of sub-networks (background) that alters come from, the tie strength with these alters and the topics discussed with them. Again, data for all 266 alters mentioned by the 65 spin-offs were analysed.

DEMOGRAPHIC BACKGROUND AND TIE STRENGTH

Table 6.11 shows that only 15 alters come from academic networks other than that of the parent organisation. Regarding the other networks, the data show that alters are quite equally distributed among the networks: 83 alters come from the personal network, 94 from the previous work network, and 74 from the business network. Furthermore, the table shows that 171 ties were identified as strong ties (65%) and 95 (35%) were weak ties. Combining the data demonstrates the relationship between the background of a tie and its strength. Almost all of ties from the personal network (94%) are strong ties. Regarding the previous work network, the table shows that two-thirds (66%) are strong ties. A small number of ties (n=15) come from other academic networks but only 33% of these are strong. Also in the business network, strong ties represent only 35% of the total number of 74 business contacts. The data indicate that the ties with contacts in the personal and previous work networks are strong ties, while with other academia and businesses, the ties are weaker.

Table 6.11 Distribution of tie strength and topics related to demographic background of alters

I	II	III		VI		V		VI	
Tie strength	total	Personal		Previous work		Other academia		Business	
	(n=266)	(n=83	(n/II)	(n=94	(n/II)	(n=15)	(n/II)	(n=74)	(n/II)
Strong ties	171	78	94%	62	66%	5	33%	26	35%
Weak ties	95	5	6%	32	34%	10	67%	48	65%
Market	162	49	60%	57	61%	6	40%	50	68%
Technology	129	44	53%	46	49%	10	67%	29	39%
Collaboration	100	37	45%	31	33%	7	47%	25	34%
Organisation	132	51	**61%**	39	**41%**	3	20%	39	53%
Resources	85	37	**45%**	32	**34%**	2	13%	14	**19%**
Finance	95	33	40%	25	**27%**	4	27%	33	**45%**

DEMOGRAPHIC BACKGROUND AND TOPICS DISCUSSED

The distribution of topics that are discussed with ties from various networks are presented in Table 6.11. The second column displays the total number of alters that discuss a certain topic, and the third column presents the data for the personal network. Eighty-three alters belong to the personal network. Market activities are discussed with the 49 alters from the personal network. This represents 60% of all alters from the personal network. Considering all topics discussed in the personal network, the organisation of the spin-off and issues concerning the market are talked through most often. Discussions about financial issues take place least often in personal networks. The other figures are interpreted in a similar way. In the previous work network, the market is discussed most often and financial issues the least. With academics from outside the parent organisation, technology is most prominent in discussions and topics related to the internal organisation of the spin-off, such

as organisational issues and resources, are the least discussed. Furthermore, in the business network many conversations are about the market and only a few are about the resources of the spin-off. In total the table shows few differences in the distribution of topics for the four types of background. Most discussions are about the market, except for the other academic networks, issues concerning the effecting of technology are discussed more often while internal organisation and resources are less discussed. A few differences, which are presented in bold in the table, were significant. Topics related to organisation were significantly (p=0.007) more frequent in discussions in personal networks than in previous work networks, the mobilisation of resources was considered more often in personal networks (p=0.001) or in the previous work network (p=0.039) compared to the business network. In addition, finance was talked about more often in the business network (p=0,012) than in the previous work network. The significance tests for other academia were not considered due to the small number of contacts.

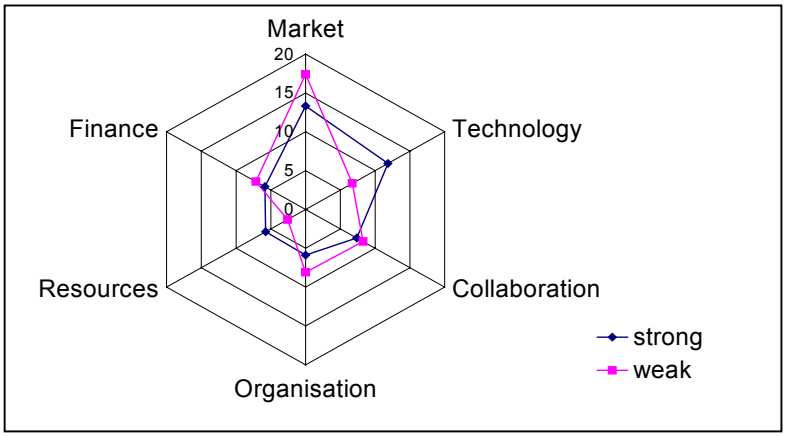
6.4.3 TIE STRENGTH

The strength of ties is based on three dyadic characteristics. The first characteristic is the frequency of contact of the tie with the alter. The second is the duration of the dyadic relationship in terms of the number of years both alter and ego have had contact. The next characteristic refers to how well the actors in the dyadic relationship know each other. The measure of tie strength is based on a linear combination of the three characteristics (Granovetter, 1973). Connecting the types of topics discussed with strong and weak ties, the data set gives information on 262 alters. In the set of topics and activities, strong ties exist with 170 alters and weak ties with 92 ties. Table 6.12 presents the average weight of a certain topic in combination with the discussion of strong or weak ties. The table is based on the following procedure. First, a selection was made of all alters that were consulted regarding a certain topic, for example, the market. Second, the average weight assigned to the topic was calculated separately for strong and weak ties. The differences between the average weights of topics discussed with strong or weak ties were small. Significant differences are found for the topic regarding technology (t=-3.983, df=256, p=0.000) and resources (t=-3.550, df=256, p=0.000). Both tests are one-tailed and the variances are unequal. The tests may indicate that the development of technology requires specific knowledge that can be found with individuals one has known for a long period of time and information about necessary resources are also found with strong ties. Table 6.12 is illustrated as a radar graph in Figure 6.4.

Table 6.12 Distribution of tie strength average weight assigned to the topics discussed

I	II		III		IV		V		VI		VII	
Tie Strength	Market		Technology		Collaboration		Organisation		Resources		Finance	
	Weight	n	Weight	n	Weight	n	Weight	n	Weight	n	Weight	n
Strong	0.13	103	**0.12**	99	0.07	68	0.06	88	**0.06**	71	0.06	31
Weak	0.17	57	**0.07**	28	0.08	31	0.08	42	**0.03**	14	0.07	63

Figure 6.4 Radar distribution of relative weight addressed to the topics discussed in strong and weak ties



6.5 CONCLUDING REMARKS

This chapter has documented the results from the case studies and the survey. The case studies are based on interviews with eighteen spin-off entrepreneurs and five officials in knowledge institutions. The results show that entrepreneurs are good at research activities but have less experience in selling their product or service, or setting up a firm. The social capital of the team is important to gain access to specific knowledge related to the start-up of the spin-off. Furthermore, the parent organisation sometimes helped the spin-off but its attitude was often passive. The interviews with officials in knowledge institutions indicate that ultimately the spin-off entrepreneurs have to show commitment and persistence.

The survey resulted in 65 spin-offs being used for model estimation. The analysis of the survey began with a preliminary evaluation of the study sample and a non-response analysis was done to assess the repercussions of omitting a number of cases on the representativeness of the current study. Few differences were found between the spin-offs that participated in the research and those that did not.

The estimation of the model clearly shows that academic spin-offs benefit from the fact that they bridge structural holes. Other measures of structural and relational embeddedness did not affect early growth. Involvement by the parent organisation in the spin-off influences the early growth of spin-offs in two opposite directions. Support in terms of tangibles such as accommodation and finance is for many spin-offs not beneficial. In fact spin-offs that are given tangible support grow more slowly. Intangible support, such as advice concerning technological and legal issues, proved to help spin-off entrepreneurs to manoeuvre their spin-off through the early years of their existence. Regarding resources, the results show that management experience did not contribute to the spin-off in its early growth. Start-up experience, however, helped the spin-off to achieve early growth. In contrast to the resources, the capabilities of the starters' team did not show significant effects.

The findings from the model estimation are underpinned with an analysis of relations at the alter level. The 65 respondents indicated 265 alters in total. For each tie between ego and

alter it was indicated whether it represented a structural hole tie, how strong the tie was, to which background the tie was connected and what types of information were discussed with that tie. The findings show that there are more structural hole ties to the business network and topics concerning the market, collaboration and finance were particularly discussed with them. Regarding the strength of tie, the results show clearly that the issues concerning the market, the financing of the spin-off and the organisation of the spin-off were discussed more often with weak ties. Strong ties were important developing technological issues.

CHAPTER 7 DISCUSSION AND CONCLUSIONS

This research project has examined the factors that influence the early growth of academic spin-offs. Two organisational theories, the social capital theory and the resource-based view, were used to identify the factors that are important in explaining and understanding the early growth of spin-offs. The two theories have divergent views on how firms establish early growth. These views were both analysed to see how they affect the early growth of spin-offs and the results were discussed in the previous chapters. This chapter discusses the theoretical and practical implications of the results to try to shed light on the general assumptions and understanding of each theory individually. By combining the two theories, increased understanding can be gained of how the theories interact and complement each other. Following on the theoretical contribution, this chapter discusses the methodological issues, the limitations of the study, and some directions concerning possible future research on academic spin-offs. The chapter concludes with a discussion of the practical implications and the factors that are important to the early growth of spin-offs to enhance understanding of the start-up process for the founders of future spin-offs. Officials in knowledge institutions and politicians can also benefit from these findings by emphasising certain elements in current spin-off support programmes or when setting up future programmes.

7.1 THEORETICAL CONTRIBUTIONS

The transfer of academic knowledge through spin-offs has received attention from scholars since the 1960s and 1970s. Initially, scholars focused on the types of spin-offs, the motivation of scientists to start a spin-off and the ways in which spin-offs can emerge. With increased knowledge on spin-offs, new research perspectives have emerged, and scholars have analysed the contribution of academic spin-offs to national and regional prosperity and to the objectives of knowledge institutions. Also, at firm level, research has focused on the role of scientists in spin-offs and the factors that can explain spin-off success.

7.1.1 KEY SUCCESS FACTORS

The present study focuses on the firm level and analyses the key success factors of the early growth of academic spin-offs. Two organisational theories at the firm level, the social capital theory and the resource-based view, are used to answer this research question.

Regarding the social capital theory, two factors are critical for the early growth of spin-offs. First, the position of the spin-off in its network is important in identifying a business opportunity. If spin-offs take a position between two clusters of networks that were unlinked before, they benefit by brokering the knowledge and resources available in both networks. The second key success factor lies in the involvement of the parent organisation. The parent organisation can support the spin-off with tangibles, such as accommodation, intellectual property rights and finance, and with intangibles such as advice and coaching in administrative, legal and organisational tasks. The findings in the present research show that tangible support has a negative effect on the early growth of spin-offs, while intangible support has a positive effect. The third main finding regards the resources of the team. Teams with previous start-up experience grow faster, while management experience in teams contributes negatively to early growth. Finally, the fourth main finding of the model estimation is that capabilities based on team diversity, cohesion and entrepreneurial orientation did not affect the early growth of spin-offs.

Table 7.1 Key success factors of early spin-off growth

The early growth of academic spin-offs is facilitated by:
• its network position to broker between academia and the business sector • its parent support based on coaching and advice • its start-up experience embodied in the starters team of the spin-off
The early growth of academic spin-offs is constrained by:
• parent support based on accommodation and finance • previous management experience among the members of the starters' team

The present study also analysed the differences of three sectors in which spin-offs operate: the life sciences, ICT/the media and consulting. Although no significant effects of differences between the sectors were found on the early growth of spin-offs, some differences between sectors do exist for the factors that affect the early growth of spin-offs. The main finding here is that ICT/the media spin-offs are different from those in the life sciences and consulting. The life-science and consulting spin-offs are more related to their parent organisation and, as a result, receive more tangible and intangible support than ICT/media spin-offs. Moreover, life-science and consulting spin-offs have more

heterogeneous networks (with contacts in both academia and the business sector) than ICT/media spin-offs.

7.1.2 ROLE OF THE SOCIAL CAPITAL THEORY AND THE RESOURCE-BASED VIEW

The two theories have divergent views as to the factors that influence the early growth of new firms. The social capital theory emphasises the role of social relations in the external network, which may provide the new firm with resources, timing advantages and referrals (Burt, 1992). The resource-based view stresses that the resources that the firm controls are important to the development of (dynamic) capabilities that pave the way to sustainable growth (Barney, 1991; Teece *et al*., 1997). Many studies on start-ups in general have focused on just one of the two theories to determine the factors that influence initial firm growth. Scholars have pleaded, however, for the use of multiple theoretical approaches to allow an understanding of the factors that are relevant for initial firm growth (Lee *et al*., 2001; Pennings *et al*., 1998). By merely taking a single theoretical approach, research may suffer from an inadequate view of the key success factors. A few studies have brought the social capital theory and the resource-based view together (Pennings *et al*., 1998; Lee *et al*., 2001; Zaheer and Bell, 2005). Although these studies use the theories in a context different from spin-offs, the main finding is that both theories are simultaneously important. The social capital theory and the resource-based view interactively influence firm performance or firm dissolution. Furthermore, both studies stress the importance of finely tuned measures to underpin the concepts of the resource-based view and the social capital theory. Pennings *et al*. (1998: 439) argue that "*... future research should measure human and social capital variables more germane to the firm level*". Similarly Lee *et al*. (2001: 635) claim "*future research should employ fine-grained measures of external network…*"

The first theoretical research question aims to examine the extent to which the social capital theory and the resource-based view, individually and in combination, can explain the early growth of spin-offs. Several models were constructed in which the theories are assessed both separately and together. The base model estimates the early growth of spin-offs based on contingent variables. A second model extends the base model with variables based on the social capital theory and indicates a significant contribution by these social capital variables. In a similar way, the variables based on the resource-based view were assessed in a third model, and again a significant contribution by these variables was found. Finally, in a fourth model, the significant variables based on both the social capital theory and the resource-based model were included. Compared to the base model, the contribution of these variables were more than the sum of the contributions in the second and third models. In other words, the estimated models clearly show the individual contribution of the social capital theory and the resource-based view, and when combined the contribution of both theories exceeds the sum of the individual contributions. This indicates that both theories are not only individually contributing to the explanation of the early growth of spin-off but also complement each other. As such, the theories do not overlap but individually explain the early growth of spin-offs and in combination enhance the explanatory power. We suggest that the specific contribution of each theory and the combined power of the two theories are not restricted to academic spin-offs. While Lee *et al*. (2001) provided weak support for the social capital theory and Pennings *et al*. (1998) applied a broad definition of

human and social capital, this study indicates that both theories address different aspects and together provide strong insight into the early growth of firms based on sophisticated measures of the social capital theory.

7.1.3 BENEFICIAL AND DETRIMENTAL SOCIAL RELATIONS

The second theoretical research question was formulated as "*what types of social relations are beneficial and what types are detrimental to the early growth of academic spin-offs*?" This second theoretical research question refers to the confusion that exists concerning the specific aspects of social relations that create social capital (Adler and Kwon, 2002). Two research streams use different approaches to explain the effects of social capital. The *structural embeddedness* stream is based on the structural composition of social relations (Burt, 1992; Baum *et al*., 2000). The *relational embeddedness* stream is based on the relational aspects of social relations (Burt, 1997; Podolny and Baron, 1997). The two research streams are analysed to see how they affect the early growth of spin-offs.

The main finding is that with respect to structural embeddedness, structural hole ties are important when transferring academic knowledge into a business opportunity. Most structural hole ties have connections with the business environment. Spin-offs that have structural hole ties to the business network display higher growth ratios. The role of structural hole ties is even clearer when the importance of the activities discussed in the network is considered. When market activities and finding finance was important the structural hole ties were utilised. Although less often, this was also the case for activities concerning the technology and collaborating with partners. When activities such as organisation and resources were more important, non-structural hole ties were employed. Redundancy based on the background of social relations shows that business contacts are important in identifying market opportunities and/or evaluating them. Furthermore, business contacts were important in discussions about the financing of the spin-off. Contacts with the parent organisation helped the spin-off in its initial market analyses and technology development. These discussions concerning the market clarify the possibilities about applications that might exist and which were best to pursue. Several spin-offs also made contact with other academics outside the parent organisation. In these cases, the spin-off pursued a business opportunity based on academic knowledge that did not reflect the core of the parent's research field and turned to academics who had specific knowledge. Finally, personal contacts, such as friends and family, were consulted regarding the market opportunities, the resources and the organisation of the spin-off.

Regarding relational embeddedness, this study could not clarify the role of tie strength related to the early growth of academic spin-offs. Neither the strong tie nor the weak tie argument could be confirmed by the data from 65 spin-offs. Further analysis revealed that both strong and weak ties are important to the start-up of a spin-off. The rationale is that strong ties may be important for topics other than those that weak ties are important for. An analysis of the topics discussed with strong and weak ties showed that weak ties are important for gathering information regarding the market. On the other hand, strong ties were more often conferred when specific and complex knowledge about the technological development was needed.

The findings regarding structural and relational embeddedness imply that for different purposes, different social relations are favourable. The present study documented empirically that the network structure most conducive to the early growth of academic spin-offs depends on the content of the social tie involved. In that respect this research extends the knowledge on how the structure and content of spin-off networks affect early growth. This research joins the work of Podolny and Baron (1997) and postulates that to obtain early growth, the network structure may be no less important than knowing whom to consult for specific information and assistance.

7.2 CONTRIBUTION TO THE SOCIAL CAPITAL THEORY

The role of the social capital theory in explaining the early growth of spin-offs was analysed using hypotheses based on structural and relational embeddedness and parent involvement. In addition, the contents of discussions in network relationships were analysed to increase the understanding of the role of specific relationships. These, however, are not formulated in hypotheses. This section discusses the hypotheses and elaborates on how they contribute to the social capital theory.

7.2.1 IMPACT OF STRUCTURAL EMBEDDEDNESS

Structural embeddedness refers to redundancy in the external network of the spin-off. The redundant – non-redundant continuum reflects two diverging arguments: the closure argument and the structural hole argument. The closure argument stresses that redundant network contacts can provide smooth communication, reputational effects and continuity of access to external resources (Larson, 1992; Uzzi, 1999; Steier and Greenwood, 2000). The structural hole argument claims that a network rich in non-redundant contacts provides access to a wider circle of information about unique resources and opportunities, and referrals provide a wider scope of potential business partners (McEvily and Zaheer, 1999; Baum *et al*., 2000). This research analyses both arguments based on a redundancy measure in terms of connections between network contacts (Hypothesis 1a) and in terms of the demographic attributes of these network contacts (Hypothesis 1b).

The first hypothesis (1a) refers to structural embeddedness in terms of inter-connectedness. Inter-connectedness indicates whether a spin-off's contacts are not only connected to the spin-off itself but also to each other. The closure argument suggests that spin-offs in a dense network show a high level of inter-connectedness among all the contacts involved. The results from regression analysis in Table 6.7 show that network density, i.e. the closure argument, does not show a significant effect on the early growth of a spin-off. Hypothesis 1a could not be confirmed for academic spin-offs.

The alternative hypothesis (1a) states that the more structural holes there are in the external network of the spin-off, the faster early growth will be. More structural holes in the spin-off network indicates lower levels of inter-connectedness and is discussed as the structural hole argument. The results in Model 2b and in Model 4 (see Table 6.7) provided supportive evidence for the *alternative* Hypothesis 1a, and thereby maintained the structural hole argument by Burt (1992). This argument indicates that spin-offs that have networks rich in

structural holes obtain more diverse information and, as a result, may have more business opportunities from which they can choose the most promising.

The second hypothesis, Hypothesis 1b, discusses structural embeddedness in terms of its demographic attributes. Spin-offs that have a heterogeneous network of contacts, i.e. contacts from different backgrounds such as the academic or the business environment, are believed to be equipped with different types of information. In the same way as the structural hole argument (Burt, 1992), Baum *et al*. (2000) and Powell *et al*. (1996) stress that heterogeneous networks increase firm performance. Results from Model 2c did not confirm the effect of heterogeneity on early spin-off growth as predicted by Hypothesis 1b, and as a result Hypothesis 1b could not be confirmed. The findings suggest that non-redundancy based on demographic background cannot explain the early growth of academic spin-offs. In other words, non-redundancy based on demographic backgrounds may not be appropriate enough to operationalise the assumption that individuals from different backgrounds are equipped with different types of information.

Spin-offs that are able to bridge a structural hole are in a better position to capitalise on their potential to transfer academic knowledge and to commercialise the knowledge more successfully. In other words, spin-offs that are structurally embedded in a network rich in structural holes are in a better position to grow compared to spin-offs that find themselves in dense networks. These findings suggest that the structural embeddedness of spin-offs is central in shaping the social capital of spin-offs. The structural hole connection provides competitive advantages by building bridge relationships (Burt, 1992). The possibility of brokerage is the principle underlying the structural hole argument and the competitive advantage the theory predicts for entrepreneurial managers (Burt, 1992). Previous studies have explained that structural hole connections provide benefits in three ways. Structural holes can enhance the identification of opportunities (Burt, 2004), offers benefits through timing, which is crucial for the identification of entrepreneurial opportunities and exploratory learning (Rhee, 2004), and reach out to a large network of referrals (Burt, 1992). Academic spin-offs can be detached to some extent from their academic environment by bridging structural holes to the business environment. Bridging relationships provide access to novel information and help identify business opportunities. Moreover, structural holes provide spin-offs the possibilities to broker between contacts from both academic and business environments. The findings are consistent with previous research (Burt, 1992, 2000, 2004; Gargiulo and Benassi, 2000; Zaheer and Bell, 2005) and extend the social capital theory by applying the structural hole argument to academic spin-offs.

7.2.2 IMPACT OF RELATIONAL EMBEDDEDNESS

Relational embeddedness refers to the strength of ties. According to the "strength of tie" argument, a weak tie may benefit the search for novel information (Granovetter, 1973), whereas a strong tie may contribute to the transfer of complex knowledge (Hansen, 1999) and reliable resources (Aldrich, 1999). The role of tie strength on the early growth of firms is still under debate. Several studies stress that linkages with strong ties are more advantageous to the early growth of firms (Gulati, 1995; Larson, 1992), while others argue for the importance of weak ties (Aldrich *et al*., 1996; Mitsuhashi, 2003).

In the present study, the strength of tie has not proved to be significant in any of the three models (2a, 2b and 2c) and the effect of tie strength on the early growth of spin-offs could not be verified. As a result, we established that Hypothesis 1c could not be validated. Since the strong ties are measured as a percentage of the total number of ties, the opposite, the number of weak ties, is also not significant.

The ambiguous role of tie strength in previous research may also explain the absence of any effect of tie strength in this research. Elfring and Hulsink (2003) found that start-ups need a mix of strong and weak ties. Each type of tie strength offers a different benefit. Rowley *et al*. (2000) found that the strength of the tie varies according to the degree of exploration. Their study indicates that in the more *exploratory* semiconductor industries, weak ties were beneficial to firm performance, while in the more *exploitative* steel industries, strong ties were important in success. Recent research findings increasingly see the strength of tie arguments not as opposing views but as different principles that operate at the same time. They play different roles that are valuable for different purposes (Burt, 2000). Particular ties are beneficial to different entrepreneurial processes that can take place simultaneously (Elfring and Hulsink, 2003). This research analysed the role of particular ties in the discussions of different topics at the alter level. Strong ties were most often consulted when it involved the technology that the spin-off uses, or when resources were needed. Weak ties were more important for the evaluation of market opportunities and possibilities for collaboration. Academic spin-offs are unfamiliar with these activities because their roots are in the academic environment. These findings are consistent with previous research that showed that weak ties are beneficial to receiving novel information (Granovetter, 1985; Hansen, 1999; Elfring and Hulsink, 2003) and to facilitating explorative activities (Rowley *et al*., 2000). Strong ties were used to develop technology and organise the new venture. These activities were often done with contacts in the parent organisation and with personal contacts. The connections with the parent organisation are strong ties that can facilitate the complexities of technology development (Hansen, 1999; Shan *et al*., 1994). Moreover, spin-off entrepreneurs can rely on these strong ties for the resources they need and decisions regarding the organisation of the spin-off (Shane and Cable, 2002; Uzzi and Gullispie, 2002).

7.2.3 IMPACT OF TIE CONTENT

The next contribution of the present research to the social capital theory lies in the linkage between the structural and relational embeddedness of relationships and their content (Provan and Milward, 1995; Podolny and Baron, 1997). Most studies on structural and relational embeddedness employ idiosyncratic relationships of contacts and pass over the content of what is discussed or who these contacts actually are. This research connects the structural and relational embeddedness of relationships with the content of the discussions in these relationships. The findings indicate that structural hole ties were important in the search for novel information about technological possibilities in the market and possibilities for collaboration and acquiring finance, while the non-structural hole ties were important to the organising of the firm and acquiring resources. Similar observations were made for the strength of tie. Weak ties were more important when acquiring information about the market and potential business partners, while strong ties were more important when

technology development and resources for setting up the spin-off were being considered. These findings are in line with previous research (Burt, 2000; Hansen, 1999; McEvily and Zaheer, 1999) that suggested the importance of the contingent value of exploiting and exploring activities when discussing the structural and relational aspects of network ties. The present study extends these findings by considering the actual content of the discussions in the business networks of academic spin-offs.

7.2.4 IMPACT OF PARENT INVOLVEMENT

The variables of tangible and intangible support and the variable of relatedness between spin-off and parent organisation estimate the impact of parent involvement on the early growth of spin-offs. Regarding parent support, the regression models indicate that tangible support displayed a negative effect on early growth, while intangible support positively influenced the early growth of spin-offs. The estimation confirms that intangible support is a positive predictor of the early growth of spin-offs, which confirms the hypothesis 1e. Intangible support reflects support such as coaching and advice on legal, administrative or organisational issues. The other type of support, tangible support, was also hypothesised (1d) to positively contribute to the early growth of spin-offs. The estimation of the final model, however, displays an opposite finding. Tangible support by the parent organisation was found to negatively affect the early growth of spin-offs. Consequently, the effect of tangible support (Hypothesis 1d) could not be confirmed by the data. In other words, spin-offs experience positive effects from support that is based on advice regarding activities, such as technology development and/or administrative tasks. But support based on tangibles, such as accommodation and finance, did not contribute to their early growth. The third hypothesis based on parent involvement refers to the relatedness between spin-off and parent. The regression model could not document a significant effect of relatedness on early growth and consequently Hypothesis 1f was rejected.

The findings of parent support partly contradicted our expectations of the beneficial effects of a strong tie. Evidence that parent involvement can have beneficial as well as detrimental effects on spin-off performance has also not been extensively discussed in business incubation studies in general. However, some studies have already discussed the detrimental effect of strong ties and indicate that social capital may be a source of constraint for individual behaviour. As Gargiulo and Benassi (1999: 299) put it: "*the network that provided a manager with social capital might also limit his ability to change the composition of this network as required by his task environment*". Strong ties can constrain entrepreneurs because they want them to comply with their expectations and obligations. Strong links may impose a "cognitive lock-in" effect that prevents entrepreneurs from reaching out to novel information (Grabher, 1993). Entrepreneurs cope with new demands or opportunities, and the impersonal "arm's-length" transactions pose fewer obstacles to the pursuit of economic interest (Burt, 1992; Williamson, 1994). In addition, when academic spin-offs evolve from an academic to a business setting, they face changes in their task environment. The different task environment requires new resources and capabilities that are often not yet present but can be found in the spin-off's external network. However, spin-off entrepreneurs may be constrained in exploring their external network when they are supported with too many tangible assets such as finance,

accommodation and intellectual property. Tangible support impedes spin-off entrepreneurs and prevents them from searching beyond their network of strong ties for new opportunities and possibilities.

The detrimental effect of too much tangible support was also observed during the interviews. A new-business development manager at a research centre stated that the national government invests too much in concrete terms (e.g. accommodation for start-ups) while programmes focusing on managing a start-up receive too little attention. Also a spin-off entrepreneur explained that being accommodated in a knowledge institution is not always positive for running a business.

> "*When I received potential customers at the university they often asked me about the status of the company. How long had the company been running and had we had other customers before? Other customers were interested in whether the company was operating autonomously from the knowledge institution. But there were other problems not only with customers. Other scientists would 'accidentally' walk in and look at the things we were doing and plagued our work in the laboratory. It was not only the privacy of our business we wanted to ensure. The things they touched and the questions they raised about annoyed us too. At a certain point I took the door handle off*."

The detrimental effects of support are an aspect that many studies in business incubation do not address. Too often, studies on business incubation stress that supportive activities turn out to be positive to the early growth of new firms or as having no effect. The fact that supportive activities can also be harmful to the early growth of new firms is not considered. These reported positive effects of support may be biased by the small number of observations that result from case studies (Fergusson and Olofsson, 2004; Chan and Lau, 2004). In research on corporate spin-offs it was found that spin-offs may also be hampered by high coordination costs and political problems associated with resource sharing (Sorrentino and Williams, 1995). Although studies on business incubation do not address the detrimental effects of support, they stress that the value of support lies in activities that entrepreneurs have little experience in (Chan and Lau, 2004). A benchmark study by the Centre for Strategy & Evaluation Services of the European Commission (CSES, 2002) stresses that valuable support is based on the training of entrepreneurs. This present study shows similar findings: intangible support such as advice and support in organising the business contributes to a spin-off's early growth. The fact that tangible support is not always positive to the early growth of spin-offs while the intention is to help spin-offs clearly shows a managerial problem.

The research could not, however, confirm a positive significant effect of relatedness between the parent organisation and its spin-off on the early growth of the spin-off. Previous research on corporate venturing showed that relatedness may have more complicated effects on the new venture's performance. In an analysis of corporate ventures, Sorrentino and Williams (1995) could not confirm a positive effect of relatedness on performance but they did find positive interaction between relatedness and intangible assets in the market share of the new venture. This indicates that the negative effect of high relatedness can be neutralised by making use of intangible assets available in the parent organisation. In another study on corporate venturing, Thornhill and Amit (2000) found that

based on the market and technology, a corporate fit between the new venture and the parent increases the success of the new venture. They indicated that success is mainly a result of the relational fit, which is based on the cultural factors such as commitment and awareness. Other studies that have analysed the relatedness between a start-up and an established company found that established companies provided learning opportunities (Baum *et al*., 2000) and raised the credibility of the start-up (Larson, 1992; Stuart *et al*., 1999). A recent study by Sapienza *et al*. (2004) found that the growth of the spin-off is maximized when the knowledge base of the spin-off partially overlaps with that of the parent. Too much overlap will inhibit the search for novel information and too little overlap hampers assimilation of the knowledge. An analysis of the non-linear effect of relatedness (e.g. an inverted U-shape) on early spin-off growth showed that the standardised coefficient of the relatedness variable increased but not enough for it to become significant. Apparently, academic spin-offs may get less benefit from their relatedness to their parent compared to corporate spin-offs. The findings in literature are based on corporate spin-offs. The main activities and orientation to business are more similar for corporate spin-offs and corporate parents than for academic spin-offs and academic parents. However, some spin-offs are still related to their parent. Spin-offs in the life sciences in particular carry out research that is related to that of the parent and consulting spin-offs use academic knowledge in consulting practices. Sector analyses confirmed this by indicating that spin-offs in the life sciences and consulting are significantly ($p<.01$) more related to their parent compared to those in ICT/the media.

The contribution to the social capital theory lies in the analysis of the parent organisation as a strong tie that can influence the early growth of spin-offs. The estimated models provide evidence that tangible and intangible support play different roles in the early growth of spin-offs. Contrary to expectation, tangible support in terms of providing finance, accommodation and intellectual property negatively affected the early growth of a spin-off. Intangible support, in terms of technology, legal, organisational and administrative advice positively contributed to spin-offs experiencing faster growth. This may indicate that a strong tie can have a beneficial effect as well as a detrimental role for academic spin-offs. Academic spin-offs can benefit from the involvement of their parent when support is related to activities that facilitate the start-up process. Entrepreneurs in those spin-offs can focus on the transfer of the academic invention or knowledge to a commercial business proposition without being distracted by organisational or administrative tasks. However, when academic spin-offs stay too close to the academic environment they may be constrained in their search for novel information. Strong linkages with the academic environment hamper spin-offs from changing the composition of their network to suit the new task environment (Gargiulo and Benassi, 1999). Moreover, linkages with the academic environment make it more difficult for spin-offs to come into contact with business partners. Customers and investors find it difficult to assess the autonomy and credibility of spin-offs that are housed in a university or are financed by one. Strong ties with the parent can restrict the independence of the spin-off and prevent or discourage potential business partners from contacting it. According to Portes (1998), strong ties can constrain individual freedom and bar outsiders from gaining access to the same resources through particularistic preferences. Doutriaux (1987) also found that spin-offs were likely to grow more quickly if the academic entrepreneur cut his or her employment ties with the university. By

addressing the "dark side" of social capital, this study improves the understanding of social capital by not merely focusing on its "bright side" (Gargiulo and Benassi, 1999). The findings show that the involvement of a large organisation in the support of a start-up is delicate and may provide seemingly confusing results but in fact work out differently depending on the type of support provided.

Table 7.2 Assessment of hypotheses regarding the Social Capital Theory

Hypothesis 1a:	(Alternative) The more structural holes there are in the external network of the spin-off, the faster the spin-off's early growth will be.	Supported
Hypothesis 1b:	The more heterogeneity there is in the external network of the spin-off, the faster the spin-off's early growth will be.	Not supported
Hypothesis 1c	The more strong/weak (alternative) ties there are in the external network of the spin-off, the faster the spin-off's early growth will be.	Not supported
Hypothesis 1d	The more tangible the support by the parent organisation the faster the spin-off's early growth will be.	Reversed effect
Hypothesis 1e	The more intangible the support by the parent organisation the faster the spin-offs' early growth will be.	Supported
Hypothesis 1f.	The more relatedness there is between the spin-off and its parent organisation, the faster the spin-off's early growth will be.	Not supported

7.3 CONTRIBUTION TO RESOURCE-BASED VIEW

The role of the resource-based view in explaining the early growth of spin-offs is analysed using hypotheses based on the resources and capabilities of the starters' team. This section discusses these hypotheses and elaborates on how they contribute to the resource-based view.

7.3.1 IMPACT OF TEAM RESOURCES

The resources of the spin-off are discussed in terms of the prior experience accumulated by the members of the spin-off starters' team. Spin-offs are founded with little more than the experience captured in the minds of the individuals that form the starters' team (see Section 3.3.4). Also, for spin-offs in biotechnology we believe that the amount of capital they have raised is a reflection of the team's experience and knowledge. Four types of prior experience that are relevant to the start-up of an academic spin-off have been distinguished. These experiences are management, industry, research, and start-up experience. Management experience refers to the skills and knowledge of running a business and directing others. Industry experience indicates whether members of the starters' team have worked in a business environment before. The extent to which members participated in research programmes before the start of the spin-off reflects their research experience. And finally, start-up experience refers to individuals who have either worked in a small entrepreneurial firm before or have started a firm before the current spin-off. The empirical results are presented in Table 6.7.

MANAGEMENT EXPERIENCE

In the regression analysis, Model 4 presented a significant negative effect of prior management experience on the early growth of spin-offs. The negative effect of management experience does not confirm the hypothesised positive effect as formulated by Hypothesis 2a. As a result, Hypothesis 2a could not be confirmed.

Previous studies postulated that prior management experience contributes to the seizing of new growth opportunities (Kor, 2003) and is associated with higher growth (Chandler and Jansen, 1992; Duschenau and Gartner, 1990). These studies analyse the role of management experience in existing firms in general. The role of management experience in a spin-off has received less attention. A study of French biotech spin-offs also indicated that management experience does not seem to be a factor that determines performance (Corolleur *et al*., 2004). An in-depth analysis of management experience showed that among the 197 members of starters' teams in all 65 spin-offs, 20 had management experience from an academic background, 30 from a business background and 37 from both business and academic backgrounds.

INDUSTRY EXPERIENCE

Previous experience in industry does not have a significant relationship with early growth (see Model 3a). As with management experience, previous studies suggest that experience in industry is beneficial to seizing growth opportunities (Kor, 2003) and achieving higher growth (Chandler and Jansen, 1992). However, experience in industry may also turn out differently for academic spin-offs. A study by Corolleur *et al*. (2004) did not find any significant effect of prior industry experience. An explanation for the absence of this effect may lie in the fact that these young firms need to focus on the translation of academic knowledge to the market. This may not so much require industry experience as experience in adapting an academic finding to market demands.

RESEARCH EXPERIENCE

Model 3a in Table 6.7 shows no significant effect of research experience on early growth. Hence, Hypothesis 2c could not be supported for spin-offs. Although this research does not confirm the role of research experience, it does not prove that research experience is not important either. The contribution of prior research experience may not lie only in 'just having' research experience but in being a star scientist (Corolleur *et al*., 2004). The study by Corolleur *et al*. found that famous scientists run more innovative projects. Spin-offs based on radical innovations tend to be more risky but also more valuable. Their study, however, did not find evidence that the more experienced founders ran spin-offs that were growing faster.

START-UP EXPERIENCE

The regression model considered that start-up experience was a positive significant predictor of early growth in spin-offs, thereby upholding Hypothesis 2d. The positive effect of start-up experience is in line with previous studies on entrepreneurial firms. Brüderl *et al*. (1992) and Chandler and Jansen (1992) found that start-up experience was important to the early growth of firms. Like start-ups in general (Eisenhardt and Schoonhoven, 1990),

academic spin-offs can also benefit from start-up experience to overcome the liabilities of newness and smallness (Vohora *et al*., 2004).

The findings show that two types of resources are important to the early growth of academic spin-offs: management and start-up experience. Spin-offs with start-up experience are endowed with knowledge and skills that are important to directing the new firm to growth. The entrepreneurs in such firms are acquainted with the obstacles that can be expected when firms grow. In academic spin-offs, academic knowledge is translated into commercial products and services, but during this translation, they have to overcome several critical junctures if they are to succeed (Vohora *et al*., 2004). Having knowledge about how to deal with critical junctures can increase the success of the new spin-off. Also research on serial entrepreneurs shows that investors are more willing to invest in firms that are started by individuals who have played a major role in a previous venture (Wright *et al*., 1997). Serial entrepreneurs already have knowledge about how to deal with entrepreneurial situations. Such knowledge is essential for academic spin-offs that are often more focused on technology or academic knowledge. Sometimes an entrepreneur from outside the knowledge institution who has previous experience in setting up ventures (a surrogate entrepreneur) supports the spin-off team. A study by Franklin *et al*. (2001) found that a combination of academic and surrogate entrepreneurs might be the best approach for setting up an academic spin-off. Radosevich (1995) found evidence that the surrogate entrepreneur may increase the probability of commercial success when the academic inventor initially supports the technology transfer. In the present study, the role of start-up experience was important for academic spin-offs to achieve early growth.

Contrary to our expectations, the findings indicate that spin-off teams with management experience were not faster but were in fact slower to realise early growth. Seemingly, the skills and capabilities of a manager are not beneficial to the early growth of spin-offs. This observation may run counter to findings in previous research studies on general start-ups (Kor, 2003; Chandler and Jansen, 1992; Duschenau and Gartner, 1990). But research in spin-offs postulates findings similar to ours that management experience is not a good predictor of early spin-off success (Corrolleur *et al*., 2004). Management experience reflects the capabilities of setting up structures and routines that warrant a stable and continuous business process. Academic spin-offs in particular are in transition from an academic environment to a business environment. The main element in this transition is that spin-off entrepreneurs are confronted with unfamiliar roles, new work relationships and incipient organisational routines that need a flexible approach. Although management experience in itself may not be detrimental it clearly needs specific attention as how to take advantage of this experience.

7.3.2 IMPACT OF TEAM CAPABILITIES

Five hypotheses were formulated to analyse the role of team capabilities. Three refer to team diversity and the other two refer to team cohesion and the team's entrepreneurial orientation. Teams that are diverse with respect to their background are believed to be more creative and to find more business opportunities for their firm (Boeker, 1997; Keck, 1997). Although diversity within the team may lead to more ideas and better opportunities, when team members do not speak each other's language or do not understand each other, their

creativity can become lost in dispute (Pelled *et al*., 1999; Knight *et al*., 1999). Cohesive teams work together well and are believed to improve the team's effectiveness and increase firm performance (Amason and Sapienza, 1997). Besides the internal team process, the external entrepreneurial orientation is also believed to affect the early growth of firms (Zahra and Covin, 1995; Wiklund and Shephard, 2003). Teams may work well together and have splendid ideas but if they lack an entrepreneurial orientation they will not create the necessary environment to allow the spin-off to grow.

TENURE, FUNCTIONAL AND INDUSTRY DIVERSITY, AND TEAM COHESION

Tenure diversity describes how team members have joined the spin-off at different times. New members in the spin-off may bring in new ideas, or at least, are not hampered by path dependencies of previous activities. They may have a different mind-set and have less trouble in terminating ideas or activities that show little potential. In Model 3b we assessed the role of tenure diversity but found no significant effect. Despite the hypothesised positive effect of tenure diversity on the early growth of spin-offs, we could not confirm Hypothesis 2e. The influence of functional diversity was hypothesised with arguments similar to those used for tenure diversity. Members with experience in different functions may bring into the spin-off different kinds of knowledge, ideas or contacts and thereby raise the performance of the spin-off. However, estimating the effect of functional diversity proved not to be significant in Model 3b, and Hypothesis 2f was not supported. The influence of industry diversity among team members was hypothesised to be beneficial to the early growth of academic spin-offs. Nevertheless, the result is similar to that for the other types of diversity and Hypothesis 2g could also not be confirmed. The positive role of industry diversity among spin-off team members could not be established. Cohesive teams are believed to work well together and thereby improve the team's effectiveness and, eventually, the performance of the team. In Model 3b, the role of team cohesion was analysed on the early growth of the spin-off. The estimation however could not find a significant effect of team cohesion on the early growth of spin-off and, as a result, could not support Hypothesis 2h.

The absence of any effect of the different types of team diversity and the absence of positive effects of team cohesion in this research may be attributed to at least three causes. First, previous research studies that found evidence of the role of diversity on team performance were carried out among upper echelons and R&D teams of established firms (Hambrick *et al*., 1996; Bantel and Jackson, 1989; Wiersema and Bantel, 1992; Reagans and Zuckerman, 2001). Only a few studies analysed the role of diversity and cohesion among entrepreneurial teams. Second, the studies on entrepreneurial team diversity and cohesion were based on case studies (Roure and Madique, 1986) or used different dependent variables. Smith *et al*., (1994) found that cohesion was related to sales growth and to the returns on investments, and Ucbasaran *et al*., (2003) related diversity to member entry. This study analysed the role of diversity and cohesion on the early growth of spin-offs, which is a different dependent variable. The third cause may lie in the fact that diversity and cohesion have different effects on team processes and eventually may differ in their effect on team performance. A study by Ensley *et al*. (2002) analysed the role of cohesion on team performance and used the mediating variables of cognitive and affective conflict to assess its role on venture growth. The fact that diversity and cohesion may have

ambiguous outcomes for firm performance can be explained by the cognitive and affective conflict they invoke (Amason and Sapienza, 1997). If diversity leads to cognitive or task-oriented conflict, discussions can improve the effectiveness of the decision-making in teams and result in higher firm growth. But if diversity leads to affective conflict, which is individual-oriented, discussions can turn into disputes, distrust and hostility that hamper the team's performance. The cohesion in a team can then harmonise the effect of cognitive and affective conflict. Recently, a variety of studies have addressed the moderating effect of cohesion on diversity and performance. Chandler *et al*. (2005) found that the antecedents and moderators of team heterogeneity were associated with higher turnover in venture teams. Amason *et al*. (2005) also postulated that a team's demographic characteristics influence its information-processing ability, which in turn affect venture performance. And Aspelund (2005) stressed that the heterogeneity in the functional experience of the founding team may reduce the likelihood of firm failure. The fact that diversity and cohesion do not predict the early growth of a spin-off may be due to the more complex effect of these factors on task- and affective conflict. In the present research, we ran additional analyses on the interaction of diversity and cohesion, but no significant effects were found.

ENTREPRENEURIAL ORIENTATION

Hypothesis 2i claims that entrepreneurial orientation is important to the early growth of spin-offs. It analyses the extent that the spin-off team is innovative, proactive and risk-taking (Wiklund and Shepherd, 2003). Teams with an entrepreneurial orientation are more driven by perceptions of opportunity and are less worried about the resources they control (Stevenson and Gumpert, 1985). The regression analysis, however, did not show significant effect for entrepreneurial orientation. Consequently, Hypothesis 2i could not be confirmed. Two explanations can be given for the absence of the role of entrepreneurial orientation. First, the present study uses the measurement by Stevenson and Gumpert (1985) to assess the entrepreneurial orientation of academic spin-offs. Other studies have used the scales of innovativeness, proactiveness and risk-taking by Miller (1983). Covin and Slevin (1989) found that entrepreneurial orientation was positively related to venture performance and Lee *et al*. (2001) found a positive weak effect of entrepreneurial orientation on venture performance. Wiklund and Shepherd (2003) argue that entrepreneurial orientation enhances the knowledge-based resources of the team and this consequently affects the performance of the firm positively. The absence of a significant effect of entrepreneurial orientation may be attributed to the large difference between managerial focus and entrepreneurial focus on the scale of Stevenson and Gumpert (1985). A management focus is directed at running a business, while an entrepreneurial focus is oriented at establishing a business. This study focuses on the start-up of a spin-off, which is more related to an entrepreneurial focus than to a managerial focus. As a result, managerial focus may not be present. As explained earlier, academic spin-offs translate academic knowledge to the market. During that translation a clear focus on the market and a strong entrepreneurial orientation are needed. Many of the spin-offs exhibit such a market focus and an entrepreneurial orientation.

The second explanation that we suggest is that having an entrepreneurial orientation says little about the ability of the spin-off team to deal with the actions associated with a high-tech start-up. The entrepreneurial orientation is based on the importance that spin-off

entrepreneurs address to activities associated with an entrepreneurial focus, and is, as such, a perception and not behaviour. In that respect, spin-off members with start-up experience are not only entrepreneurially oriented but actually have the skills and capabilities to direct a start-up. So the indicator of start-up experience may be a better indicator for the early growth of academic spin-offs. Moreover, when academic spin-offs translate academic knowledge into commercial ends, the focus cannot be merely on the technological research and development. Over the last five years, investors in spin-offs have increasingly required spin-offs to work out technological leads for the future, but simultaneously generate a cash-flow from existing products and services. Academic spin-offs need an explorative orientation to adapt academic knowledge to commercial applications and an exploitative orientation to capitalise on the current knowledge and capabilities of the spin-off. In dealing with both the explorative and exploitative activities, spin-offs that have accumulated start-up experience before are in a better position to bring the spin-off to early growth compared to spin-offs with high levels of management experience.

The present research contributes to the resource-based view in that it analyses the role of team demographics on early spin-off growth. Research on the role of team demographics on firm performance is based on upper echelon's (Hambrick *et al*., 1996; Pelled *et al*., 1999; Amason and Sapienza, 1997) and R&D teams in large established firms (Acona and Caldwell, 1992a; Reagans and Zuckerman, 2001). Less research exists on the demographics of teams in academic spin-offs. Although several studies analyse the role of the scientist in the spin-off process (Shane, 2000; Murray, 2004; Corolleur *et al*., 2004), the role of the team's network (Nicolaou and Birley, 2003b) and the formation of spin-off teams (Clarysse and Moray, 2004), they do not discuss the demographics of teams. This study uses the team's demographics to analyse the resources and capabilities of teams that eventually lead to early spin-off growth. The research and business experiences were not conclusive and neither were the dynamic capabilities based on team diversity, cohesion and entrepreneurial orientation. However, the findings suggest that capabilities have not yet emerged in spin-off start-ups. Capabilities cannot be bought or easily copied but require long periods of learning and investment to evolve (Amit and Schoemaker, 1993). Academic spin-offs in particular need to translate their academic knowledge into a business opportunity. Firms can establish dynamic capabilities by creating new knowledge resources in the firm and recombining the existing knowledge with new knowledge acquired (Cohen and Levinthal, 1990). Therefore, it might be more useful to analyse the role of the team's innovation and learning capabilities on the early growth of academic spin-offs (Lant and Mezias, 1990).

Table 7.3 Assessment of hypotheses regarding the Resource-based View

Hypotheses 2a/b/c/d	The more management (hyp.2a), business (hyp.2b), research (hyp.2c), or start-up (hyp.2d) experience there is among the members of the spin-off's starters' team, the faster the spin-off's early growth will be.	2a reverse effect 2d supported
Hypothesis 2e/f/g	The more tenure diversity (hyp.2e), functional diversity (hyp.2f), or industry diversity (hyp.2g) there is among the members of the spin-off's starters' team, the faster the spin-off's early growth will be.	Not supported
Hypothesis 2h	The more cohesion there is among the members of the spin-off's starters' team, the faster the spin-off's early growth will be.	Not supported
Hypothesis 2i	The more entrepreneurial orientation there is among the members of the spin-off's starters' team, the faster the spin-off's early growth will be.	Not supported

7.4 METHODOLOGICAL IMPLICATIONS AND IDEAS FOR FURTHER RESEARCH

The present study offers several important methodological contributions. A variety of research instruments drawn from the social capital theory and the resource-based view have been combined in this single study. The use of these instruments presented three implications that are discussed here. First, the study combined network measures with the results of the discussions with the contacts in those networks. The content of discussions offers an understanding of the importance of certain network contacts and consequently increases knowledge about which ties are favourable to certain objectives. By considering not only the structural and relational characteristics of ties but also the content of the discussions with these ties, it becomes clearer as to who to contact in the pursuit of certain objectives. Second, the variables in this research are measured with formative- and reflective-based constructs. Formative constructs directly reflect the operational definition, while the reflective construct reflects a perception or attitude (Bollen, 1989). In our questionnaire, we introduced variables that reflect the types of support that the parent organisation might provide to a spin-off. A support variable is a direct reflection of the support the spin-off has received and is, therefore, a formative construct. The newness of the business activity to the team, for example, is in the perception of the team and, as such, is a reflective construct. Each type of construct needs a different approach to assess its reliability and validity. Making the distinction between formative and reflective constructs improves the assessment of their reliability and validity, and consequently the understanding of these variables. The third methodological contribution in this research is an analysis of suppressor variables. Suppressor effects can appear when the variables are conceptually different but share similar variances. Several variables in this research used summated scales and as such may introduce suppressor effects (Cohen *et al*., 1983). Suppressor variables can assist in predicting of dependent variables (i.e., they increase the effect size) due to their correlation with other independent variables (Tabachnick and Fidell, 1996). Appendix B1 explains the effects of suppressor variables in this research in more detail. Identification of suppressor effects is important because non-identification of significant suppressor effects could lead to misjudgements in the analysis.

Several limitations of this research need to be discussed. First, the data obtained were collected from a single entrepreneur in a spin-off. We asked the entrepreneur to provide information about the whole starters' team. Although we took several steps when designing the questionnaire to limit concerns regarding single-informant data, the issues of key informant bias and common method bias cannot be completely ruled out (Podsakoff *et al*., 2003). Future research might benefit from more detailed information when analysing the starters' team. However difficulties will remain since teams, particular in spin-offs, change constantly as the spin-off develops.

Second, the importance of certain network contacts is based on the importance of activities that were discussed with these ties. This research first identified, for each respondent, the level of importance attached to distinct start-up activities. Next, respondents were asked to indicate who they discussed these start-up activities with and the network characteristics of these individuals. This approach revealed some interesting findings about the role of certain types of network contacts. It is possible that discrepancies as to the importance of individual alters may have influenced the results. For example market evaluation is an

important start-up activity and discussed between two alters. Alter 1 may be more important than alter 2 but this research placed equal importance on both. More contrast can be obtained when the importance of distinct alters regarding certain activities is considered. Further in-depth research on the content of ties and the importance of individual alters might provide more knowledge about the role of tie strength; the background alters come from and the role of structural holes.

Third, future research could benefit from a more thorough assessment of the resources and capabilities of the spin-off to analyse exploration and exploitation capabilities The most prominent task in spin-offs is translating an academic finding to the market place. The resources and capabilities that are beneficial to start-ups and small firms in general may be different to those needed by academic spin-offs. Resources and capabilities in the innovation trajectory of an academic spin-off might be better reflected by experience and capabilities in adapting technological findings to market demands and capabilities in seizing opportunities. Fourth, future spin-off research could explore the debate highlighted by Makadok (2001: 389) who stresses that "… *capability building only creates economic profit if a firm is successful at acquiring other resources on which the capability in question can exert its productivity-enhancing influence*". Hatch and Dyer (2004) also argue that valuable and rare resources provide a firm with the potential to develop learning capabilities that result in higher performance. Future research could consider an analysis of the relationship between a firm's resources and the effectiveness of its activities rather than the relationship between resources and overall performance (Ray *et al*., 2004). The fact that firms have advantages in some activities and are in a disadvantage in others may cancel out the true effects of resources. Research into spin-offs could particularly benefit from such analysis because they must work out technological leads and capitalise on current findings to generate cash-flow simultaneously. These findings will increase theoretical and practical understanding.

7.5 MANAGERIAL IMPLICATIONS

The findings of this research have clear implications for spin-off entrepreneurs, officials in knowledge institutions and policy makers. Chapter of this manuscript outlined the practical relevance of studying academic spin-offs and this is summarised in Table 7.4.

Table 7.4 Practical relevance of studying academic spin-offs

Actors in the spin-off process	Are interested in…	And may question…
Spin-off entrepreneurs	Improving chance of success and performance	How should the starters' team be configured? What network structure should be developed and what influences this structure? How can we benefit from the parent involvement?
Officials in knowledge institutions	Knowledge valorisation and prestige	When are spin-offs appropriate? What objectives and returns can we expect? How should we be involved in the spin-off founding process?
Politicians	Economic growth and development	What hampers spin-off venturing? What types of support are available and what is their effect?

The present research has identified several key success factors regarding the early growth of academic spin-offs. Academic spin-offs develop in a scientific environment while business opportunities lie in the business world. The founders of spin-offs need to search beyond their academic environment to find business opportunities. It is important that networks are used to bridge the gap between the academic and business environment. When spin-offs bridge this gap, they can broker their knowledge and control resources on either side of the bridge.

Another key success factor is the start-up experience among the founders of a spin-off. Spin-offs that have members with previous start-up experience can benefit from their skills and knowledge about starting up a new venture. Academic high-technology spin-offs, in particular, are based on a scientific finding that must be translated to commercial ends. In that transition many critical junctures, not only those related to technology will be encountered. Spin-off founders may have to work out business plans, convince investors, set up business partnerships and eventually attract customers. Most scientists are not acquainted with these business-related activities and may struggle to solve a critical problem in their path to growth. Individuals with start-up experience have encountered these issues before and may be more successful in moving on into a new phase of growth. Management experience turned out to be detrimental to the early growth of spin-offs. Management experience can be constraining to the early growth when it focuses on cost-reduction and risk avoiding behaviour.

The next key success factor lies in the involvement of the parent organisation. The support by the parent organisation can have a positive as well as a negative effect on the early growth of spin-offs. Parent support based on accommodation, finance and intellectual property is negatively related to spin-off performance. It can lead to a view that is not externally oriented enough and the spin-off may stay too close to the parent and not actively approach the market. When spin-offs stay too close to the parent organisation, they may not come across new ideas that might emerge from discussions in the business environment; they will encounter fewer opportunities to choose from. Furthermore, spin-offs that are financed by the parent organisation may have fewer incentives to look for external funding

and fewer discussions about their business plans. Spin-offs that are financed by investors in the market have to explain their business plan in more detail. These spin-offs have to put more time and energy into their business plan before they receive investment and, consequently, because of that energy and time, are cautious about spending any capital they have raised. The investor also looks over the shoulder of the spin-off's management team and checks expenditures. Such spin-offs may receive specific business knowledge support from an investor to help face any difficulties when the spin-off grows. As a result, the capital that is raised by the parent organisation may be based on business plans that are less detailed and the capital may be spent more easily than capital that is raised on the open market.

Support concerning intellectual property may also hamper the spin-off. Intellectual property rights (IPR) often involve serious investments for a spin-off. The application of IPR needs thorough research of existing IPRs, formulation of a new IPR, and capital to register them. Furthermore, the IPR may not be used later on because the business plan changes during the start-up period or spin-offs try to avoid the IPR when the parent organisation claims royalties. We have also discussed how spin-offs start with little more than the experience and skills of its founders. If these experiences and skills are formulated in IPR in which the parent organisation has a strong say, investors and business partners are more cautious. It is more difficult for investors and business partners to determine the value and independence of such spin-offs.

Although the parent organisation may constrain the early growth of its spin-off, parent involvement can also turn out to be helpful to the spin-off. Support activities based on coaching and advice are found to be beneficial to the early growth of academic spin-offs. Scientific coaching and advice on organising the spin-off, setting up its administration and guidance with legal affairs can help the spin-off to focus on its core activity, namely the transfer of academic knowledge to the market. In such instances, spin-offs are not distracted and do not have to pick up extra skills or pay experts for their expertise.

The factors that are key for success have clear implications for entrepreneurs in spin-offs, officials in knowledge institutions and policy makers.

7.5.1 SPIN-OFFS ENTREPRENEURS

Spin-off entrepreneurs aim to increase their chances of success and to enhance the performance of their spin-off. To improve their chances, firms need a competitive advantage that is often rooted in a good business opportunity. Recognising a business opportunity is important for providing a scientific finding as a commercial good in the market place. Nascent entrepreneurs also ask themselves where they can find these business opportunities in order to get their spin-off founded. Many opportunities emerge from discussions with others, but who to contact remains unclear. The findings of the present research suggest that contacts with whom structural holes can be bridged are important. These structural holes are connections between contacts in clusters that were not closely connected before. The contacts may not be unaware of each other, but as Burt (1984) states: the two are so focused on their own businesses that they pay little attention to the activities of people in other clusters (see Figure 7.1a). The network without structural holes (Figure 7.1b) can be considered a perfect market in which all information is transparent and

accessible to all. The network with structural holes offers a competitive advantage. The disconnections between individuals, the holes in their network, leave some individuals unaware of the benefits they may offer to others. In other words, the structural holes between individuals are entrepreneurial opportunities for third parties to broker the flow of information and control resources between people on opposite sites of the structural hole.

Figure 7.1a
A spin-off operating in a network with structural holes

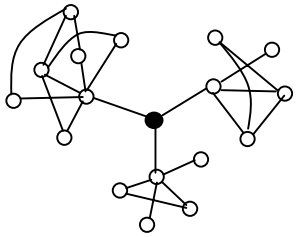
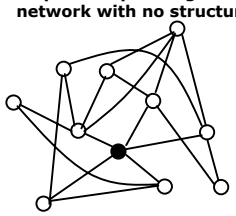


Figure 7.1b
A spin-off operating in a network with no structural holes



In other words, if the spin-off has a network that includes structural holes, it may enjoy a competitive advantage. When the spin-off connects with business partners that were not associated with the parent organisation, it can broker the academic knowledge to the business environment and benefit from the resources available on either the academic or the business side. Moreover, the findings clarified that structural holes are especially convenient when the spin-off needs to collect information regarding the market, collaborate with business partners or access financial capital.

The parent organisation may offer important benefits to the spin-off as well. The spin-off can receive support concerning various activities and resources from the parent organisation. The spin-off entrepreneur must recognise that although the parent provides support activities with the best intentions, they may end up as beneficial to the performance of the spin-off. In the pursuit of spin-off growth and profitability, spin-offs need to maximise the time available to translate academic knowledge to market standings. More time is available if the parent organisation helps out in peripheral activities so that the spin-off can focus on those activities associated with the translation. Peripheral activities are associated with advice how to start the spin-off, set up business agreements and organise administrative tasks. Parent support based on financial capital and accommodation increases the perception among business partners that the spin-off is closely associated with the parent and may consequently lead them to question the autonomy and self-sufficiency of the spin-off. A spin-off that grows independently of its parent can still make use of advice and scientific coaching by the parent and at the same time show its own ability to be a viable business.

Spin-offs need certain resources and capabilities that are typical of their main activity in order to transfer scientific knowledge into a viable product, process or service. Specific types of experience are then important in establishing initial growth. Our analyses of Dutch spin-offs show that start-up experience is important in founding a new academic spin-off. Knowing how to deal with the first phases of growth clearly makes a difference. Vohora *et al*. (2003) already showed the importance of critical junctures. Teams that are able to recognise and pass critical junctures will eventually survive. When teams cannot overcome

such hurdles, they may not grow or might even abandon their business all together. Although spin-off entrepreneurs can attend master classes and other types of courses on entrepreneurship and benefit from business meetings for networking, the findings in this research clearly show that having start-up experience in the spin-off team is the most important factor to the success of a spin-off. Spin-off teams that have no start-up experience are advised to include at least one individual in the team who has such experience. These individuals not only recognise the critical junctures and obstacles the spin-off faces during its early growth but also know when to expect problems, how to prevent these setbacks and how to act at that moment (Krueger, 1993; Krueger and Brazael, 1994). Another aspect that can be learned is the detrimental effect of management experience. It is not that management experience is a liability, but spin-off entrepreneurs must understand that management experience can become a liability if it removes the focus from the entrepreneurial activity and induces risk-avoiding behaviour. During early growth, work relationships and the business activity change a lot and do not need organised routines and tight procedures.

7.5.2 KNOWLEDGE INSTITUTIONS

When adapting academic knowledge to the market, several transfer mechanisms are available to the knowledge institution. Besides contract research, knowledge institutions are increasingly using spin-offs to capitalise on academic knowledge. Accordingly, knowledge institutions may question when spin-offs are appropriate. Findings in the literature (Thursby *et al*., 2001; Shane, 2004) indicate that spin-offs are appropriate when early inventions are concerned. Inventions in a later stage of development are more codified and more suitable to transfer through licensing. Furthermore, the applications of inventions are clearer in a later stage and they are then better equipped for contract research. Our research suggests that spin-offs are appropriate when the commercial application of the scientific knowledge lies in a business environment in which the parent is not (yet) active. Spin-offs can then bridge the two separate networks. Controlling the resources and information in both networks provides the spin-off with an opportunity for competitive advantage. Moreover, when spin-offs bring together two previously separate worlds, they may face less competition. And if the spin-off emerges in a business environment in which the parent organisation has no connections, it may provide the parent with opportunities to realise the possibilities of applying its own academic knowledge in a new environment.

When spin-offs apply academic knowledge in areas related to those of the parent organisation, the knowledge institution should realise that the returns from IP exploitation through spin-offs are uncertain and are typically to be realised over the medium or long term. The management of the spin-off activity, therefore, requires up-front investment and lengthy payback periods. Institutions need to consider these financial realities when framing their spin-off policy and monitoring the performance of a spin-off. Furthermore, a knowledge institution needs to negotiate an agreement that gives it an appropriate share in any revenues, but it also needs to ensure that university staff can use any results in future research. Agreements need to be framed so that the financial interests of knowledge institutions and of individual researchers do not compromise the institution’s independence.

Regarding the involvement of the parent organisation, the findings clearly indicate that the parent should keep its spin-offs at arm's length. The parent organisation should not embrace the spin-off too closely as it may constrain it in its freedom and signal to others that the spin-off has not reached maturity. Moreover, the entanglement of resources between spin-off and knowledge institution makes the spin-off less business-oriented and if competition over these resources exists it may be frustrating. As one official at a knowledge institution explained: "*the competition over resources within the knowledge institution may be the largest barrier for spin-offs to emerge"*. Furthermore, spin-offs that remain too close to the parent organisations are less likely to establish commercial opportunities and find difficulties in changing their external network to the requirements of the new task environment in the business world. The support of the parent organisation can benefit the spin-off if it concerns activities, so that the spin-off entrepreneur can focus on transferring academic knowledge to commercial ends. Examples of these types of support are advice, coaching and help in administrative and legal tasks. In the market place, these professional services are often too expensive for start-ups.

Other types of activities that knowledge institutions can fulfil are the bringing together of academic researchers, experienced entrepreneurs, investors and businessmen. By assembling these individuals, an environment can be created in which structural holes can be bridged. For example, academia can meet business and encounter opportunities for setting up a new business. New bridges between the academic and business environments emerge. In addition, when a new spin-off is founded, the knowledge institution can assess the composition of the team and advise including an entrepreneur with start-up experience if the team lacks this.

7.5.3 GOVERNMENTAL AUTHORITIES

Governmental authorities are mainly concerned with national economic growth and job creation. To that end, spin-offs can contribute by brokering the knowledge that is being developed in knowledge institutions. When granting new research programmes, governmental authorities increasingly require that the research findings be applied in business. Following these requirements, when spin-offs emerge, governmental authorities may ask "*what hampers the spin-off venturing process and which support instruments are effective?*"

Considering support instruments, the findings of the present study have important policy implications. Some authors (Holtz-Eakin, 2000; Santarelli and Vivarelli, 2002) question the rationale for public support of new firms because it may distort and delay the competitive selection process and subsidise inefficiencies. The present study indicates that public support should not embrace a spin-off but rather should keep it at arm's length. By keeping spin-offs at a distance, they can help spin-off entrepreneurs understand the barriers in the start-up process and what they need to do to overcome them. Furthermore, support should be aimed at facilitating the networking of spin-offs so they are better able to develop bridges between academia and industry. In that way, support programmes focused on network meetings, coaching and advice may be more fruitful. Incubators in particular should not only serve as facilitators but also stimulate the networking between academia and the business environment. They should develop skills to monitor a spin-off team and

assess whether new skills and experiences are needed, and if so, introduce new members accordingly.

7.6 CONCLUDING REMARKS

The present research has documented the factors that determine the early growth of academic spin-offs in the Netherlands. Based on an analysis of data collected from 65 spin-offs in a survey of 297 spin-offs, the results indicate that if spin-offs bridge structural holes they have a better chance of growing. Furthermore, the inclusion of a member with start-up experience in the team benefits spin-off growth, while management experience does not always contribute to such growth. Regarding the parent organisation, it was found that the support it provides to its spin-off can have beneficial effects if it concerns advice and coaching activities. Support based on accommodation, finance and intellectual property turned out to be detrimental.

These findings have essential repercussions regarding the two organisational theories used in this research. Although the two theories have divergent views of the factors that determine a firm's early growth analysis shows that the two are complementary. The findings also contribute to the social capital theory regarding the Burt-Coleman debate by stressing that structural holes are essential for spin-offs to grow. Analysis of parent involvement indicates that social capital can also have a "dark side".

These findings provide equally interesting views for scholars on theoretical debates and for practitioners who want their academic spin-off to prosper.

REFERENCE LIST

Adler, P.S., & Kwon, S.-W. 2002. Social capital: Prospects for a new concept. *Academy of Management Review*, 27(1): 17-40.

Aernoudt, R. 2004. Incubators: Tool for entrepreneurship? *Small Business Economics*, 23(2): 127-135.

Aldrich, H.E. 1979. *Organizations and environments*. Englewood Cliffs, NJ: Prentice Hall.

Aldrich, H.E. 1999. *Organizations evolving*. London: Sage Publications.

Aldrich, H.E., Rosen, E. & Woodward, W. 1986. Social behavior and entrepreneurial networks. In N. Churchill, B. Kirchhoff, W. Krasner, & K. Vesper (Eds.), *Frontiers of Entrepreneurship Research:* 355-369. Wellesley, MA: Babson College.

Aldrich, H.E., & Zimmer, C. 1986. Entrepreneurship through social networks. In D.L. Sexton & R.W. Smilor (Eds.), *The art and science of entrepreneurship:* 3-23. Cambridge, MA: Ballinger.

Aldrich, H.E., Elam, A.B., & Reese, P.R. 1996. Strong ties, weak ties, and strangers: do women business owners differ from men in their use of networking to obtain assistance? In S. Birley & I.C. MacMillan (Eds.), *Entrepreneurship in a global contest:* 1-25. London: Routledge Ltd.

Allen, D.N., & McCluskey, R. 1990. Structure, policy, services and Performance in the business incubator industry. *Entrepreneurship Theory and Practice*, 15(2): 61-77.

Almus, M., & Nerlinger, E.A. 2000. Testing Gibrat's law for young firms – empirical results for West Germany. *Small Business Economics*, 15: 1-12.

Amason, A.C. 1996. Distinguishing the effects of functional and dysfunctional conflict on strategic decision making: Resolving a paradox for top management teams. *Academy of Management Journal*, 39: 123-148.

Amason, A.C., & Sapienza, H.J. 1997. The effects of top management team size and interaction norms on cognitive and affective conflict. *Journal of Management*, 23(4): 495-516.

Amason, A.C., Shrader, R.C., & Tompson, G.H. 2005. Newness and novelty: Relating top management team composition to new venture performance. *Journal of Business Venturing*, article in press, 20 June 2005.

Amit, R., & Schoemaker, P.J.H. 1993. Strategic assets and organizational rent. *Strategic Management Journal*, 14: 33-46.

Ancona, D.G., & Caldwell, D.F. 1992a. Demography and design: predictors of new product team performance. *Organization Science*, 3: 321-341.

Ancona, D.G., & Caldwell, D.F. 1992b. Bridging the boundary: external activity and performance in organizational teams. *Administrative Science Quarterly*, 37: 634-665.

Armstrong, J.S., & Overton, T.S. 1977. Estimating non response bias in mail survey. *Journal of Marketing Research*, 14: 396-402.

Aspelund, A., Berg-Utby, T., & Skjevdal, R. 2005. Initial resources' influence on new venture survival: a longitudinal study of new technology-based firms. *Technovation*, 25(11): 1337-1347.

Audretsch, D.B., Klomp, L., Santarelli, E., & Thurik, A.R. 2005. Gibrat's law: Are the services different? *Review of Industrial Organization*, 24(3): 301-324.

Autio, E., 2000. Growth of technology-based new firms. In: Sexton, D.L., Landstrom, H. (Eds.), The Blackwell Handbook of Entrepreneurship. Blackwell, Oxford, pp. 329-347.

Bagozzi, R.P. 1984. A prospectus for theory construction in marketing. *Journal of Marketing,* 48: 11-29.

Bandura, A. 1997. *Self efficacy: The exercise of self-control*. New York: W.H. Freedman.

Bantel, K.A., & Jackson, S.E. 1989. Top management and innovations in banking: Does the composition of the top team make a difference? *Strategic Management Journal*, 10(Summer Special Issue): 107-124.

Barney, J.B. 1991. Firm resources and competitive advantage. *Journal of Management*, 17(1): 99-120.

Barney, J.B. 2001. Is the resource-based view a useful perspective for strategic management research? Yes. *Academy of Management Review*, 26(1): 41-56.

Barney, J.B., Wright, M., & Ketchen jr, D.J. 2001. The resource-based view of the firm: Ten years after 1991. *Journal of Management*, 27: 625-641.

Batjargal, B. 2003. Social capital and entrepreneurial performance in Russia: A longitudinal study. *Organization Studies*, 24(4): 535-556.

Baum, J.A.C., & Oliver, C. 1992. Institutional embeddedness and the dynamics of organizational populations. *American Sociological Review*, 57: 540-559.

Baum, J.A.C., Calabrese, T., & Silverman, B.S. 2000. Don't go it alone: Alliance network composition and startups' performance in Canadian biotechnology. *Strategic Management Journal*, 21: 267-294.

Baum, J.A.C., & Silverman, B.S. 2004. Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups. *Journal of Business Venturing*, 19 (3): 411-436.

Bensaou, M. & Venkatraman, N. 1995. Configurations of interorganizational relation-ships: A comparison between U.S. and Japanese automakers. *Management Science*, 41(9): 1471-1492.

Birch, D.L. 1981. Who creates jobs. *The Public Interest*, 65 (Fall): 62-82.

Birch, D.L. 1987. *Job generation in America*. New York: The Free Press.

Birley, S. 1985. The role of networks in the entrepreneurial process. *Journal of Business Venturing*, 11: 107-117

Blair, D., & Hitchens, D. 1998. *Campus companies – UK and Ireland*. Aldershot, UK: Ashgate.

Blau, P.M. 1977. *Inequality and heterogeneity*. New York: The Free Press.

Boeker, W. 1997. Strategic Change: The influence of managerial characteristics and organizational growth. *Academy of Management Journal*, 40(1): 152-170.

Bollen, K.A. 1989. Structural equations with latent variables. New York: Wiley.

Bollen, K.A., & Hoyle, R.H. 1990. Perceived cohesion: a conceptual and empirical examination. *Social Forces*, 69: 479–504.

Bollen, K.A., & Lennox, R. 1991. Conventional wisdom on measurement: A structural equation perspective. *Psychological Bulletin*, 11(2): 305-314.

Bøllingtoft, A., & Ulhøi, J.P. 2004. The networked incubator – leveraging entrepreneurial agency? *Journal of Business Venturing*, 20(2): 265-290.

Bourdieu, P. 1985. The forms of capital. In J.G. Richardson (Ed.) *Handbook of theory and research for the sociology and education:* 241-258. New York: Greenwood Press.

Borgatti, S.P., Jones, C., & Everett, M.G. 1998. Network measures of social capital. *Connections,* 21(2): 1-36.

Borgatti, S.P., & Foster, P.C. 2003. The Network Paradigm in Organizational Research: A Review and Typology. *Journal of Management,* 29(6): 991-1013.

Boxman, E.A.W., De Graaf, P.M., & Flap, H.D. 1991. The impact of social and human capital on the income attainment of Dutch managers. *Social Networks*, 13: 51-73.

Bray, M., & Lee J. 2000. University revenues from technology transfer: Licensees vs. equity positions. *Journal of Business Venturing*, 15(5/6): 385-392.

Brown, S.L., & Eisenhardt, K.M. 1995. Product development: Past research, present findings, and future directions. *Academy of Management Review*, 20: 343-378.

Brüderl, J., & Preisendörfer, P. 2000. Fast growing business. *International Journal of Sociology*, 30: 45-70.

Brüderl, J., Preisendörfer P., & Ziegler, R. 1992. Survival changes of newly funded business organizations. *American Sociological Review*, 57: 227-242.

Brush, C.G., & Vanderwerf, P.A. 1992. A comparison of methods and sources for obtaining estimates of new venture performance. *Journal of Business Venturing*, 72: 157-170.

Burt, R.S. 1984. Network items in the General Social Survey. *Social Networks*, 6: 293-339.

Burt, R.S. 1992. *Structural Holes*. Cambridge, MA: Harvard University Press.

Burt, R.S. 1997a. The contingent value of social capital. *Administrative Science Quarterly*, 42(2): 339-365.

Burt, R.S. 1997b. A note on social capital and network content. *Social Forces*, 19: 355-373.

Burt, R.S. 2000. The network sructure of scial cpital. In B.M. Staw and R.I. Sutton (Eds.), *Research in Organizational Behavior, 22:* 345-423. Greenwich, CT: JAI Press.

Burt, R.S. 2001. Attachment, decay, and social network. *Journal of Organizational Behavior*, 22(6): 619-643.

Burt, R.S. 2004. Structural holes and good ideas. *American Journal of Sociology*, 110(2): 349-399.

Burt, R.S., Hogarth, R.M., & Michaud, C. 2000. The social capital of French and American managers. *Organization Science*, 11(2): 123-147.

Cabral, L.M.B., & Mata, J. 2003. On the evolution of the firm size distribution: Facts and theory, *American Economic Review*, 93: 1075-1090.

Castanias, R.P., & Helfat, C.E. 2001. The managerial rents model: Theory and empirical analysis. *Journal of Management*, 27: 661-678.

Chan, K.F., & Lau, T., 2004. Assessing technology incubator programs in the science park: the good, the bad and the ugly, *Technovation*, 25: 1215-1228

Chandler, G.N., 1996. Business similarity as a moderator of the relationship between pre-ownership experience and venture performance. *Entrepreneurship Theory and Practice*, 20: 51-65.

Chandler, G.N., & Jansen, E.J. 1992. Founder's self-assessed competence and venture performance. *Journal of Business Venturing,* 7: 223–236.

Chandler, G.N., & Hanks, S.H. 1994a. Founder competence, the environment, and venture performance. *Entrepreneurship, Theory and Practice*, (Spring): 77-89.

Chandler, G.N., & Hanks, S.H. 1994b. Market attractiveness, resource-based capabilities, venture strategies, and venture performance. *Journal of Business Venturing*, 9: 331-349.

Chandler, G.N., Honig, B., & Wiklund, J. 2005. Antecedents, moderators, and performance consequences of membership change in new venture teams. *Journal of Business Venturing*, 20(5): 705-725.

Chiesa, V., & Piccaluga, A. 2000. Exploitation and diffusion of public research: the general framework and the case of academic spin-off companies. *R&D Management*, 30: 329-340.

Chong, L., & Gibbons, P. 1997. Corporate entrepreneurship: The roles of ideology and social capital. *Group and Organization Management*, 22: 10-30.

Chrisman, J., Hynes, T., & Fraser, S. 1995. Faculty entrepreneurship and economic development: The case of the University of Calgary. *Journal of Business Venturing*, 10: 267-281.

Churchill, G.A. 1979. A paradigm for developing better measures of marketing construct. *Journal of Marketing Research*, 16(1): 64-73.

Clarysse, B., & Nathalie, M. 2004. A process study of entrepreneurial team formation: the case of a research-based spin-off. *Journal of Business Venturing*, 19(1): 55.

Clarysse, B., Wright, M., Lockett, A., Van de Velde, E., & Vohora, A. 2005. Spinning out new ventures: a typology of incubation strategies from European research institutions. *Journal of Business Venturing*, 20: 183-216.

Cohen, W. 2000. Taking care of Business. *ASEE Prism Online*, January: 1-5.

Cohen, W., & Levinthal, D. 1990. Absorptive Capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1): 128-135.

Cohen, J., West, S.G., Aiken, L., & Cohen, P. 1983. *Applied multiple regression/ correlation analysis for the behavioral sciences.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Coleman, J.S. 1988. Social capital in the creation of human capital. *American Journal of Sociology*, 94 (Supplement): S95-S120.

Coleman, J.S. 1990. *Foundations of social theories.* Cambridge, MA: Harvard University Press.

Colombo, M.G., Delmastro, M., & Grilli, L. 2004. Entrepreneurs' human capital and the start-up size of new technologybased firms. *International Journal of Industrial Organization*, 22(8-9): 1183-1211.

Cooper, A.C. 1972a. Spin-off companies and technical entrepreneurship. *IEEE Transactions on Engineering*, 1: EM-18.

Cooper, A.C. 1972b. Technical entrepreneurship: What do we know. *R&D Management*, 32: 59-65.

Cooper, A.C. 1993. Challenges in predicting new firm performance. *Journal of Business Venturing*, 8(3): 241-253.

Cooper, A.C., & Bruno, A.V. 1977. Success among high-technology firms. *Business Horizons,* (April): 16–20.

Cooper, A.C., Gimeno-Gascon, F.J., & Woo, C.Y. 1994. Initial human and financial capital as predictors of new venture performance. *Journal of Business Venturing,* 9: 371-395.

Corolleur, C.C.F., Carrere, M., & Mangematin, V. 2004. Turning scientific and technological capital into economic capital: the experience of biotech start-ups in France. *Research Policy*, 33: 631-642.

Courville, T., & Thompson, B. 2001. Use of structure coefficients in published multiple regression articles: β is not enough. *Educational and Psychological Measurement*, 61: 229-248.

Covin, J.G., & Slevin, D.P. 1989. Strategic management of small firms in hostile and benign environments. *Strategic Management Journal*, 10(1): 75-87.

CSES, 2002, *Benchmarking of business incubators final report, for the European Commission Enterprise Directorate General*. Kent, U.K.: Centre for Strategy & Evaluation Services,

D'Aveni, R., 1994. *Hypercompetition: the dynamics of strategic maneuvering*. New York, NY: Basic Books.

Davidsson, P., 1995. Determinants of entrepreneurial intentions. Paper presented at the *RENT IX* Workshop, Piacenza, Italy, Nov. 23-24.

Dearborn, D., & Simon, H.A. 1958. Selective perceptions: a note on the departmental identification of executives. *Sociometry*, 38: 140-144.

De Coster, R., & Butler, C. 2005. Assessment of proposals for new technology ventures in the UK: characteristics of university spin-off companies. *Technovation*, 25(5): 535-543.

Deeds, D.L., & Hill, C.W.L. 1996. Strategic alliances and the rate of new product development: An empirical study of entrepreneurial biotechnology firms. *Journal of Business Venturing*, 11: 41–55.

Diamantopoulos, A., & Winklhofer, H. 2001. Index construction with formative indicators: an alternative to scale development. *Journal of Marketing Research*, 38(2): 269-277.

Dierickx, I., & Cool, K. 1989. Asset stock accumulation and sustainability of competitive advantage. *Management Science*, (December): 1504-1511.

DiGregorio, D., & Shane, S. 2003. Why do some universities generate more start-ups than others? *Research Policy*, 32(2): 209-227.

Doutriaux, J. 1987. Growth-pattern of academic entrepreneurial firms. *Journal of Business Venturing*, 2(4): 285-297.

Doutriaux, J. 1992. Emerging high-technology firms: how durable are their comparative start-up advantages. J*ournal of Business Venturing,* 7(4): 303–322 .

Downes, R., & Eadie, G. 1999. The creation and support of academic spin-out companies. In: R. Oakey (Ed.), *New Technology-Based Firms in the 1990's:* 4-14. London: Paul Chapman Publishers.

Druilhe, C., & Garnsey, E. 2004. Do academic spin-offs differ and does it matter? *Journal of Technology Transfer*, 29: 269-285.

Duschenau, D.A., & Gartner, W.B. 1990. A profile of new venture success and failure in an emerging industry. *Journal of Business Venturing*, 5: 297-312.

Duysters, G., & Vanhaverbeke, W. 1996. Strategic interactions in DRAM and RISC technology: A network approach. *Scandinavian Journal of Management*, 12(4): 437-461.

Dyer, J., & Singh, H. 1998. The relational view: Cooperative strategy and sources of interorganizational competitive Strategy. *Academy of Management Review*, 23: 660-679.

Eisenhardt, K.M. 1989. Building theories from case study research, *Academy of Management Review*, 14: 532-50.

Eisenhardt, K.M., & Schoonhoven, C.B. 1990. Organizational growth: linking founding team, strategy, environment, and growth Among U.S. semiconductor ventures, 1979-1988. *Administrative Science Quarterly*, 35(3): 543-576.

Eisenhardt, K.M., & Martin, J.A. 2000. Dynamic capabilities: what are they? *Strategic Management Journal*, 21: 1105-1121.

Elfring, T., & Foss, N.J. 1999. Competence building: understanding the role of internal venturing and spin-offs. *Advances in Applied Business Strategy*, 6A: 97-119.

Elfring, T., & Hulsink, W. 2003. Networks in entrepreneurship: The case of high-technology firms. *Small Business Economics*, 21: 409-422.

Elron, E. 1997. Top management teams within multinational corporations: Effects of cultural heterogeneity. *The Leadership Quarterly*, 8(4): 393-412.

Ensley, M.D., Pearson, A.W., & Amason, A.C. 2002. Understanding the dynamics of new venture top management teams: cohesion, conflict, and new venture performance. *Journal of Business Venturing*, 17(4): 365-386.

Erikson, T. 2002. Entrepreneurial capital: the emerging venture's most important asset and competitive advantage. *Journal of Business Venturing*, 17(3): 275-290.

Etzkowitz, H., & Leydesdorff, L. 2000. The dynamics of innovation: from National Systems and Mode 2 to a Triple Helix of university–industry–government relations. *Research Policy*, 29(2): 109-123.

European Commission, 2002. *Benchmarking industry-science relations - The role of framework conditions*. Research project commissioned by European Commission, Enterprise DG and Federal Ministry of Economy and Labour. Vienna/ Mannheim: Austria.

European Communities, 2004. *Innovation in Europe, results for the EU, Iceland and Norway*. Luxembourg, report KS-59-04-257-EN.

Evans, D.S. 1987. The relationship between firm growth, size, and age: Estimates for 100 manufacturing industries. *The Journal of Industrial Economics*, 35: 567-581.

Feeser, H.R., & Willard, G.E. 1989. Incubators and performance: A comparison of high and low growth high tech firms. *Journal of Business Venturing*, 46: 429-442.

Ferguson, R., & Olofsson, C., 2004. Science parks and the development of NTBF's-location, survival and growth. *Journal of Technology Transfer,* 29(1): 5-17.

Fichman, M., & Levinthal, D.A. 1991. Honeymoons and the liability of adolescence: A new perspective on duration dependence in social and organizational relationships. *Academy of Management Review*, 16: 442-468.

Fiet, J.O. 1996. The informational basis for entrepreneurial discovery. *Small Business Economics,* 8: 419–430.

Flynn, D. 1991. The critical relationship between venture capitalists and entrepreneurs: planning, decision-making, and control. *Small Business Economics*, 3: 185-196.

Foo, M.D., Wong, P.K., & Ong, A. 2005. Do other think you have a viable business idea? Team diversity and judges' evaluation of ideas in a business plan competition. *Journal of Business Venturing*, 20: 385-402.

Foss, L. 1993. Resources, networks and entrepreneurship: a survey of 153 starters and 84 non-starters in the cod farming industry in Norway. In N. Churchill, B. Kirchhoff, W. Krasner, & K. Vesper (Eds.), *Frontiers of Entrepreneurship Research:* 355-369. Wellesley, MA: Babson College.

Franklin, S., Lockett, A., & Wright, M. 2001. Academic and surrogate entrepreneurs in university spin-out companies. *Journal of Technology Transfer*, 26(1/2): 127-141.

Gabbay, S.M., & Leenders, R.Th.A.J. 1999. CSC: The structure of advantage and disadvantage. In R.Th.A.J. Leenders & S.M. Gabbay (Eds.), *Corporate Social Capital and Liability:* 483-494. New York: Kluwer Academic Publishers.

Gargiulo, M., & Benassi, M. 1999. The dark side of social capital. In R.Th.A.J. Leenders and S.M. Gabbay (Eds.), *Corporate social capital and liability:* 483-494. New York: Kluwer Academic Publishers.

Gargiulo, M., & Benassi, M. 2000. Trapped in your own net? network cohesion, structural holes, and the adaptation of social capital. *Organization Science*, 11(2): 183-196.

Gatewood, E.J., Shaver, K.G. & Gartner, W.B. 1995. A longitudinal study of cognitive factors influencing start-up behaviors and success at venture creation. *Journal of Business Venturing*, 19: 371-391.

George, G., Zahra, S.A., & Wood, D.R. 2002. The effects of business-university alliances on innovative output and financial performance: a study of publicly traded biotechnology firms. *Journal of Business Venturing*, 17: 577-609.

Goslin, L.N. 1987. Characteristics of successful high-tech start-up firms. In N. Churchill, B. Kirchhoff, W. Krasner, & K. Vesper (Eds.), *Frontiers of Entrepreneurship Research.* Wellesley, MA: Babson College.

Grabher, G. 1993. *The embedded firm: on the socioeconomics of industrial networks*. London/New York: Routledge.

Granovetter, M. 1973. The strength of weak ties*. American Journal of Sociology*, 78: 1360-1380.

Granovetter, M. 1974. *Getting a job: A study of contacts and careers*. Cambridge, MA: Harvard University Press.

Granovetter, M. 1985. Economic action and social structure: the problem of embeddedness. *American Journal of Sociology*, 91(3): 481-510.

Granovetter, M. 1992. Problems of explanation in economic sociology. In N. Nohria and R. Eccles (Eds.), *Networks and organizations: structure, form and action:* 25-56. Boston, MA: Harvard Business School Press.

Grant, R.M. 1996. Prospering in dynamic-competitive environments: organizational capability as knowledge integration. *Organization Science*, 7(4): 375-387.

Greve, A. 1995. Networks and entrepreneurship – an analysis of social relations, occupational background, and use of contacts during the establishment process. *Scandinavian Journal of Management*, 11(1): 1-24.

Gulati, R. 1995. Social structure and alliance formation patterns: A longitudinal analysis. *Administrative Science Quarterly*, 40: 619-652.

Gulati, R. 1998. Alliances and networks. *Strategic Management Journal*, 19(Special Issue): 293-317.

Gulati, R., & Higgins, M.C. 2003. Which ties matter when? The contingent effects of interorganizational partnerships on IPO success. *Strategic management Journal*, 24: 127-144.

Hagedoorn, J. 1993. Understanding the rationale of strategic technology partnering: interorganizational modes of cooperation and sectoral differences. *Strategic Management Journal*, 14(5): 371-385.

Hagedoorn, J., & Schakenraad, J. 1992. Leading companies and networks of strategic alliances in information technologies. *Research Policy*, 21: 163-190.

Hair, J.F. jr., Anderson, R.E., Tatham, R.L., & Black, W.C. 1998. *Multivariate data analysis, 5th edition*. Upper Saddle River, New Jersey: Prentice-Hall Inc.

Haleblian, J., & Finkelstein, S. 1993. Top management team size, CEO dominance, and firm performance: The moderating roles of environmental turbulence and discretion. *Academy of Management Journal*, 36: 844-863.

Hambrick, D.C., & Mason, P.A. 1984. Upper echelons: the organization as a reflection of its top managers. *Academy of Management Review*, 92: 193–206.

Hambrick, D.C., Sueng Cho, T., & Chen, M.-J. 1996. The influence of top management heterogeneity on firms' competitive moves. *Administrative Science Quarterly*, 41(4): 659-684.

Hamel, G., & Prahalad, C.K. 1994. *Competing for the future.* Boston: Harvard Business School Press.

Hannan, M.T., & Freeman, J.H. 1984. Structural inertia and organizational change. *American Sociological Review*, 49(2): 149-164.

Hansen, M. 1999. The search transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly*, 44: 82-111.

Haong, H., & Antoncic, B. 2003. Network-based research in entrepreneurship: A critical review. *Journal of Business Venturing*, 18: 165-187.

Hart, P.E., & Oulton, N. 1996. Growth and Size of Firm. *Economic Journal*, 106: 1242-1252.

Hatch, N.W., & Dyer, J.H. 2004. Human capital and learning as a source of sustainable competitive advantage. *Strategic Management Journal*, 25: 1155-1178.

Heeler, R.M., & Ray, M.L. 1972. Measure validation in marketing, *Journal of Marketing Research*, 9: 361-370.

Henderson, R., & Cockburn, I. 1994. Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal*, 15(Special Issue): 63-84.

Hirschman, A.O. 1972. *Exit, voice, and loyalty*. Cambridge, MA: Harvard University Press.

Higgins, M., & Gulati, R. 2003. Getting off to a good start: The effects of upper echelon affiliations in interorganizational endorsements and IPO success. *Organization Science*, 14(3): 244-263.

Hills, G.E., Lumpkin, G.T., & Singh, R.P. 1997. Opportunity recognition: Perceptions and behaviors of entrepreneurs. In N. Churchill, B. Kirchhoff, W. Krasner, & K. Vesper (Eds.), *Frontiers of Entrepreneurship Research:* 168-182. Wellesley, MA: Babson College.

Hite, J.M. 2005. The evolution of relationally-embedded network ties. *Entrepreneurship Theory and Practice*, 29(1): 113-144.

Hite, J.M., & Hesterly, W.S. 2001 Research notes and commentaries: the evolution of firm networks: from emergence to early growth of the firm. *Strategic Management Journal*, 22: 275-286.

Hitt, M.A., & Ireland, R.D. 1985. Corporate distinctive competence, strategy, industry, and performance. *Strategic Management Journal*, 6(3): 273-293.

Hitt M.A., Dacin, M.T., Levitas, E., Arregle, J.-L. & Borza, A. 2000. Partner selection in emerging and developed market contexts: resource-based and organizational learning perspectives. *Academy of Management Journal*, 43(3): 449-467.

Hoang, H., & Antoncic, B. 2003. Network-based research in entrepreneurship. A critical review. *Journal of Business Venturing*, 18: 165-187.

Holtz-Eakin, D. 2000. Public policy and entrepreneurship. *Small Business Economics,* 15(4): 283-291.

Hsu, D., & Bernstein, T. 1997. Managing the university technology licensing process: findings from case studies. *Journal of the Association of University Technology Managers*, 9, 1-33.

Hu, H., & Buitelaar, N. 2002. *Gaining momentum, The Netherlands life sciences sector report 2002*. Biopartner report: Drukkerij Damen.

Itami, H. 1987. *Mobilizing invisible assets*. Cambridge: Harvard University Press.

Jehn, K.A. 1994. Enhancing effectiveness: An investigation of advantages and disadvantages of value-based intragroup conflict. *International Journal of Conflict Management*, 5: 223-228.

Jehn, K.A. 1995. A multi-method examination of the benefits and detriments of intragroup conflict. *Administrative Science Quarterly*, 40: 256-282.

Jensen R.A., Thursby, J.G., & Thursby, M.C. 2003. Disclosure and licensing of university inventions: 'The best we can do with the s**t we get to work with'. *International Journal of Industrial Organization*, 21: 1271-1300.

Jick, T.D. 1979. Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly*, 24: 602-611.

Karnebeek A.J. 2001. *Spin-offs and the University of Twente, sixteen years of experience in incubating start-ups*. Enschede, The Netherlands: Twente University Press.

Keck, S.L. 1997. Top management team structure: Differential effects by environmental context. *Organization Science*, 8(2): 143-156.

Kendall, M. & Stuart, A.S. 1977. *The advanced theory of statistics*. New York: MacMillan.

Kirzner, I. 1979. *Perception, opportunity, and profit: studies in the theory of entrepreneurship*. Chicago: University of Chicago Press.

Knight, D., Pearce, C.L., Smith, K.G., Olian, J.D., Sims, H.P., & Smith, K.A. 1999. Top management team diversity, group process, and strategic consensus. *Strategic Management Journal*, 20: 445-465.

Kobus, J. 1992. Universities and the creation of spin-off companies. *Industry and Higher Education*, 6(3): 136-142.

Kogut, B. 1996. What firms do? Coordination, identity, and learning. *Organization Science*, 7(5): 502-518.

Kogut, B. 1988. Joint ventures: theoretical and empirical perspectives. *Strategic Management Journal*, 9: 319-332.

Kogut, B. 2000. The network as knowledge: generative rules and the emergence of structure. *Strategic Management Journal*, 21: 405-425.

Kor, Y.Y. 2003. Experience-based top management team competence and sustained growth. *Organization Science*, 14(6): 707-719.

Korunka, C, Frank, H., & Lueger, M. 2003. The entrepreneurial personality in the context of resources, environment, and the startup process - A configurational approach. *Entrepreneurship Theory and Practice,* Fall: 23-42.

Krackhardt, D. 1996. Comment on Burt and Knez's third party effects on trust. *Rationality and Society*, 8(1): 111-120

Krueger, N.F. 1993. The impact of prior entrepreneurial exposure on perceptions of new venture feasibility and desirebility. *Entrepreneurship Theory & Practice*, Fall: 5-21.

Krueger, N.F., & Brazael, D.V. 1994. Entrepreneurial potention and potential entrepreneurs. *Entrepreneurship Theory & Practice*, Spring: 91-104.

Lai, G., Lin, N., & Leung, S. 1998. Network resources, contact resources and status attainment. *Social Networks*, 20: 159-178.

Lamont, L.M. 1972. What entrepreneurs learn form experience. *Journal of Small Business Management*, 10: 36-41.

Lant, T.K., & Mezias, S.J. 1990. Managing discontinuous change: A simulation study of organizational learning and entrepreneurship. *Strategic Management Journal*, 11(Summer Issue): 147- 179.

Larsen, J.K., & Rogers, E.M. 1987. Silicon Valley: The rise and falling off of entrepreneurial fever. In R.W. Smilor, G. Kozmetsky and D.V. Gibson, *Creating the Technopolis: Linking technology commercialization to economic development:* 99-115. Cambridge MA: Ballinger Publishing Company.

Larson, A. 1992. Network dyads in entrepreneurial settings: A study of the governance of exchange relationships. *Administrative Science Quarterly*, 37: 76-104.

Larson, A., & Starr, J. 1992. A network model of organization formation. *Entrepreneurship Theory and Practice*, 17(1): 5-15.

Lee, Y.S. 1996. Technology transfer and the research university: a search or the boundaries of industry collaboration. *Research Policy*, 25(6): 843-863.

Lee, C., Lee, K., & Pennings, J.M. 2001. Internal capabilities, external networks, and performance: A study on technology-based ventures. *Strategic Management Journal*, 22: 615-640.

Leenders, R.Th.A.J., & Gabbay, S.M. (Eds.) 1999a. *Corporate social capital and liability*. New York: Kluwer Academic Publishers.

Leenders, R.Th.A.J., & Gabbay, S.M. 1999a. CSC: An agenda for the future. In R.Th.A.J. Leenders & S.M. Gabbay (Eds.), *Corporate social capital and liability:* 483-494. New York: Kluwer Academic Publishers.

Levinthal, D.A. 1997. Adaptation on rugged landscapes. *Management Science*, 43: 934-950.

Lin, N. 2001. *Social capital, a theory of social structure and action*. Cambridge: Cambridge University Press.

Lockett, A., Wright, M., & Franklin, S. 2003. Technology transfer and universities' spin-out strategies. *Small Business Economics*, 20(2): 185-200.

Lotti, F., Santarelli, E., & Vivarelli, M. 2001. The Relationship Between Size and Growth: The Case of Italian Newborn Firms. *Applied Economics Letters*, 8: 451-454.

Louis, K., Jones, L., Anderson, M., Blumenthal, D., & Campbell, E. 2001. Entrepreneurship, secrecy and productivity: A comparison of clinical and non-clinical faculty. *Journal of Technology Transfer*, 26(3): 233-245.

Lumpkin, G.T., & Dess, G.G. 1996. Clarifying the entrepreneurial orientation construct and linking it to performance. *Academy of Management Review*, 21(1): 135-172.

MacCallum, R.C., & Browne, M.W. 1993. The use of causal indicators in covariance structure models: Some practical issues. *Psychological Bulletin*, 114, 533-541.

MacMillan, I.C. 1986. To really learn about entrepreneurship, let's study habitual entrepreneurs. *Journal of Business Venturing*, 1: 241-243.

Makadok, R. 2001. Toward a synthesis of the resource-based and dynamic-capability views of rent creation. *Strategic Management Journal*, 22: 387-401.

Mahar, J.F., & Coddington, D.C. 1965. The scientific complex – proceed with caution, *Harvard Business Review*, 43: 140-155.

March, J.G. 1991. Exploration and exploitation in organizational learning. *Organization Science*, 2: 71-87.

Markman, G.D., Phan, P.H., Balkin, D.B., & Gianiodis, P.T. 2005. Entrepreneurship and university-based technology transfer. *Journal of Business Venturing*, 20(2): 241-263.

Marsden, P.V., & Campbell, K., 1984. Measuring tie strength. *Social Forces*, 63(2): 483-501.

Marsden, P.V. 1987. Core discussion networks of Americans. *American Sociological Review,* 52: 122-131.

Marsden, P.V. 1993. The reliability of network density and composition measures. *Social Networks*, 15: 399–421.

Maselli, A. 1996. *Spin-offs zur durchführung von innovationen – Eine analyse aus institutionenökonomischer sicht*. Deutscher Universitäts Verlag, Gabler.

Matkin, G. 1990. *Technology Transfer and the University*. New York, Macmillan

McCain, B.E., O'Reilly III, C.A., & Pfeffer, J. 1983. The effects of departmental demography on turnover: The case of a university. *Academy of Management Journal*, 26: 626-641.

McCallister, L., & Fischer, C. 1978. A procedure for surveying personal networks. *Sociological Methods and Research*, 7: 131-148.

McEvily, B., & Zaheer, A., 1999. Bridging ties: A source of firm heterogeneity in competitive capabilities. *Strategic Management Journal*, 20: 1133-1156.

McGee, J.E., Dowling, M.J., & Megginson, W.L. 1995. Cooperative strategy and new venture performance: the role of business strategy and management experience. *Strategic Management Journal*, 16(7): 565-581.

McGrath, R.G. 2001. Exploratory learning, innovative capacity, and managerial oversight. *Academy of Management Journal*, 44(1): 118-131.

Meyer-Krahmer, F., & Schmoch, U. 1998. Science-based technologies: university-industry interactions in four fields. *Research Policy*, 27(8): 835-851.

Mian, S.A. 1994. US university sponsored technology incubators: an overview of management, policies, and performance. Technovation, 14(8): 515-528.

Mian, S.A. 1996. Assessing value-added contributions of the university technology business incubators to tenant firms. *Research Policy*, 25(3): 325-336.

Mian, S.A. 1997. Assessing and managing the university technology business incubator: an integrative framework. *Journal of Business Venturing*, 2: 251-285.

Miles, M.B., & Huberman, A.M. 1984. *Qualitative data analysis: A source book of new methods*. Beverly Hills, CA: Sage.

Miles, G., Snow, C.C., & Sharfman, M.P. 1993. Industry variety and performance. *Strategic Management Journal*, 14: 163-177.

Miller, D. 1983. The correlates of entrepreneurship in three types of firms. *Management Science*, 29(7): 770–791.

Miner, A.S., Amburgey, T.L., & Stearns, T. 1990. Interorganizational linkages and population dynamics: Buffering and transformational shields. *Administrative Science Quarterly*, 35: 689-713.

Ministery of Economic Affairs, 1998. *Researchers op ondernemerspad*. The Hague: Report 03I20 by the department of Infrastructure and Innovation of the Ministry of Economic Affairs.

Ministery of Education, Culture and Science, 2003. *Researchers op ondernemingspad: internationale benchmarkstudie naar spin-offs uit kennisinstellingen*, Ministerie van Economische Zaken, EZ Beleidsstudies 2, Den Haag, 2003.

Ministery of Education, Culture and Science, 2005. *Valorisatie van onderzoek als taak van de universiteiten*. http://www.minocw.nl/brief2k/2005/doc/1855a.pdf.

Mintzberg, H. 1990. The design school: Reconsidering the basic premises of strategic management. *Strategic Management Journal*, 11: 171-195.

Mitsuhashi, H. 2003. Effects of the social origins of alliances on alliance performance. *Organization Studies*, 24(2): 321-339.

Moerbeek, H.H.S. 2001. *Friends and foes in the occupational career: The influence of sweet and sour social capital on the labour market*. PhD Thesis, Katholieke Universiteit Nijmegen.

Mohr, J., & Spekman, R. 1994. Characteristics of partnership success: Partnership attributes, communication behavior, and conflict resolution techniques. *Strategic Management Journal*, 15(2): 135-152.

Mowery, D.C., & Shane, S.A. 2002. Introduction to special issue on university entrepreneurship and technology transfer. *Management Science*, 48(1): 5-9.

Murray, F. 2004. The role of academic inventors in entrepreneurial firms: sharing the laboratory life. *Research Policy*, 33(4): 643-659.

Mustar, P. 1997. Spin-off enterprises – How French academics create high-tech companies: conditions for success and failure. *Science and Public Policy*, 24(1): 37-43.

Nelson, T. 2003. The persistence of founder influence: Management, ownership, and performance effects at initial public offering. *Strategic Management Journal*, 24: 707-724.

Nelson, R.R., & Winter, S.G. 1982. An *evolutionary theory of economic change*. Cambridge, Mass. and London: Harvard University Press.

Nicolaou, N., & Birley, S. 2003a. Academic networks in a trichotomous categorisation of university spinouts. *Journal of Business Venturing*, 18(3): 333-359.

Nicolaou, N., & Birley, S. 2003b. Social networks in organizational emergence: The university spinout phenomenon. *Management Science*, 49(12): 1702-1725.

Nohria, N. 1992. Information and search in the creation of new business ventures: The case of the 128 venture group. In N. Nobria & R. Eccles (Eds.), *Networks and organizations: Structure, form, and action:* 240-261. Boston, MA: Harvard Business School.

Nohria, N., & Garcia-Pont, C. 1991. Global strategic linkages and industry structure. *Strategic Management Journal*, 12: 105-124.

NOWT, 2003. *Wetenschaps- en technologie- indicatoren in 2003*. Report by the Ministry of Education, The Hague,

NOWT, 2004. *NOWT update nr.4*, mei 2004: www.nowt.nl

NOWT, 2004. *NOWT update nr.5*, november 2004: www.nowt.nl

OECD, 2003. *Turning science into business – patenting and licensing at public research organisations*.| Parijs: Organisation for Economic Co-operation and Development.

Omta, S.W.F. 1995. *Critical success factors in Biomedical research and pharmaceutical organisations*. Kluwer Academic Publishers: Dordrecht, Holland.

Omta, S.W.F, Trienekens, J.H., & Beers, G. 2001. Chain and network science: A research framework. *Journal on Chain and Network Science*, 1 (1): 1-6.

Omta, S.W.F., & Van Rossum, W. 1999. The management of social capital in R&D collaborations. In R.Th.A.J. Leenders & S.M. Gabbay (Eds.), *Corporate social capital and liability:* 356-376. Dordrecht: Kluwer Academic Publishers.

Onwuegbuzie, A.J., & Daniel, L.G. (2003). Typology of analytical and interpretational errors in quantitative and qualitative educational research. *Current Issues in Education [On-line]*, 6(2). Available: http://cie.ed.asu.edu/volume6/number2/.

O'Reilly III, C.A., Caldwell, D.F., & Barnett, W.P. 1989. Work group demography, social integration, and turnover. *Administrative Science Quarterly*, 34(1): 21-37.

Paulhus, D.L., Robins, R.W., Trzesniewski, K.H. & Tracy, J.L. 2004. Two replicable suppressor situations in personality research. *Multivariate Behavioral Research*, 39(2): 303-328.

Pelled, L.H. 1996. Demographic diversity, conflict, and work group outcomes: an intervening process theory. *Organisation Science*, 7(6): 615-631.

Pelled, L.H., Eisenhardt, K.M., & Xin, K.R. 1999. Exploring the black box: an analysis of work group diversity, conflict, and performance. *Administrative Science Quarterly*, 44: 1-28.

Pennings, J.M., Lee, K., & Witteloostuijn, A. 1998. Human capital, social capital, and firm dissolution. *Academy of Management Journal*, 41: 425-440.

Pennings, J.M., & Lee, K. 1999. Social capital of organization: Conceptualization, level of analysis, and performance implications. In R.Th.A.J. Leenders & S.M. Gabbay (Eds.), *Corporate social capital and liability:* 43-67. Dordrecht: Kluwer Academic Publishers.

Pennings, J.M., Barkema, H., & Douma, S. 1994. Organizational learning and diversification. *Academy of Management Journal*, 37: 608-640.

Penrose, E. 1959. *The theory of the growth of the firm*. New York: Wiley.

Peteraf, M.A. 1993. The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal*, 14: 179-192.

Phillips, B.D., & Kirchoff, B.A. 1989. Formation, growth and survival; small firm dynamics in the U.S. economy. *Small Business Economics*, 11: 65-74.

Pinkley, R.L. 1990. Dimensions of conflict frame: Disputant interpretations of conflict. *Journal of Applied Psychology*, 75: 117-126.

Pinto, M.B., Pinto, J.K., & Prescott, J.E. 1993. Antecedents and consequences of project team cross-functional cooperation. *Management Science*, 39: 1281-1297.

Pirnay, F., Surlemont, B., & Nlemvo, F. 2003. Toward a typology of university spin-offs. *Small Business Economics*, 21: 355-369.

Pisano, G.P. 1990. The R&D boundaries of the firm: An empirical analysis. *Administrative Science Quarterly*, 35: 153-176.

Pitts, R.A., & Hopkins, H.D. 1982. Firm diversity: conceptualization and measurement. *Academy of Management Review*, 7: 620-629.

Podolny, J.M. 1993. A status-based model of market competition. *American Journal of Sociology*, 98: 829-872.

Podolny, J.M. 1994. Market uncertainty and the character of economic exchange. *Administrative Science Quarterly*, 39: 458-483.

Podolny, J.M., & Baron, J.N. 1997. Resources and relationships: Social networks and the mobility in the workplace. *American Sociological Review*, 62: 673-693.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y. & Podsakoff, N.P. 2003. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5): 879-903.

Portes, A. 1998. Social capital: its origins and applications in modern sociology. *Annual Review of Sociology* 24(1): 1-24.

Powell, W.W. 1990. Neither market nor hierarchy: Network forms of organization. In B.M. Staw & L.L. Cummings (Eds.), *Research in Organisational Behavior, Vol. 12:* 295-336. Greenwich, CT: JAI Press.

Powell, W.W., Koput, K.W., & Smith-Doerr, L. 1996. Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology. *Administrative Science Quarterly*, 41(1): 116-145.

Prahalad, C.K., & Hamel, G., 1990. The core competence of the corporation. *Harvard Business Review*, 68(3): 79-91.

Prahalad, C.K., & Hamel, G. 1994. Strategy as a field of study: why search for a new paradigm? *Strategic Management Journal*, 15: 5-16.

Pressman, L., Gutterman, S.K., Abrams, I., Geist, D.E., & Nelsen, L. 1995. Pre-production investments and jobs induced by MIT exclusive patent licenses: A preliminary model to measure the economic impact of university licensing. *Journal of Association of University Technology Managers*, 7: 49-81.

Priem, R.L. 1990. Top management team group factors, consensus, and firm performance. *Strategic Management Journal*, 11: 469-478.

Priem, R.L., & Butler, J.E. 2001a. Is the resource-based view a useful perspective for strategic management research? *Academy of Management Review*, 26(1): 22-40.

Priem, R.L., & Butler, J.E. 2001b. Tautology in the resource-based view and the implications of externally determined resource value: Further comments. *Academy of Management Review*, 26(1): 57-66.

Provan, K.G., & Milward, H.B. 1995. A preliminary theory of interorganizational network effectiveness: A comparative study of four community mental health systems. *Administrative Science Quarterly*, 40: 1-33.

Radosevich, R. 1995. A model for entrepreneurial spin-offs from public technology sources. *International Journal of Technology Management*, 10(7/8): 879-893.

Ray, G., Barney, J.B., & Muhanna, W.A. 2004. Capabilities, business processes, and competitive advantage: Choosing the dependent variable in empirical tests of the Resource-Based View. *Strategic Management Journal*, 25: 25-37.

Reagans, R., & Zuckerman, E.W. 2001. Networks, diversity, and productivity: The social capital of corporate R&D teams. *Organizations Science*, 12(4): 502-517.

Renzulli, L.A., Aldrich, H.E., & Moody, J. 2000. Family matters: gender, networks, and entrepreneurial outcomes. *Social Forces*, 79(2): 523-546.

Reynolds, P. 1994. *Reducing barriers to understanding new firm gestation. Prevalence and success of nascent entrepreneurs*. Paper presented at the Academy of Management Meetings, Dallas, TX.

Rhee, M. 2004. Network updating and exploratory learning environment. *Journal of Management*, 41(6): 933-949.

Rice, M.P. 2002. Co-production of business assistance in business incubators An exploratory study. *Journal of business venturing*, 17: 163-187.

Rindfleisch, A., & Moorman, C. 2001. The acquisition and utilization of information in new product alliances: A strength-of-ties perspective. *Journal of Marketing*, 65(2): 1-16.

Roberts, E.B. 1968. Entrepreneurship and technology: A basic study of innovators. *Research Management*, 11(4): 249-266.

Roberts, E.B. 1991. *Entrepreneurs in high-technology – Lessons form MIT and beyond.* New York: Oxford University Press.

Roberts, E.B., & Wainer, H. 1968. New enterprises on route 128. *Science Journal*, December 1968.

Roberts, E.B., & Malone, D.E. 1996. Policies and structures for spinning off new companies from research and development organizations. *R&D Management*, 26(1): 17-48.

Rogers, M.E., & Larson, J.K. 1984, *Silicon Valley fever: growth of high-technology culture.* New York, NY: Basic Books.

Romanelli, E., & Schoonhoven, K. 2001. The local origins of new firms. In K. Schoonhoven & E. Romanelli (Eds.), *The entrepreneurial dynamic:* 40-67. Stanford, CA: Stanford University Press.

Romanelli, E. 1989. Environments and strategies of organization start-up: effects on early survival. *Administrative Science Quarterly,* 34: 369-387.

Roure, J.B., & Maidique, M.A. 1986. Linking prefunding factors and high-technology venture success: An exploratory study. *Journal of Business Venturing*, 1: 295-306.

Rowley, T., Behrens, D., & Krackhardt, D. 2000. Redundant governance structures: An analysis of structural and relational embeddedness in the steel and semiconductor industries. *Strategic Management Journal*, 21: 369-386.

Rumelt, R. 1984. Towards a strategic theory of the firm. In R. Lamb (Ed.), *Competitive Strategic Management:* 556-570. Englewood Cliffs, NJ: Prentice-Hall.

Saaty, T.L. 1980. *The analytic hierarchy process: planning, priority setting, resource allocation*. New York, NY: McGraw-Hill.

Santarelli, E., & Vivarelli, M. (2002). Is subsidizing entry an optimal policy? *Industrial and Corporate Change*, 11(1): 39-52.

Sapienza, H.J., Parhankangas, A., & Autio, E. 2004. Knowledge relatedness and post-spin-off growth. *Journal of business Venturing*, 19(6): 809-829.

Scholten, V.E., Elfring, T., & Omta, S.W.F. 2004. *The parent connection; The effect of the parent – spin-off relationship on the spin-off's successes*. Paper presented at Babson Kaufman Entrepreneurship Research Conference, June 3-5, 2004, University of Strathclyde, Glasgow.

Scholten, V.E., Omta, S.W.F., & Kemp, R.G.M. 2004. *Entrepreneurship for life: The entrepreneurial intention among academics in the life sciences*. Paper presented at the European Summer University 2004, Twente.

Scott, J. 1991. *Social network analysis: a handbook*. Thousand Oaks, CA: Sage.

Shan, W., Walker, G., & Kogut, B. 1994. Interfirm cooperation and startup innovation in the biotechnology industry. *Strategic Management Journal*, 15: 387-394.

Shane, S.A. 2000. Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science*, 11(4): 448-462.

Shane, S.A. 2003. *A general theory of Entrepreneurship – The individual-opportunity nexus*. Cheltenham, UK: Edward Elgar Publishing Limited.

Shane, S.A. 2004. *Academic Entrepreneurship, University Spin-offs and Wealth Creation*. Cheltenham, UK: Edward Elgar Publishing Limited.

Shane, S.A., & Venkataraman, S. 2000. The promise of entrepreneurship as a field of research. *Academy of management Review*, 26(1): 13-17.

Shane, S.A., & Cable, D.M. 2002. Network ties, reputation and the financing of new ventures. *Management Science*, 48(3): 364-381.

Shane, S.A., & Stuart, T. 2002. Organizational endowments and the performance of university start-ups. *Management Science*, 48(1): 154-170.

Shepherd, D.A., & DeTienne, D.R. 2005. Prior knowledge, potential financial reward and opportunity identification. *Entrepreneurship Theory and Practice*, January: 91-112.

Shepherd, D.A., Douglas, E.J., & Shanley, M. 2000. New venture survival-ignorance, external shocks, and risk reduction strategies. *Journal of Business Venturing*, 15(5): 393-410.

Siegel, R., Siegel, E., & MacMillan, I.C. 1993. Characteristics distinguishing High- Growth ventures. *Journal of Business Venturing*, 8: 169-180.

Simon, M., Houghton, S.M., & Aquino, K. 2000. Cognitive biases, risk perception, and venture formation: How individuals decide to start companies. *Journal of Business Venturing*, 15: 113-134.

Simons, T., Pelled, L., & Smith, K. 1999. Making use of difference: Diversity, debate, and decision comprehensiveness in top management teams. *Academy of Management Journal*, 42(6): 662-673.

Singh, R., Hills, G., Hybels, R., & Lumpkin, G. 1999. Opportunity recognition through social network characteristics of entrepreneurs. In P. Reynolds, W. Bygrave, S. Manigart, C. Mason, G. Meyer, H. Sapienza & K. Shaver (Eds.), *Frontiers of entrepreneurship Research:* 228-241. Babson Park, US: Babson College.

Smith, K.G., Smith, K.A., Olian, J.D., Sims, H.P., O'Bannon, D.P., & Scully, J.A. 1994. Top management team demography and process: The role of social integration and communication. *Administrative Science Quarterly*, 39: 412-438.

Sorenson, O., & Stuart, T.E. 2001. Syndication networks and the spatial distribution of venture capital investment. *American Journal of Sociology*, 106: 1546-1588.

Sorrentino, M., & Williams, M.L. 1995. Relatedness and corporate venturing: Does it really matter? *Journal of Business Venturing*, 10: 59-73.

Stake, R. 1995. *The art of case research*. Thousand Oaks, CA: Sage Publications.

Stalk, G., Evans, P. & Shulman, L.E. 1992. Competing on capabilities: The new rules of corporate strategy. *Harvard Business Review*, 70(2): 57-69.

Stankiewics, R. 1994. Spin-off companies from universities. *Scientific and public policy*, 21: 99-109.

Starr, A.S., & MacMillan, I.C., 1990. Resource co-optation via social contracting resource acquisition strategies for new resources, *Strategic Management Journal*, 11: 79-92.

Steier, L., & Greenwood, R. 2000. Entrepreneurship and the evolution of angel financial networks. *Organization Studies*, 21(1): 163-192.

Stevenson, H.H. 1983. *A perspective on entrepreneurship*. Harvard Business School, Working paper #9-3: 84-131.

Stevenson, H.H., & Gumpert, D.E. 1985. The heart of entrepreneurship. *Harvard Business Review*. March-April: 85-94.

Stevenson, H.H., & Jarillo, J.C. 1990. A paradigm of entrepreneurship: entrepreneurial management. *Strategic Management Journal*, 11(Special Issue): 17-27.

Stevenson, H., Roberts, H.J., & Grousbeck, H.I. 1989. *New business ventures and the entrepreneur.* Homewood, IL: Irwin.

Steffensen, M., Rogers, E.M., & Speakman, K. 1999. Spin-offs from research centers at a research university. *Journal of Business Venturing*, 15: 93-111.

Stuart, T.E. 1998. Network positions and propensities to collaborate: An investigation of strategic alliance formation in a high-technology industry. *Administrative Science Quarterly*, 43(3): 668–698.

Stuart, T.E. 2000. Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. *Strategic Management Journal*, 21(8): 791-811.

Stuart, T.E., Ha, H., & Hybels, R. 1999. Interorganizational endorsement and the performance of entrepreneurial ventures. *Administrative Science Quarterly*, 44: 315-349.

Sudmant, W. 2002. *The economic impact of the university of British Columbia on the greater Vancouver regional district*. Report by the University of British Columbia.

Sutton, J. 1997. Gibrat's legacy. *Journal of Economic Literature*, 35(1): 40-59.

Sykes, H.B. 1986. The anatomy of a corporate venturing program: Factors influencing success. *Journal of Business Venturing*, 1: 275-293.

Tabachnick, B.G., & Fidell, L.S. 1996. *Using multivariate statistics*, *3rd ed.* New York: Harper Collins College Publishers.

Teece, D.J., Pisano, G., & Shuen, A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7): 509-533.

Thompson, B. 1995. Stepwise regression and stepwise discriminant analysis need not apply here: A guidelines editorial. Educational and Psychological Measurement, 55: 525-534.

Thompson, B., & Borrello, G. (1985). The importance of structure coefficients in regression research. *Educational and Psychological Measurement*, 45: 203-209.

Thorburn, L. 2000. Government policies to encourage creation of spin-off firms from academic institutions. Paper presented at the APEC symposium on intellectual property rights, Sapporp, Japan.

Thornhill, S., & Amit., R. 2000. A dynamic perspective of internal fit in corporate venturing. *Journal of Business Venturing*, 16, 25-50.

Thursby, J., Jensen, R., & Thursby, M. 2001. Objectives, characteristics and outcomes of university licensing: A survey of major U.S. universities. *Journal of Technology Transfer*, 26: 59-72.

Tijssen, R.J.W., & Van Leeuwen, T.N. 2004. Measuring the impact of academic science on industrial research. Paper presented at *8th International Conference on Science and Technology Indicators*, Leiden, Netherlands, 23-25 September 2004.

Tsai, W., & Ghoshal, S. 1998. Social capital and value creation: The role of intrafirm networks. *Academy of Management Journal*, 41: 464-478.

Tsui, A.S., Egan, T.D., & O'Reilly III, C.A. 1992. Being different: Relational demography and organizational attachment. *Administrative Science Quarterly*, 37: 549-579.

Ucbasaran, D., Lockett, A., Wright, M., & Westhead, P. 2003. Entrepreneurial founder teams: Factors associated with member entry and exit. *Entrepreneurship Theory and Practice*, Winter: 107-127.

Uzzi, B. 1996. The sources and consequences of embeddedness for the economic performance of organizations: the network effects. *American Sociological Review*, 61: 674-698.

Uzzi, B. 1999. Social Embeddedness in the creation of financial capital. *American Sociological Review*, 64: 481-505.

Uzzi, B., & Gillespie, J.J. 2002. Knowledge spillover in corporate financing networks: Embeddedness and the firm's debt Performance. *Strategic Management Journal*, 23: 595-618.

Van Der Gaag, M., & Snijders, T.A.B. 2005. The resource generator: social capital quantification with concrete items. *Social Networks*, 27:1-29.

Van Lieshout, M., Ellen, G.-J., & Van Reekum, R. 2004. *ICT scan 2003: Universitaire ICT-kennis en kennistransfer in Nederland 2000-2002*. STB-04-08 report by TNO, The Netherlands.

Van Tilburg, J.J., & Vorstman, C.M., 1994. Ondernemen met technologie: het ontstaan en de groei van nieuwe kennisintensieve bedrijven vanuit de Universiteit Twente. Enschede : Van der Meer & van Tilburg

Vohora, A., Wright, M., & Lockett, A. 2004. Critical junctures in the development of university high-tech spin-out companies. *Research Policy*, 33: 147-175.

Von Hippel, E. 1987. Sticky information and the locus of problem solving: implications for innovation. *Management Science*, 40(4): 429-440.

Walker, G., Kogut, B., & Shan, W. 1997. Social capital, structural holes and the formation of an industry network. *Organization Science*, 8: 109–125.

Wasserman, S., & Faust, K. 1994. *Social network analysis: methods and applications*. Cambridge UK: Cambridge University Press.

Wasserman, S., & Galaskiewicz, J. 1994. *Advances in social network analysis: Research in the social and behavioral sciences*. Thousand Oaks, CA: Sage Publications.

Wernerfelt, B. 1984. A resource-based view of the firm. *Strategic Management Journal*, 5: 171-180.

Wernerfelt, B. 1995. The resource-based view of the firm: Ten years after. *Strategic Management Journal*, 16: 171-174.

Westhead, P., Wright, M., & Ucbasaran, D. 2001. The internationalization of new and Small Firms: A resource-based view. *Journal of Business Venturing*, 16: 333-358

Wiersema, M.F., & Bantel, K.A. 1992. Top management team demography and corporate strategic change. *Academy of Management Journal*, 35: 91–121.

Wijffels, H.H.F., Breimer, D.D., Halvers, L.J., Meijer, E.M., & Tent, H. 2004. *De kracht van directe verbindingen*. Rapport van ad hoc commissie Brugfunctie TNO en GTI's, Ministerie Economische Zaken: Den Haag, mei 2004.

Wiklund, J. 1999. The sustainability of the entrepreneurial orientation–performance relationship. *Entrepreneurship Theory and Practice*, 24: 37–48.

Wiklund, J., & Shepherd, D. 2003. Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses. *Strategic Management Journal* 24(13): 1307-1314.

Williamson, O.E. 1994. Transaction cost economics and organization theory. In N. Smelser & R. Swedberg (Eds.), *The handbook of economic sociology:* 77-107. Princeton NJ: Princeton University Press.

Winston, W.L. 1994. *Operations research: applications and algorithms, 3rd Ed*. Boston: PWS-Kent.

Woo, C.Y., Willard, G.E., & Daellenbach, U.S. 1992. Spin-off performance: A case of overstated expectations? *Strategic Management Journal*, 13(6): 433-447.

Wright, M., Robbie, K., & Ennew, C. 1997. Venture capitalists and serial entrepreneurs. *Journal of Business Venturing,* 12: 227-249.

Wright, M., Westhead, P., & Sohl, J. 1998. Editor's introduction: habitual entrepreneurs and angel investors. *Entrepreneurship Theory and Practice*, 22(4): 5-21.

Wright, M., Vohora, A., & Lockett, A. 2004. The formation of high-tech university spinouts through joint ventures. *Journal of Technology Transfer*, 29(3-4): 287-310.

Yin, R.K. 1994. *Case study research: design and methods, 2nd Ed*. Beverly Hills, CA: Sage Publishing.

Yin, R.K. 2003. *Case study research design and methods 3rd Ed.* Thousand Oaks, CA: Sage Publishing.

Yli-Renko, H., Autio, E., & Sapienza, H.J. 2001. Social capital, knowledge acquisition, and knowledge exploitation in young, technology-based firms. *Strategic Management Journal,* 22: 587-613.

Zacharakis, A.L., & Meyer, G.D. 2000. The potential of actuarial decision models: can they improve the venture capital investment decision? *Journal of Business Venturing*, 15: 323-346.

Zaheer, A., & Bell, G.G. 2005. Benefiting from network position: Firm capabilities, structural holes and performance. *Strategic Management Journal*, 26: 809-825.

Zahra, S.A. 1996. Technology strategy and performance: A study of corporate-sponsored and independent biotechnology ventures. *Journal of Business Venturing*, 11(4): 289-321.

Zahra S.A., & Covin, J. 1995. Contextual influence on the corporate entrepreneurship–performance relationship: a longitudinal analysis. *Journal of Business Venturing*, 10: 43-58.

Zahra, S.A., & Nielsen, A.P. 2002. Sources of capabilities, integration and technology commercialization. *Strategic Management Journal*, 23: 377-398.

Zander, U., & Kogut, B. 1995. Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test, *Organization Science*, 6(1): 76-92.

Zenger, T.R., & Lawrence, B.S. 1989. Organizational demography: The differential effects of age and tenure distributions on technological communication. *Academy of Management Journal*, 32: 353-376.

APPENDIX A1: SURVEY QUESTIONNAIRE

Starters team

1. Who are the members of the startersteam?	**You**	**1 …**	**2 …**	**3 …**	**4 …**	**5 …**
2. This person is part of the team since (month/ yr)	--/--	--/--	--/--	--/--	--/--	--/--
Before entering the spin-off who has more than 2 years …						
3. …management experience?	❑	❑	❑	❑	❑	❑
4. …research experience?	❑	❑	❑	❑	❑	❑
5. …worked in the industry of the spin-off?	❑	❑	❑	❑	❑	❑
6. …worked in a start-up before?	❑	❑	❑	❑	❑	❑
7. Will you mark those corresponding members that knew each other before they participated in this new company?	**You**	**1**	**2**	**3**	**4**	**5**
You		❑	❑	❑	❑	❑
1			❑	❑	❑	❑
2				❑	❑	❑
3					❑	❑
4						❑

Spin-off

8. When originated the first idea for the spin-off:	_ yr	When is definitely started:	_ yr
9. Who took the initiative for the spin-off	❑ member of the starters team	❑ the university	
10. In which sector is the spin-off active:			
11. Will you give the division of shares:	Member of the starters team:	.....	
	University (ex. Via a holding):	.....	
	other:	.....	
	total:	100 %	

Will you fill out how much you agree on the following statements: *completely agree =1; completely disagree =7*							
12. During the start-up, the development process was completely new to us.	1	2	3	4	5	6	7
13. During the start-up, the skills and technology were completely new to us.	1	2	3	4	5	6	7
14. During the start-up, the demands of the customers were completely new to us.	1	2	3	4	5	6	7
15. During the start-up, it was completely new to us how the competition acts.	1	2	3	4	5	6	7
16. It was important to enter the market with a relative simple innovation.	1	2	3	4	5	6	7
17. When we started we could do more then the market needed.	1	2	3	4	5	6	7
18. Only after a few years we could take full advantage of our academic knowledge	1	2	3	4	5	6	7
19. The coming years, a lot of investments must be done in marketing activities.	1	2	3	4	5	6	7
20. The coming years, the customers must be approached intensively.	1	2	3	4	5	6	7
21. The coming years, a lot of investments must be put in R&D activities.	1	2	3	4	5	6	7
22. The coming years, many employees will stay in R&D.	1	2	3	4	5	6	7
23. The spin-off works with the same customers as the parent organisation.	1	2	3	4	5	6	7
24. The spin-off works with the same partners as the parent organisation.	1	2	3	4	5	6	7
25. The spin-off complements to the activities of the parent organisation.	1	2	3	4	5	6	7
26. The spin-off works in the same knowledge field as the parent organisation.	1	2	3	4	5	6	7

Support by the Parent Organisation

With parent organisation we refer to the university or research institute from which the spin-off has originated.

27. What is the name of the parent organisation?	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Can you give for the following issues whether the parent organisation has supported your spin-off in this issue and consequently how important was the support for the spin-off.

The parent organisation has provided …	No, we did not receive support but we should have	No, we did not receive support but it could have made things easier	No, we did not receive support but it was not necessary	Yes, we receive support but it was not necessary	Yes, we received support and it made things easier for us	Yes, we received support and it was crucial
28. finance	❑	❑	❑	❑	❑	❑
29. ownership rights or IP	❑	❑	❑	❑	❑	❑
30. start-up orders	❑	❑	❑	❑	❑	❑
31. accommodation or laboratory	❑	❑	❑	❑	❑	❑
32. legal support	❑	❑	❑	❑	❑	❑
33. organisational support	❑	❑	❑	❑	❑	❑
34. technological support	❑	❑	❑	❑	❑	❑
35. administrative support	❑	❑	❑	❑	❑	❑

Start-up activities

Will you choose from the pairs of activities below, the activity that has or had the most attention among the members in the starters-team during start-up.

example: The market, customers and competition had a lot more attention during the start-up process then the technology or the development process.

	The market, customers & competition	(++)	+	0	+	++	Technology & development process
36.	The market, customers & competition	++	+	0	+	++	Technology & development process
37.	The market, customers & competition	++	+	0	+	++	Co-operation with partners
38.	The market, customers & competition	++	+	0	+	++	Organisation, legal & financial issues.
39.	The market, customers & competition	++	+	0	+	++	Employees, accommodation & equipment
40.	The market, customers & competition	++	+	0	+	++	Finding finance
41.	Technology & development process	++	+	0	+	++	Co-operation with partners
42.	Technology & development process	++	+	0	+	++	Organisation, legal & financial issues
43.	Technology & development process	++	+	0	+	++	Employees, accommodation & equipment
44.	Technology & development process	++	+	0	+	++	Finding finance
45.	Co-operation with partners	++	+	0	+	++	Organisation, legal and financial issues.
46.	Co-operation with partners	++	+	0	+	++	Employees, accommodation & equipment
47.	Co-operation with partners	++	+	0	+	++	Finding finance
48.	Organisation, legal & financial issues	++	+	0	+	++	Employees, accommodation & equipment
49.	Organisation, legal & financial issues	++	+	0	+	++	Finding finance
50.	Employees, accommodation & equipment	++	+	0	+	++	Finding finance

Network

Most people discuss from time to time important issues with others, for example with family, colleagues etc. We ask you to give a maximum of 7 names of people who were important the start-up of the spin-off. It can involve a discussion on market, competition, finance, equipment and accommodation, etc.

Person	1	2	3	4	5	6	7
51. How is the contact made? Via your…							
personal network (family, friends)	❑	❑	❑	❑	❑	❑	❑
network of the university or research institute	❑	❑	❑	❑	❑	❑	❑
network of other universities	❑	❑	❑	❑	❑	❑	❑
business network	❑	❑	❑	❑	❑	❑	❑
52. How well do you know the person? Very well	❑	❑	❑	❑	❑	❑	❑
	❑	❑	❑	❑	❑	❑	❑
Somehow	❑	❑	❑	❑	❑	❑	❑
Very little							
53. How intensive is the contact? ± 1 x a week	❑	❑	❑	❑	❑	❑	❑
± 1 x a month	❑	❑	❑	❑	❑	❑	❑
± 1 x a half year	❑	❑	❑	❑	❑	❑	❑
54. How many years do you know this person?	_ _ yr	_ _ yr	_ _ yr	_ _ yr	_ _ yr	_ _ yr	_ _ yr
55. What did you discuss with this person?							
Market, customers and competition……	❑	❑	❑	❑	❑	❑	❑
Technology and development process……	❑	❑	❑	❑	❑	❑	❑
Co-operation and partners……	❑	❑	❑	❑	❑	❑	❑
Organisation, legal and finance issues……	❑	❑	❑	❑	❑	❑	❑
Employees, equipment and accommodation…	❑	❑	❑	❑	❑	❑	❑
Finance questions……	❑	❑	❑	❑	❑	❑	❑

56. Relationships among the contacts in the external network

Can you mark the contacts that know each other?	1	2	3	4	5	6	7
Person 1		❑	❑	❑	❑	❑	❑
Person 2			❑	❑	❑	❑	❑
Person 3				❑	❑	❑	❑
Person 4					❑	❑	❑
Person 5						❑	❑
Person 6							❑

Performance

Can you give an indication of the following numbers	End 2001	End 2002	End 2003
57. The total number of full time employees	…… fte	…… fte	…… fte
58. The total number of full time employees working in R&D	…… fte	…… fte	…… fte
59. The cash-flow	€/ fl …… mln	€/ fl …… mln	€/ fl …… mln
60. The R&D expenditures	€/ fl …… mln	€/ fl …… mln	€/ fl …… mln

APPENDIX A2: DENSITY MEASURE

The density in the external network is calculated by the number of existing ties divided by the number of potential ties. The more ties between the contacts in the network, the more people know each other and there is more redundancy in the network. In the questionnaire we gathered data on this measure. We first asked the respondent to name up to seven persons with whom issues regarding the start-up of the spin-off were discussed. Second, we asked the respondent to indicate in a connection table (see Table AT.1), who the contacts are connected with. We did so by asking whether contact 1 and contact 2 knew each other.[23] Table AT.1 determines whether the 7 persons have contact with each other. If two persons have contact with each other, the respondent marked this with a cross in the corresponding box. We only asked the respondent to fill out the part above the diagonal since the part beneath the diagonal is similar for the criteria we use, which is "knowing each other".

Table AT.1 The connection table as taken from the questionnaire

3c Relationships among the contacts in the external network							
Can you mark the contacts that know each other.	1	2	3	4	5	6	7
Person 1		❑	❑	❑	❑	❑	❑
Person 2			❑	❑	❑	❑	❑
Person 3				❑	❑	❑	❑
Person 4					❑	❑	❑
Person 5						❑	❑
Person 6							❑

Using Microsoft Excel we reformulated Table AT.1 into an adjacency matrix (Matrix AM, see A.1).

$$\begin{bmatrix} p_{11} & .. & p_{1j} \\ .. & .. & .. \\ p_{i1} & .. & p_{ij} \end{bmatrix} \qquad (A.1)$$

Summation of the matrix for both rows and columns provides the number of existing ties (Equation A.2):

$$z_{ij} = \sum_{i=1}^{7} \sum_{j=1}^{7} p_{ij} \qquad (A.2)$$

Here z_{ij} indicates a connection between contact i and j. The number of potential ties in the network is given by the number of contacts n times all other contacts divided by two because of bi-directionality (Equation A.3):

$$potential\ ties = \tfrac{1}{2}n\cdot(n-1) \qquad (A.3)$$

Finally the density of the network is then the number of existing ties by potential ties (Equation A.4 & A.4a):

$$density = z_{ij} / (\tfrac{1}{2}n\cdot(n-1)) \qquad (A.4)$$

$$= 2z_{ij} / (n\cdot(n-1)) \qquad (A.4a)$$

[23] The respondents were specifically asked to indicate whether two contacts knew each other. Knowing each other does not necessarily imply a connection, it indicates that two contacts know each other. If we had only asked for an established connection it might misrepresent the redundancy in the network because knowing each other is already a connection. Furthermore, we asked whether the connection was bi-directional (two contacts know each other) and not if contact A knows B and if contact B knows A (uni-directional). This reduction simplifies the filling out of the questionnaire. Moreover. during interviews, we observed that redundancy based on uni-directional ties did not differ much from bi-directional.

APPENDIX A3: STRUCTURAL HOLE MEASURE

The structural hole measure is, like the density measure, based on the connection table (see Table AT.1). To calculate the number of contacts that bridge a structural hole in the respondent's network, we needed to measure the level of constraint in the network. Constraint describes the extent to which a person's network is concentrated in redundant contacts based on the proportion of time and energy invested in a relationship combined with its structural position.

The theoretical discussion of the constraint measure is partly based on Burt (1992). Figure *AF.1* represents a small network of four contacts around ego *i*. According to Burt (1992: 54), '*... entrepreneurial opportunities are constrained to the extent that another of your contacts q, in whom you have invested a large proportion of your network time and energy, has invested heaviliy in a relationship with contact j.'*

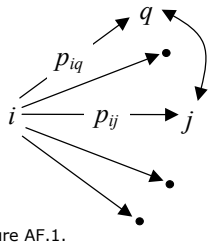


Figure AF.1.
Hole conditions of constraint (Burt, 1992)

In formal terms, this is written as Equation A.6.

$$P_{iq} \cdot P_{qj} \qquad (A.6)$$

In Equation *A.6*, P_{iq} is the proportion of network time and energy invested in contact *q* by ego *i* and P_{qj} is the proportional strength of *q*'s relationship with contact *j*. If the outcome of Equation A.6 is high, it means that investments in contact *q* can also lead to contact *j* which make the presence of a structural hole between the two contacts unlikely.

If Equation *A.6* is aggregated for all other contacts *q* we have the indirect investments in contact *j*. Adding *i*'s direct connection with *j* defines the proportion of *i*'s network time and energy that involves directly and indirectly *j* (see Equation A.7)

$$p_{ij} + \sum_{q} p_{iq} \cdot p_{qj}, \; q \neq i, j. \qquad (A.7)$$

The constraint in the relationship with contact *j* is then limited by the amount of energy and time you have spent on contact *j* and by the number of structural holes that surround contact *j*. The constraint on ego by the lack of structural holes around *j* is then calculated by the amount of constraint multiplied by the lack of structural holes (see Equation A.8). The total constraint in the network of the ego is then the aggregated Equation A.9 for all contacts.

$$\left(p_{ij} + \sum_{q} p_{iq} \cdot p_{qj} \right)^2, q \neq i, j. \qquad (A.8)$$

$$\sum_{q=1}^{n} \left(p_{ij} + \sum_{q} p_{iq} \cdot p_{qj} \right)^2, q \neq i, j. \qquad (A.9)$$

The total constraint indicates the chances of opportunities in ego's network, but to find the number of structural holes Equation *A.6* satisfies. In Equation *A.6*, if the constraint on contact *j* equals zero, (the second part of Equation A.6 is zero) this indicates that contact *j* provides the potential to bridge a structural hole. The number of structural holes in ego's network is then equal to the number of contacts for which $\Sigma_q(Piq \cdot P_{qj})$ is zero.

APPENDIX A4: HETEROGENEITY MEASURE

The heterogeneity in ego's network was calculated by asking respondents to indicate the demographic background of each of the contacts they mentioned. Table AT.2 was used to collect this data in the questionnaire.

Table AT.2 The background table as taken from the questionnaire

Person	1	2	3	4	5	6	7
How is the contact made? Via your…							
personal network (family, friends)	❑	❑	❑	❑	❑	❑	❑
network at the university or research institute	❑	❑	❑	❑	❑	❑	❑
network of other universities	❑	❑	❑	❑	❑	❑	❑
business network	❑	❑	❑	❑	❑	❑	❑

In Table AT.2, the respondent marked the backgrounds for each of the contacts to which the contact belongs. The corresponding box was then marked leaving the others empty. We then rewrote Table AT.2 as a background matrix (see A.10)

$$\begin{bmatrix} b_{11} & .. & b_{1j} \\ .. & .. & .. \\ b_{i1} & .. & b_{ij} \end{bmatrix} \qquad (A.10)$$

In this matrix *j* represent the contacts named by the respondent and *i* refers to the background. (*1* are friends and family; *2* are the contacts at the university or research institute; *3* come from other universities; and *4* is the business environment). For example, if contact number 3 is from the parent organisation, box b_{23} is marked with a '1' and b_{13}; b_{33}; and b_{43} are marked '0'. The sum of all matrix elements in row *i* is presented by Equation A.11.

$$\sum_{j=1}^{n} b_j \qquad (A.11)$$

The proportion of the contacts that are from similar backgrounds is given by the number of contacts from the same background (Equation A.12) divided by the total number of contacts (n_j):

$$\left(\frac{\sum_{j=1}^{n} b_j}{n_j} \right) \qquad (A.12)$$

When we square each proportion of background and subtract it from a 1 (a complete homogenous network) we have an indicator of the heterogeneity, see Equation A.13.

$$\text{heterogeneity} = 1 - \left[\sum_{b=1}^{k} \left(\frac{\sum_{j=1}^{n} b_j}{n_j} \right)^2 \right] \qquad (A.13)$$

APPENDIX A5: CALCULATIONS OF THE ANALYTICAL HIERARCHICAL PROCESS

The Analytical Hierarchical Process (Saaty, 1980) measures the weights of each activity regarding the importance of that activity during the early growth of the spin-off. The main assumption is that all six activities have a positive but yet unknown weight of importance: w_1, $w_2 \ldots w_6$. The sum of all six weights is 1: ($w_1 + w_2 + \ldots + w_6 = 1$). Each weight is calculated based on the calculations by Buijsman, Trienekens and Van Beek (1998). Respondents assessed a total of 15 pairwise comparisons, each activity is compared with the other, see Table AT.3.

Table AT.3 Pairwise comparisons of six activities, as taken from the questionnaire

Will you choose, from the pairs of activities below, the activity that has or had the most attention among the members in the starters' team during start-up.

Example: The market, customers and competition had a lot more attention during the start-up process then the technology or the development process.

	The market, customers & competition	(++)	+	0	+	++	Technology & development process
1	The market, customers & competition	++	+	0	+	++	Technology & development process
2	The market, customers & competition	++	+	0	+	++	Co-operation with partners

The pairwise comparisons result in matrix $A = (a_{ij})$, where element a_{ij} gives the relative importance of activity *i* compared to activity *j*. The importance was measured on an integer-valued 1-3 scale, with each number shown in Table AT.4. If, for example, $a_{13} = 2$, activity 1 is moderately more important than activity 2. Regarding the consistency of the matrix, for all *i* it is necessary that $a_{ii} = 1$, and if $a_{ij} = k$, then it is necessary that $a_{ji} = 1/k$. Thus, if $a_{13} = 2$, then $a_{31} = ½$ must hold.

Table AT.4 Interpretation of entries in a pairwise comparison matrix

Value in table AT.3	Value of a_{ij}	Interpretation
0	1	Activities *i* and *j* are of equal importance
+	2	Activity *i* is weakly more important than activity *j*
++	3	Activity *i* is moderately more important than activity *j*
+++	4	Activity *i* is absolutely more important than activity *j*

When the respondent has made the pairwise comparisons, the unknown weights of each activity can be calculated based on two characteristics of Matrix A_{ij}.

The sum of all matrix elements in row *i* is given by Equation A.14, (Characteristic I, Winston 1997)

$$\sum_{i=1}^{6} a_{ij} = \frac{1}{Wj} \sum_{i=1}^{6} Wi \quad (A.14)$$

The sum of all matrix elements in column *j* is then given by Equation A.15, (Characteristic II, Winston, 1997)

$$\sum_{i=1}^{6} a_{ij} = \frac{1}{Wj} \sum_{i=1}^{6} Wi \quad (A.15)$$

The sum of all matrix elements of A is then:

$$\sum_{j=1}^{6} \sum_{i=1}^{6} a_{ij} = \sum_{j=1}^{6} \frac{1}{Wj} \quad (A.16)$$

Each activity *i* has then the relative importance of w_i compared to the other activities (Equation A.17)

$$Wi = \sum_{j=1}^{6} a_{ij} / \sum_{j=1}^{6} \sum_{i=1}^{6} a_{ij} \quad (A.17)$$

Calculating each weight provides the vector:

$$w = [w_1, w_2 \ldots w_n] \quad (A.18)$$

CHECKING FOR CONSISTENCY.

If the respondent fills out the pairwise comparisons with more inconsistency, the calculated weights for each activity become less precise. Therefore, Saaty (1980) argues that to validate the measure, a check for internal consistency is necessary. Calculating the internal consistency is done according a four-step procedure (Winston, 1997: 757).[24]

Step 1 Compute $A\mathbf{w}^{T}$. Where A represents the matrix of pairwise comparisons and **w** denotes our estimate of the respondents' weights. For example we obtain:

$$A\mathbf{w}^{T} = \begin{bmatrix} 1 & 5 & 2 & 4 \\ 0.2 & 1 & 0.5 & 0.5 \\ 0.5 & 2 & 1 & 2 \\ 0.25 & 2 & 0.5 & 1 \end{bmatrix} \begin{bmatrix} 0.5115 \\ 0.0986 \\ 0.2433 \\ 0.1466 \end{bmatrix} = \begin{bmatrix} 2.0775 \\ 0.3959 \\ 0.9894 \\ 0.5933 \end{bmatrix}$$

Step 2 Compute

$$\frac{1}{n}\sum_{i=1}^{i=n} \frac{i\text{th entry in } A\mathbf{w}^{T}}{i\text{th entry in } \mathbf{w}^{T}}$$

$$= \left\{\frac{1}{4}\right\}\left\{\frac{2.0775}{0.5115} + \frac{0.3959}{0.0986} + \frac{0.9894}{0.2433} + \frac{0.5933}{0.1466}\right\} = 4.05$$

Step 3 Compute the **consistency index** (CI):

$$\text{CI} = \frac{(\text{result step 2}) - n}{n-1} = \frac{4.05 - 4}{3} = 0.17$$

Step 4 Compare CI to the random index (RI) for the appropriate value of *n*, shown in Table AT.6. A perfect consistent respondent has CI =0. The RI index is the average value of CI in Table AT.6 are chosen at random, subject to the constraint that all diagonal entries must equal 1 and $a_{ij} = (a_{ji})^{-1}$. If CI is sufficiently small, comparisons made by the respondent are probably consistent enough to give useful estimates of the weights. According to Wilson (1997), the ratio CI/RI must be smaller than 0.10. If the ratio exceeds 0.10, serious inconsistencies may exist, and the AHP may not yield meaningful results. In case of n =6, as in our study, the random index is calculated as 1.24. Based on 120 iterations of random inconsistency, we calculated R.I. =0.35 as for our four-point scale and six activities. This value is used to validate our measures that used the AHP technique.

[24] There is some criticism about making decisions in multiple-objective problems (see Winston, 1997). First the method requires checking that the respondent believes that each activity is mutually preferentially independent. Second, the number of activities remains arbitrary and adding another alternative activity may change the ranking of the original alternatives. Third, Saaty uses a nine-point scale to measure the preferences. This scale is arbitrary and has significant impact on the consistency index. In our case, we used a four-point scale (see Table AT.3). During our interviews we observed that the nine-point scale, as proposed by Saaty, influences the willingness to fill out this question negatively. Since the objective of our questionnaire involves not only the ranking of importance of start-up activities we simplified the measure by using a four-point scale. Regarding consistency, our scale is about 4 times more sensitive. One-point difference on a nine-point scale (a 3 in stead of a 4) does not give as much inconsistency as it does from a three to a five on a five-point scale.

APPENDIX A6: CALCULATIONS OF THE BIRCH INDEX

The early growth of spin-offs is measured based on the increased number of employees in the spin-off. The increase can be calculated in absolute values and in relative values. Both the relative and absolute values pose some problems regarding the size of the spin-off. Compared to large firms, smaller firms grow more quickly in relative terms but more slowly in absolute terms. The Birch Index (1981) combines the relative and absolute growth of employees of a firm in a single measure. The measure is often used in economics to control for the effect of firm size.

Table AT.5 shows the relative and absolute growth of typical firms. These firms are distinguished in small and large and in low and high growth. The table shows that the relative growth of small firms is much higher compared to the larger firms, while the larger firms grow more in absolute employees. Based on relative growth, the order of low to high growth would be 3 – 1 – 4 – 2. In this order, the growth index for the high-growth large firm is similar to that of the low-growth small firm. In other words, a large firm that grows by 10 employees has the same growth index as the small firm that grows by a single employee. Based on the absolute growth index, the order would be 1 – 3 – 2 – 4.

This research employs the Birch Growth Index with small adaptations. Since this research focuses on young firms in particular, we introduced a root extraction in the absolute part. This root extraction makes the larger firms less dominant in the growth index.

Table AT.5 Examples of four typologies, which both firm size and firm growth differ

Case	Typology	Employees in 2001	Employees in 2003	Relative growth Index	Absolute growth Index	Birch growth Index
				(2003 - 2001) / 2001* 100%	(2003 - 2001)	$(2003-2001)^{1/2}$ * (2003/2001)
1	Low-growth small firm	2	3	50	1	1.5
2	High-growth small firm	2	8	300	6	9.8
3	Low-growth large firm	20	22	10	2	1.5
4	High-growth large firm	20	30	50	10	4.7

APPENDIX B1 SUPPRESSOR VARIABLES

Analysis of the suppressor effects is presented in Tables BT.1 and BT.2. In addition to standardised coefficients (Beta) and significance tests, the structure coefficients and the collinearity statistics are also given. The structure coefficients (zero-order correlations) are the direct correlations between a predictor and criterion variable. These values can be found in the second column of Tables BT.1 and BT.2. The tables also present the partial correlations of each predictor. The partial correlation is the strength of the relationship between the criterion and a single predictor when the effects of the other predictor variables in the model are constant.[25] Collinearity statistics (variance inflation factor - VIF) show whether two or more independent variables are closely related.

The values presented in Table BT.1 are important when reporting the results of a multiple regression model (Thompson and Borrello, 1985). Consideration of both the structure and the standardised coefficients can offer essential information on the contribution of each of the regression variables (Courville and Thompson, 2001). Consequently the independent variables are assessed that are included in the final model on the four *criteria* regarding the structure and standardised coefficients (Onwuegbuzie and Daniel, 2003: 21):

1. If both structure (zero order coefficients) and standardised coefficients (β weights) are low, the independent variable does not serve as a good predictor.
2. The extent that regression structure coefficients correspond with the standardised weights shows how uncorrelated the predictor variables are.
3. If the standardised coefficient demonstrates a low value but the structure coefficient shows a high value, then the effect of the predictor variable on the criterion is high. The predictor may, however, display high levels of collinearity with other predictor variables.
4. The fourth criterion is that if the structure coefficient is low but the standardised coefficient is high, a suppressor variable may be present.

The fourth criterion involves a low structure coefficient and a high standardised coefficient. If regression variables show this combination, they are believed to be suppressor variables. Suppressor variables suppress or mask part of the variance of another predictor. This may seem problematic but suppressor variables assist in the prediction of criterion variables because of their relationship with other predictor variables (Tabachnick and Fidell, 1996). Due to the relationship with other predictor variables, suppressor variables suppress the variance of other predictor variables that is irrelevant to the prediction of the criterion variable and thereby increase the predictive power of the independent variables. Suppressor variables are likely to be found in data that are aggregated or when variables are sums or averages of multiple observations (Cohen *et al*., 1983). Table BT.1 presents the estimates of the resource-based variables as given by Model 3a in Table 6.6, Section 6.3.

[25] "Partial correlation coefficients are used in sequential variable selection methods of regression model estimation to identify the predictor variable with the greatest incremental predictive power beyond the predictor variables already in the regression model" (Hair *et al*., 1998: 146).

Table BT.1 Model estimation of the spin-off early growth

		Model 3a1 Management experience			Model 3a2 Industry experience			Model 3a3 Research experience			Model 3a4 Start-up experience			Model 3a5 Management experience			Model 3a6 Management Research Starters experience		
	Zero-order	Beta	Par-tial	VIF	Beta	Par-tial	VIF	Beta	Par-tial	VIF	Beta	Par-tial	VIF	Beta	Par-tial	VIF	Beta	Par-tial	VIF
Newness to the team	-.14	-.07	-.08	1.33	-.02	-.02	1.18	.04	.05	1.28	.00	.00	1.18	-.09	-.10	1.33	-.04	-.04	1.48
Newness to the market	.19	.15	.18	1.03	.14	.17	1.03	.15	.18	1.02	.15	.18	1.02	.18	.22	1.04	.18†	.23	1.04
Spin-off size	.41**	.45**	.44	1.28	.44**	.42	1.33	.55**	.48	1.55	.47**	.46	1.30	.48**	.48	1.30	.56**	.51	1.57
Spin-off age	-.22*	-.32*	-.34	1.23	-.34*	-.35	1.23	-.35**	-.37	1.23	-.32**	-.34	1.23	-.28**	-.31	1.26	-.30**	-.33	1.27
Capital investment	.23*	.11	.13	1.12	.14	.16	1.12	.10	.11	1.14	.16	.18	1.12	.13	.16	1.13	.11	.13	1.17
Team size	.20†	.14	.14	1.56	.08	.08	1.49	.19	.18	1.68	-.04	-.04	1.47	.06	.06	1.67	.16	.15	2.13
Management experience	.00	-.16	-.16	1.44										-.29*	-.28	1.71	-.26†	-.26	1.75
Industry experience	.05				-.04	-.04	1.39												
Research experience	.08							-.26†	-.23	1.96							-.21	-.19	2.01
Start-up experience	.20†										.20†	.22	1.30	.31*	.31	1.54	.30*	.30	1.56
Adj. R2		0.27			0.25			0.29			0.28			0.33			0.34		
F		4.30			4.00			4.64			4.56			4.86			4.64		
p		>.1			>.1			<.01			<.01			<.01			<.01		

**p<0.01 *p<0.05 †p<0.1

The control variables that measure the newness to the team, the newness to the market, and the level of investment show both low structure and low standardised coefficients. According to the first criterion (Onwuegbuzie and Daniel, 2003), these variables are not good predictors of the early growth of an academic spin-off. The second criterion assesses both the structure and standardised coefficients. In Table BT.1 the control variables 'spin-off's size' and 'spin-off's age' have similar standardised and structure coefficients and show significance levels at 99%. These variables are good predictors of the early growth of a spin-off. Model 3a1 only includes the team size and management experience. In this model, team size and management experience are not significant. For management experience, the structure coefficient is zero, while the standardised coefficient (β) is -.16 which suggests, according to criterion 4 (Onwuegbuzie and Daniel, 2003), that a suppressor variable may be present in management experience. In the next model, Model 3a2, the effect of industry experience is estimated. In this model, the structure and standardised coefficients are comparable and not significant, indicating that industry experience is not a good predictor of the early growth of spin-offs. Model 3a3 estimates the effects of research experience. In this case, the structure coefficient is low while the standardised coefficient is significant at 90%, which may also indicate a suppressor effect is present, see criterion 4. The fourth model, Model 3a4, estimates the effects of start-up experience and indicates a significant value for both the structure and standardised coefficient, thereby estimating start-up experience as a good predictor of the early growth of spin-offs. In the fifth model, management and start-up experience are included. In this model both the effects of management and start-up experience increase and are significant at 95%, making them both good predictors of the early growth of spin-offs. Including research experience, which was initially significant at 90%, with management and start-up experience shows that it loses significance and also management and start-up experience become less good predictors of early growth. None of the regression variables in our final model shows collinearity and the third criterion is met (Onwuegbuzie and Daniel, 2003). The absence of collinearity is also shown by the collinearity statistics. The variance inflation factor (VIF) was calculated in each of the regression models. The maximum VIF within the models was 1.93, which is well below the rule-of-thumb threshold of 10 (Neter, Wasserman and Kutner, 1990).

Comparing Models 3a1 and 3a5 shows that the structure coefficient for management experience and early growth is zero ($r=0.000$), while the standardised coefficient is significant and negative in direction ($\beta=-0.273$). In other words, there is no direct relationship between management experience and the early growth of spin-offs. In regression, however, management experience shows a strong and negative effect on the early growth of a firm. This situation is known as classical suppression (Cohen *et al*., 1988). With classical regression, one predictor variable is correlated with the criterion variable ($r_{Y1}>0$) and another predictor variable is not correlated with the criterion variable ($r_{Y2}=0$). The two predictor variables, however, are highly correlated ($r_{12}>0$). Figure BF.1 shows this situation visually. In the final regression model, the criterion variable (Y) is the early growth of the firm. According to the structure coefficient, there is no relation between management experience and the early growth of a spin-off. Consequently in Figure BF.1, management experience is represented by X_2, starters' experience by X_1 and early growth is represented by Y.

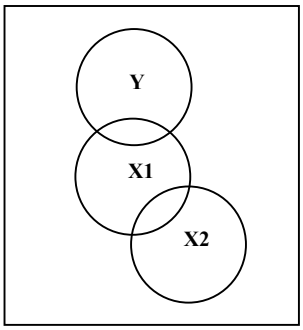


Figure BF.1: Classical Suppression

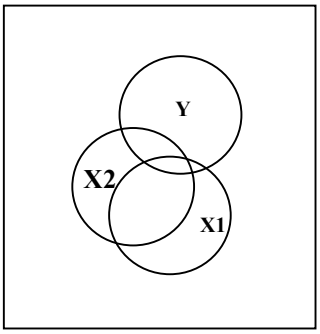


Figure BF.2: Negative or Net Suppression

Table 6.6 (Section 6.3) provides the structure coefficients among the independent variables and a strong relationship between management experience (X_2) and starters' experience (X_1), i.e. $r = 0.50$ is noticed. In addition, starters' experience has a zero-order correlation with early growth of $r = 0.20$. With classical suppression, the presence of management experience will increase the multiple correlation, even though it has no relationship with a spin-off's early growth. The inclusion of the independent variable of management experience suppresses some of what would otherwise be error variance in start-up experience.

SUPPRESSION EFFECT OF TANGIBLE SUPPORT AND INTANGIBLE SUPPORT

The next suppression effect rests with the parent support variables. This suppression is more complicated and is presented in Figure BF.2. Both parent support variables (tangible support = x1; intangible = x2) have small structure coefficients and are positively related to early growth (Y): $r_{yx1} = 0.056$; $r_{yx2} = 0.062$. Their intercorrelation shows a positive and strong relationship among the two independents ($r_{x1x2} = 0.579$). High intercorrelation may indicate a redundancy between the two but the true identity is revealed when the two are put in a regression (Paulhus *et al*., 2004). When calculating the regression coefficients, one of the independent variables shows an opposite sign to the zero-order coefficient. This type of suppression is labelled differently by different researchers: Rosenberg (1968) referred to it as the *correction for distortion*, Conger (1974) named it *negative suppression*, Cohen *et al*. (1983) called it *net suppression* and, more recently, Paulhus *et al*. (2004) have argued for the term *cross-over suppression*. In this study it is referred to as *negative suppression* since one of the variables changes its sign from positive to negative. Table BT.2 shows the regression coefficients of the estimated models to underpin the suppressor effects.

The suppressor effect of intangible support is more complicated and results from the masking effect of various variables. Model 2d1 shows that tangible support is marginally significant and Model 2d2 shows that intangible support is not significant. Combining the two support variables increases the effect of tangible support. If the structural hole variable is included, the predictive power of both intangible and tangible support is further increased. Adding the start-up experience variable also increases the predictive power of the two, and when both the structural hole variable and the start-up experience variable are included, the predictive power of intangible support becomes significant at 90%.

Table BT.2 Model estimation of the spin-off early growth

		Model 2d1 Tangible support			Model 2d2 Intangible support			Model 2d3 Tangible & intangible support			Model 2d4 Tangible & intangible support & structural holes			Model 2d5 Tangible & intangible support & start-up exp.			Model 2d6 Tangible & intangible support structural holes & start-up exp.		
	Zero-order	Beta	Par-tial	VIF	Beta	Par-tial	VIF	Beta	Par-tial	VIF	Beta	Par-tial	VIF	Beta	Par-tial	VIF	Beta	Par-tial	VIF
Newness to the team	-.14	-.02	-.02	1.12	.00	.00	1.12	-.01	-.02	1.12	.06	.08	1.17	-.02	-.02	1.12	.05	.07	1.18
Newness to the market	.19	.15	.18	1.02	.14	.16	1.06	.17	.21	1.09	.09	.12	1.15	.19†	.23	1.09	.11	.14	1.17
Spin-off size	.41**	.56**	.50	1.49	.49**	.46	1.37	.57**	.51	1.50	.60**	.57	1.48	.56**	.52	1.47	.59**	.57	1.48
Spin-off age	-.22*	-.41**	-.41	1.34	-.37**	-.37	1.29	-.42**	-.42	1.35	-.42**	-.46	1.30	-.38**	-.39	1.35	-.40**	-.43	1.35
Capital investment	.23*	.13	.15	1.07	.14	.16	1.07	.12	.14	1.08	.11	.15	1.07	.12	.15	1.07	.12	.16	1.07
Tangible support	.06	-.25†	-.24	1.61				-.31*	-.26	2.11	-.35*	-.33	1.92	-.31*	-.28	1.91	-.35*	-.33	1.92
Intangible support	.06				-.01	-.02	1.26	.12	.12	1.65	.20	.21	1.67	.16	.16	1.66	.21†	.23	1.69
Relatedness	.10	.02	.03	1.46	-.08	-.08	1.35	.01	.01	1.49									
Structural holes	.33**										.35**	.41	1.17				.32**	.38	1.22
Start-up experience														.19†	.23	1.07	.12	.16	1.12
Adj. R2		0.29			0.25			0.29			0.41			0.32			0.34		
F		4.74			4.00			4.23			6.45			4.84			4.64		
p		<.01			<.01			<.01			<.001			<.001			<.01		

**p<0.01 *p<0.05 †p<0.1

SAMENVATTING

Academische spin-offs zijn de laatste jaren uitgegroeid tot een niet meer weg te denken verschijnsel. Zij hebben een plaats gekregen als een manier van kennisvalorisatie, naast het onderwijzen van studenten en het uitvoeren van contractonderzoek. In dit onderzoek is een spin-off gedefinieerd als een nieuwe onderneming die is opgezet door een wetenschapper en gebaseerd is op academische kennis, ontwikkeld in een academische instelling. Kenmerkend is dat zowel de kennis als de wetenschapper vanuit een academische naar een bedrijfsmatige omgeving gaan. Deze overgang stelt andere eisen aan de wetenschapper en aan de omgeving waarin de spin-off opereert. Voor wetenschappers die een spin-off overwegen te starten en voor managers in academische instellingen en in investeringsmaatschappijen is het dus van essentieel belang de factoren te kennen die de initiële groei van academische spin-offs bepalen. Ze kunnen daar bij het opzetten en managen van de spin-off rekening mee houden.

Doel en opbouw van het proefschrift.

Het doel van dit proefschrift is inzicht te verschaffen in de factoren die de initiële groei van spin-offs bepalen. Primair wordt gekeken naar de rol van het startersteam, het netwerk van de spin-off en de rol die de kennisinstelling vervult tijdens het opstartproces. Daarmee is de hoofdvraag van dit onderzoek als volgt bepaald:

Wat zijn de kritische succesfactoren die de initiële groei van academische spin-offs bepalen?

De organisatieliteratuur kent een groot aantal factoren die de groei van startende ondernemingen bepalen. In dit proefschrift zijn de factoren globaal geclassificeerd in een tweetal interne en een tweetal externe factoren:

Intern: - De vaardigheden en kennis van het startersteam van de spin-off;

- De karakteristieken van de spin-off;

Extern: - Het sociale netwerk van de leden van het startersteam van de spin-off;

- De betrokkenheid van de moederorganisatie van de spin-off.

Deze vier factoren zijn in dit onderzoek geanalyseerd aan de hand van twee organisatie-theorieën. De invloed van het sociale netwerk van de spin-off en de betrokkenheid van de kennisinstelling worden beschreven op basis van de *sociaal kapitaaltheorie*. De vaardigheden en kennis van de leden van het starters team en de karakteristieken van de spin-off worden beschreven met behulp van de *resource-based view*. Deze twee theorieën verklaren beide de initiële groei van ondernemingen, echter de manier waarop ze de groei verklaren is verschillend. De sociaal kapitaaltheorie verklaart de initiële groei op basis van de waardevolle relaties van een onderneming die toegang geven tot middelen en kennis. De resource-based view verklaart juist de groei van een onderneming op basis van de middelen en kennis die zij bezit en controleert. In dit onderzoek wordt de groei van spin-offs geanalyseerd op basis van beide theorieën, individueel en in combinatie. De vergelijking van de twee organisatietheorieën geeft inzicht in de verklarende kracht die de beide theorieën hebben. Deze vergelijking wordt in dit onderzoek beschreven door de theoretische onderzoeksvraag:

In welke mate kan de sociaal kapitaal theorie en de resource-based view de initiële groei van academische spin-offs verklaren?

Binnen de sociaal kapitaaltheorie bestaan twee verschillende stromingen over de vraag op welke wijze een netwerk van relaties bijdraagt aan het sociaal kapitaal van een onderneming. De relationele benadering suggereert dat een onderneming een concurrentievoordeel behaalt door de contacten die het heeft met individuele actoren in het netwerk. De structurele benadering benadrukt dat een onderneming een concurrentievoordeel behaalt op basis van de positie die het inneemt in het netwerk. Ook binnen deze beide benaderingen zijn er verschillende argumenten over de potentiële voordelen van de verschillende netwerkconfiguraties.

De relationele benadering beschrijft netwerkcontacten in termen van sterke en zwakke contacten. Sterke contacten worden gekenmerkt door een sterke band die gebaseerd is op vertrouwen en een langdurige relatie. Volgens de relationele benadering kan een onderneming voordeel hebben van sterke contacten omdat de communicatie en coördinatie van activiteiten met deze contacten soepeler verloopt. Met zwakke contacten is de relatie minder intensief, recentelijk aangegaan of van tijdelijke aard. Maar deze zwakke contacten hebben wel vaak als voordeel dat zij nieuwe informatie aandragen, die voor de onderneming potentieel voordeel kunnen opleveren.

De structurele benadering beschrijft netwerken op basis van de mate waarin de contacten onderling met elkaar verbonden zijn. In een gesloten netwerk zijn alle contacten met elkaar verbonden, waardoor de personen goed op de hoogte zijn van wat de anderen doen. De transparantie in het netwerk faciliteert de coördinatie tussen de contacten en voorkomt opportunistisch gedrag. In een open netwerk daarentegen, zijn er veel minder of zelfs geen onderlinge contacten. Deze open netwerken geven een onderneming toegang tot diverse informatie en de onderneming kan een brugfunctie vormen tussen contacten die niet met elkaar in directe verbinding stonden. De onderneming kan dus een voordeel behalen door te handelen in informatie en zo twee contacten in het netwerk verbinden.

De discussies betreffende de diverse netwerkconfiguraties en het voordeel dat ze kunnen hebben voor startende ondernemingen impliceert dat voor verschillende situaties, verschillende configuraties wenselijk zijn. De tweede theoretische onderzoeksvraag is daarom als volgt geformuleerd:

Welk type relaties zijn voordelig en welk type relaties zijn nadelig voor de initiële groei van academische spin-offs?

Opbouw van het proefschrift

Het proefschrift is als volgt opgebouwd. Allereerst wordt een overzicht gegeven van de mogelijke mechanismen waarop kennisvalorisatie kan plaatsvinden. Vervolgens wordt een drietal internationale vergelijkingen gemaakt van 1) het innovatieklimaat in Nederland, 2) de interactie tussen industrie en het academisch onderzoek, en 3) het aantal academische spin-off ondernemingen. De conclusie van deze vergelijkingen is dat Nederland dreigt achter te blijven qua innovatieklimaat. Op dit moment is de samenwerking tussen industrie en wetenschap ten opzichte van andere Europese landen nog wel hoog, maar het dreigt snel terug te lopen. Deze samenwerking is voornamelijk met de bestaande grote industrie. Voor

wat betreft de kleine startende ondernemingen blijft Nederland achter bij het buitenland en bij het opzetten van nieuwe kennisintensieve ondernemingen scoort Nederland niet boven het Europese gemiddelde. Blijkbaar zijn academische onderzoekers en kennisinstellingen terughoudend om kennisvalorisatie via spin-offs te laten plaatsvinden.

Theoretisch raamwerk

Op basis van de twee organisatietheorieën wordt een theoretisch raamwerk ontwikkeld om de initiële groei van spin-offs te analyseren. De initiële groei van de spin-offs wordt berekend aan de hand van het verschil in het aantal werknemers over twee jaren. In het theoretisch raamwerk worden de vier factoren: de structuur van het netwerk van de spin-off, de rol van de kennisinstelling, de vaardigheden van het team en de karakteristieken van de spin-off, uitgewerkt in variabelen die gebaseerd zijn op eerdere studies.

Op basis van de netwerktheorie wordt de netwerkstructuur van de spin-off onderzocht. De structuur van het netwerk wordt geanalyseerd aan de hand van de mate waarin de netwerkcontacten onderling verbonden zijn en aan de hand van de mate waarin de netwerkcontacten afkomstig zijn van verschillende achtergronden. Bijvoorbeeld de industrie of de moederorganisatie. De dichtheid (closure argument) en het aantal structural holes (structural hole argument) in het netwerk beschrijven de onderlinge verbondenheid van netwerkcontacten en de heterogeniteit beschrijft de achtergrond van de diverse netwerkcontacten. De relationele configuratie van het netwerk beschrijft de sterkte van de netwerkcontacten. Hierbij wordt de relatie met de moederorganisatie van de spin-off gezien als een sterk netwerkcontact. Er wordt onderzocht welke ondersteuning de spin-off ondervindt van de moederorganisatie en in hoeverre de werkzaamheden van de spin-off verwant zijn met die van de moederorganisatie (relatedness). De ondersteuning van de moederorganisatie wordt uitgesplitst in tastbare ondersteuning zoals financiering en accommodatie en in niet-tastbare ondersteuning zoals advies en begeleiding.

Op basis van de resource-based view wordt de kennis en ervaring van het startersteam en de karakteristieken van de spin-off geanalyseerd. De kennis van het startersteam wordt uitgesplitst in managementervaring, onderzoekservaring, ervaring in de industrie waarin de spin-off opereert en ervaring met het opstarten van een nieuwe onderneming. Eerdere studies hebben aangetoond dat deze vormen van ervaring relevant zijn bij het opstarten van spin-offs. De vaardigheden van het startersteam worden geanalyseerd op basis van de variabelen die de diversiteit van de diverse leden beschrijft, de cohesie tussen de leden van het team en de ondernemersoriëntatie.

De variabelen die de karakteristieken van de spin-off beschrijven zijn de mate van nieuwheid van de activiteiten van de spin-off voor de leden van het startersteam en voor de markt. Daarnaast is de kapitaal intensiteit van de activiteiten en de leeftijd en omvang van de spin-off meegenomen in de analyse.

Het veldwerk

Voor de start van het onderzoek zijn interviews afgenomen bij 18 spin-off ondernemers en 5 managers in kennisinstellingen die betrokken zijn bij spin-offs. Deze interviews hebben inzicht gegeven in de toepassing van meetinstrumenten bij academische spin-offs. Op basis van de literatuur en de interviews zijn meetinstrumenten ontwikkeld en verwerkt in een vragenlijst. Vervolgens is er een database van academische spin-offs samengesteld op basis van informatie van verschillende websites en nieuwsbrieven van universiteiten en op basis van ondersteuningsprogramma's voor starters. De database had een omvang van 297 academische spin-offs in Nederland die opgestart zijn tussen 1996 en 2003. Naar de ondernemers van deze spin-off is de vragenlijst verstuurd. In totaal zijn er 81 ingevulde vragenlijsten retour ontvangen, waarvan er 65 bruikbaar waren voor dit onderzoek, wat een netto-score is van 23%. De data die verzameld zijn bij deze 65 spin-offs, is gebruikt om de hypotheses van het theoretische model te toetsen.

De hypothesen en resultaten

Voor de analyse van het netwerk van de spin-off is gevraagd naar de contacten, maximaal 7, die belangrijk waren voor het opstarten van de spin-off. Vervolgens is nagegaan in hoeverre deze contacten met elkaar verbonden waren en vanuit welke achtergrond men deze contacten kende. Bijvoorbeeld bedrijfsleven of privé. Over de individuele relaties met de contacten (relationele benadering) is informatie verzameld met betrekking tot de sterkte van de relaties en de onderwerpen die met de diverse contacten werden besproken. De data van de variabelen zijn vervolgens in het statistiekprogramma SPSS 11 geanalyseerd.

In de eerste stap zijn de controlevariabelen geanalyseerd. Dit zijn de omvang en leeftijd van de spin-off, de nieuwheid van de businessactiviteiten voor de markt en voor het team, en het investeringsniveau van de spin-off. Voor deze stap is het niet het doel hypotheses te ontwikkelen maar een goede beoordeling te kunnen maken ten aanzien van de bijdrage van de twee organisatietheorieën in de verklaring van de initiële groei van academische spin-offs. De grootte van de spin-off heeft een positief significante invloed op de groei van de spin-off en de leeftijd heeft een negatieve invloed.

In de tweede stap zijn de variabelen op basis van de sociaal kapitaaltheorie geanalyseerd. Vier modellen zijn opgesteld, het eerste model toetst de invloed van de dichtheid van het netwerk en de sterkte van de relaties. Het tweede model gaat in op de invloed van het aantal structural holes dat de spin-off en de sterkte van de relaties. Het derde model analyseert de rol van heterogeniteit en de sterkte van de relaties. Deze drie modellen toetsen de volgende hypothesen:

Hypothese 1a. Hoe dichter het externe netwerk van de spin-off, des te groter de initiële groei van de spin-offs (Coleman closure argument).

Hypothese 1a. (alternatief) Hoe meer structural holes in het externe netwerk van de spin-off, des te groter de initiële groei van de spin-offs (Burt structural hole argument).

Hypothese 1b. Hoe meer heterogeniteit in het externe netwerk van de spin-off, des te groter de initiële groei van de spin-offs.

De tweede hypothese, die de invloed van de *structural holes* beschrijft, wordt bevestigd voor de academische spin-offs. Er is een positief significant verband tussen het aantal structural holes in het netwerk van de spin-off en de initiële groei. Met andere woorden, een spin-off kan een concurrentievoordeel behalen door een verbinding te leggen tussen twee netwerken die eerder niet met elkaar verbonden waren. Voor de hypothesen die de dichtheid van het netwerk en de heterogeniteit van het netwerk beschrijven worden geen significante verbanden gevonden.

In alle drie de modellen wordt, naast de invloed van de structurele configuratie van het netwerk, ook de invloed van de sterkte van de relaties geanalyseerd. De sterkte van de relaties wordt weergegeven door de proporties sterke (intensieve) en zwakke (losse) contacten in het netwerk. De literatuur geeft argumenten voor de positieve invloed van zowel de sterke als van de zwakke netwerk relaties. Deze argumenten worden beschreven door onderstaande hypotheses:

Hypothese 1c. Hoe meer sterke contacten in het externe netwerk van de spin-off, des te groter de initiële groei van de spin-offs.

Hypothese 1c. (alternatief) Hoe meer zwakke contacten in het externe netwerk van de spin-off, des te groter de initiële groei van de spin-offs.

In de modellen wordt geen significant verband gevonden voor de invloed van de sterke contacten, noch voor de invloed van zwakke contacten. De sterkte van de contacten in het netwerk heeft dus geen invloed op de initiële groei van spin-off ondernemingen.

Het vierde model gaat in op de rol van de moederorganisatie. De moederorganisatie kan de spin-off ondersteunen door het geven van tastbare ondersteuning in de vorm van financiering, accommodatie en octrooien. Ondersteuning kan ook plaatsvinden door niet tastbare ondersteuning in de vorm van advies en begeleiding ten aanzien van technische en juridische zaken. Daarnaast wordt verondersteld dat een spin-off profijt kan hebben van de overeenkomsten in de activiteiten van de spin-off en de moederorganisatie van de spin-off. De volgende hypotheses zijn hiervoor opgesteld:

Hypothese 1d. Hoe meer tastbare ondersteuning door de moederorganisatie, des te groter de initiële groei van de spin-offs.

Hypothese 1e. Hoe meer niet-tastbare ondersteuning door de moederorganisatie, des te groter de initiële groei van de spin-offs.

Hypothese 1f. Hoe meer overeenkomsten in de activiteiten tussen de spin-off en de moederorganisatie, des te groter de initiële groei van de spin-offs.

Voor de tastbare ondersteuning is een significant negatief verband gevonden en voor de niet-tastbare ondersteuning is een significant positief verband gevonden. Daarmee wordt het tegenovergestelde gevonden van hypothese 1d en wordt hypothese 1e bevestigd. Voor de derde hypothese werd geen significant verband gevonden.

De derde stap in de analyse analyseert de rol van de variabelen op basis van de resource-based theorie. Deze stap behandelt twee modellen. Het eerste model meet de invloed van de kennis, ofwel de *resources* van het startersteam en het tweede model schat de invloed van de vaardigheden, ofwel *capabilities* van het startersteam. Voor de rol van de kennis van het startersteam zijn vier hypotheses geformuleerd:

Hypothesen 2a,b,c,d: Hoe meer management- (2a); industrie- (2b); onderzoek- (2c); starters- (2d) ervaring aanwezig is in het startersteam, des te groter de initiële groei van de spin-offs zal zijn.

Van deze hypothesen wordt een negatief significant verband gevonden voor de invloed van managementervaring en een positief significant verband voor de invloed van starters-ervaring. Industrie- en onderzoekservaring hebben geen significante invloed. In het tweede model van stap drie worden vijf hypothesen op basis van de vaardigheden van het team getoetst. Deze hypothesen zijn als volgt:

Hypothesen 2e,f,g: Hoe meer diversiteit in de tijd dat leden deel uitmaken van het team (2e); in de functies die zij voorheen hadden (2f); in de industrie waarin zij actief waren (2g), des te groter de initiële groei van de spin-offs.

Hypothese 2h: Hoe meer cohesie in het team, des te groter de initiële groei van de spin-offs.

Hypothesis 2i: Hoe meer ondernemersoriëntatie er in het team aanwezig is, des te groter de initiële groei van de spin-offs.

De hypothesen betreffende de vaardigheden van het startersteam worden niet bevestigd voor academische spin-offs. Blijkbaar komen deze vaardigheden bij de leden van het starters team nog niet voldoende tot hun recht, de teams zijn nog te kort bij elkaar en de omgeving van starters is te dynamiek.

Naast de analyse van de hypothesen is in dit onderzoek ook nader ingegaan op de onderwerpen die met verschillende netwerkcontacten werden besproken. Dit deel van het onderzoek had een meer verkennend karakter. Deze analyses zijn gedaan op basis van de informatie die verzameld is bij alle 266 contacten van de 65 academische spin-offs.

Uit de analyses kwam naar voren dat de contacten waarmee een *structural hole* werd gevormd, voornamelijk de zwakke contacten in het bedrijfsnetwerk en de sterke contacten in het persoonlijke netwerk waren. Met deze '*structural hole*'-contacten werden significant minder onderwerpen besproken dan met '*niet structural hole*'-contacten. Met de '*niet-structural hole*'-contacten werd vooral gesproken over de technologie, de organisatie van de spin-off en de middelen die nodig waren voor het opstarten, zoals apparatuur en personeel. De discussies met '*structural hole*'-contacten over de marktsituatie werden als meest belangrijk aangeduid.

Met de contacten in de privé-netwerken werd vooral gesproken over de organisatie en middelen om op te starten, maar weinig over de financiering. Met de contacten in de moederorganisatie werd veelvuldig over de technische- en marktmogelijkheden gesproken. Met de contacten in andere universiteiten werd vooral over de technische details gesproken, terwijl met de contacten in het bedrijfsnetwerk voornamelijk over de marktsituatie werd gesproken. Verder bleek dat de technologieontwikkeling en de middelen om op te starten belangrijk waren in de gesprekken met sterke contacten. Daarentegen werd juist met de zwakke contacten de marktsituatie besproken.

Conclusie en discussie

Het doel van het onderzoek was om inzicht te krijgen in de factoren die de initiële groei van spin-offs bepalen. Op basis van het onderzoek kunnen een aantal duidelijke conclusies getrokken worden. In de analyse van de initiële groei van de spin-offs werden geen significante invloeden geconstateerd voor de verschillende sectoren. Voor een aantal variabelen werd een overeenkomst geconstateerd tussen de spin-offs in de *life sciences* en in *consulting*. De *life sciences* en *consulting* spin-offs waren meer gerelateerd aan de activiteiten van de moederorganisatie en ontvingen meer ondersteuning in vergelijking met de *ICT/ media* spin-offs. Ten aanzien van het netwerk hadden de *life sciences* en *consulting* spin-offs meer heterogene netwerken, met zowel bedrijfscontacten als academische contacten, dan de *ICT/ media* spin-offs.

Kritische succesfactoren

Het netwerk waarin de spin-off opereert, speelt een belangrijke rol in de groei van de spin-off. Indien een spin-off een positie weet in te nemen tussen twee netwerken die niet met elkaar in verbinding staan, kan het voordeel behalen door deze twee netwerken aan elkaar te schakelen en te handelen in de kennis en middelen die aanwezig zijn in die netwerken. In het onderzoek worden deze posities *structural hole* posities genoemd. In praktische zin betekent dit dat, indien een spin-off een contact in het bedrijfsleven weet te koppelen aan de kennis uit de kennisinstelling, het een profijtelijke positie weet op te bouwen. Uit het onderzoek blijkt verder dat deze relaties veelal over de mogelijkheden van de spin-off in de markt gaan.

Een andere bevinding is dat de rol van de moederorganisatie een belangrijke invloed heeft op de initiële groei van de spin-off. De moederorganisatie wordt beschouwd als een sterke relatie die specifieke kennis en ondersteuning kan bieden. Echter, de resultaten laten zien dat tastbare ondersteuning in de vorm van bijvoorbeeld laboratoriumruimte, financiering en intellectueel eigendom, een belemmering kan betekenen voor de groei van spin-offs. Deze ondersteuning houdt de spin-offs klaarblijkelijk te dicht bij de moederorganisatie, waardoor de spin-off teveel intern georiënteerd blijft. Zoals al eerder is gemeld gaat de spin-off over van een academische omgeving naar een bedrijfsomgeving. Als gevolg daarvan worden andere eisen gesteld aan de kennis en vaardigheden van het startersteam en aan de middelen die nodig zijn voor het opstarten. Met andere woorden, de werkomgeving van de spin-off verandert, en dientengevolge moet ook het netwerk van de spin-off veranderen. Indien de spin-off te dicht bij de moederorganisatie blijft, zal het netwerk niet voldoende veranderen en zal de spin-off niet in staat zijn voldoende vernieuwing aan te brengen in de kennis, vaardigheden en middelen die het nodig heeft om in een bedrijfsmatige omgeving te kunnen opereren. Daarnaast komt uit de interviews naar voren dat de tastbare ondersteuning in de vorm van financiering en accommodatie een belemmering vormen omdat het voor andere ondernemingen niet duidelijk maakt in hoeverre de spin-off los staat van de moederorganisatie. Uit de interviews bleek echter wel dat het hebben van intellectueel eigendom door veel spin-offs ervaren wordt als een garantie voor succes. Hierdoor staat men vaak niet voldoende open voor ideeën uit de markt en houdt men teveel vast aan het intellectueel eigendom. De bevinding dat tastbare ondersteuning geen positieve bijdrage heeft, impliceert een managementprobleem. Managers in spin-off programma's en spin-off

ondernemers dienen zich bewust te zijn van deze mogelijke bijeffecten en moeten waar mogelijk hier een oplossing voor vinden.

De niet-tastbare ondersteuning heeft wel een positieve bijdrage voor de groei van academische spin-offs. Deze vorm van ondersteuning betreft de begeleiding en adviezen op technologisch, administratief, organisatorisch en juridisch gebied. Kennis over deze onderwerpen is vaak niet aanwezig bij het startersteam. Daarnaast kan deze vorm van niet-tastbare ondersteuning de spin-off helpen bij de focus op de kernactiviteiten: het vertalen van academische kennis naar een commerciële toepassing.

De resultaten van onderzoek laten verder zien dat starterservaring van groot belang is bij het opstarten van een spin-off. Indien een lid van het startersteam voorheen al eerder betrokken is geweest bij het opstarten van een onderneming is hij beter in staat de groei te managen. De persoon met starterservaring weet hoe obstakels in het groeiproces genomen moeten worden en weet wanneer deze obstakels te verwachten zijn. Managementervaring daarentegen blijkt geen positief effect te hebben op de initiële groei van spin-offs. Managers zijn geneigd de activiteiten strak te organiseren en bouwen daarmee onvoldoende flexibiliteit in. Omdat voor managementervaring in beginsel wel een positief effect is te verwachten, blijkt ook hier een bedrijfskundig probleem te liggen. Ondernemers van spin-off ondernemingen dienen zich bewust te zijn van de activiteiten die belangrijk zijn bij het sturen van de groei van een spin-off onderneming. In bepaalde situaties kunnen management vaardigheden wel een positieve bijdrage leveren, terwijl in andere situaties de management vaardigheden niet van toepassing zijn.

De eigenschappen van het spin-off startersteam in termen van diversiteit, samenhang van het team, en ondernemersoriëntatie komen niet naar voren als belangrijke factoren die de groei van een spin-off bepalen. Uit de interviews kwam naar voren dat startende spin-offs veel verandering ondervinden van buitenaf en intern verandert het team ook sterk. Men is vaak recentelijk bij een spin-off betrokken, terwijl de samenwerkingsvaardigheden juist de neiging hebben zich te ontwikkelen over langere tijd.

Onderzoeksvragen

De bevindingen van de kritische succesfactoren die de initiële groei van spin-offs bepalen, hebben naast een praktische relevantie ook een theoretische relevantie. Ten aanzien van de eerste theoretische onderzoeksvraag die de invloed van de *sociaal kapitaaltheorie* vergelijkt met de invloed van de *resource-based view*, blijkt dat beide theorieën in een belangrijke mate de initiële groei van spin-offs bepalen. Theoretisch beargumenteren de theorieën de groei op een andere manier en empirisch is dit onderscheid ook te maken. De sociaal kapitaaltheorie benadrukt de rol van het netwerk terwijl de resource-based view de rol van de kennis en vaardigheden van de spin-off benadrukt om de initiële groei te verklaren. De analyse van de invloed van het aantal *structural holes* en de rol van de moederorganisatie laat zien dat er een significante bijdrage is op basis van de sociaal kapitaaltheorie. Op basis van de resource-based view is een significante bijdrage gevonden voor de rol van starterservaring en managementervaring. Verder blijkt uit de analyses dat een combinatie van de twee theorieën, de verklaring van de initiële groei versterkt. Hiermee suggereren we dat de twee theorieën geen rivaliserende theorieën zijn, maar elkaar aanvullen in de verklaring van de initiële groei van academische spin-offs.

De tweede theoretische onderzoeksvraag analyseert de relaties die voordelig en nadelig zijn voor de initiële groei van academische spin-offs. De resultaten laten zien dat *strutural hole* relaties belangrijk zijn bij het vinden van een businessidee en bij de financiering van de spin-off. Deze *structural hole* relaties zijn veelal bedrijfs- en privé-contacten. Met contacten uit de moederorganisatie wordt voornamelijk gesproken over de technologie en de mogelijkheden van de academische kennis op de markt. De relaties met de moederorganisatie zijn veelal sterke relaties, net als de relaties met de personen in het privé-netwerk. De bedrijfscontacten zijn vaak relaties die van tijdelijke aard zijn.

Het onderzoek heeft de interne en externe factoren geanalyseerd, die van invloed zijn op de initiële groei van academische spin-offs. Het hebben van een open netwerk, starterservaring in het startersteam en ondersteuning in de vorm van advies en begeleiding helpen een spin-off eerder te groeien. Het hebben van managementervaring in het startersteam en de tastbare ondersteuning, in de vorm van accommodatie, financiering en intellectueel eigendom, hebben tegen de verwachting in vaak een belemmerende werking op de groei van een spin-off. De werking van managementervaring en tastbare ondersteuning verdienen daarom bij managers van spin-off programma's en ondernemers van academische spin-offs meer aandacht, en geven voor academici aanleiding voor vervolgonderzoek.

ABOUT THE AUTHOR

Victor Scholten was born in Brielle, the Netherlands on 9 January 1973. In 1996 he received his BSc in aeronautical engineering from a polytechnic institute in Haarlem. During his studies there he became fascinated with the complexities of aeroplanes and the many sub-contractors involved in the design and development of aircraft. This coordination and collaboration with sub-contractors inspired him to study Business Administration at Erasmus University in Rotterdam. Initially, his interest was in strategic management and in outsourcing issues but later it developed into an interest in full-service companies and intra/entrepreneurship. In June 2000, Victor Scholten received his MSc in strategic management from the Rotterdam School of Management at Erasmus University, Rotterdam. His MSc thesis was about high-tech spin-offs and their contribution to regional growth in Eindhoven. The study caught the attention of the Department of Business Administration in Wageningen, where he enrolled as a PhD student. The topic of the present thesis continues on from his MSc project and is entitled 'The Early Growth of Dutch Academic Spin-offs in the Life Sciences, ICT and Consulting'. Victor Scholten is currently working as an assistant professor in the Department of Strategic Management and Business Environment at the Faculty of Business Administration at Erasmus University, Rotterdam.

TRAINING AND SUPERVISION PLAN

Description	Institute	Year	Credits
General courses:			
NOBEM, Research Methodology	Erasmus University Rotterdam and Groningen University	2002	*10*
Problem Solving Research Methods	Henley Management College, Henley-on-Thames, Oxfordshire, England	2000	*3*
Multi-disciplinary courses/activities:			
Multi-disciplinary seminar	*Mansholt Graduate School, Wageningen, The Netherlands*	2004	*1*
Discipline-specific courses:			
Seminar on Supply Chain Management	*Mansholt Graduate School, Wageningen, The Netherlands*	2000	*3*
Seminar on International Entrepreneurship	GeorgiaTech, Atlanta, Georgia US	2001	*1*
Seminar on Entrepreneurship	Norwegian School of Management BI, Sandvika, Norway	2001	*2*
Presentations at international conferences:			
Babson Kauffman Entrepreneurship Research Conference, May 2004, Strathclyde, Scotland.		2004	*1*
European Summer University 2004, Twente, Enschede, The Netherlands		2004	
12th International Conference on High-Technology Small Firms, May 2004, TU Twente, Enschede, The Netherlands		2004	
Sunbelt Conference No.XXIV, May 2004, Portoroz, Slovenia.		2004	*1*
Research in Entrepreneurship (RENT) Conference No. XVII, November 2003, Lodz, Poland		2003	
Research in Entrepreneurship (RENT) Conference No. XVII, November 2003, Lodz, Poland		2003	
Research in Entrepreneurship (RENT) Conference No. XVI, October 2001, Barcelona, Spain		2001	
Research in Entrepreneurship (RENT) Conference No. XV, November 2001, Turku, Finland		2001	
5th World Congress on Intellectual Management, January 2001, Hamilton, Canada		2001	
Teaching activities:			
Bachelorprojecten over Leiderschap	Vrije Universiteit Amsterdam	2005	
Technopreneurship and Strategic positioning	Universiteit Leiden	2005	
Entrepreneurship and Intrapreneurship in the Life Sciences II	Wageningen Universiteit	2004	
Entrepreneurship and Intrapreneurship in the Life Sciences I	Wageningen Universiteit	2001	
Case studies Innovatief Ondernemerschap	Wageningen Universiteit	2001	
Innovatief Ondernemerschap	Wageningen Universiteit	2000	
Total (min. 20 credits)			**22**