Networks and entrepreneurial behavior: Exploring their impact on the realized absorptive capacity as academic spin-offs grow older

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EXECUTIVE SUMMARY

The increasing importance of technological knowledge for regional and innovational systems of economic development triggered the emergence of academic entrepreneurship. Mainly, the academic entrepreneurship is expressed by the founding of academic spin-offs, whose purpose is to make profits by commercializing university technological knowledge. As these spin-offs are newly established, they lack several types of resources critical for their growth and survival. From the resource based view of the firm and the social capital theory, knowledge coming from external environment is a resource that has been proved to have influence on the academic spin-offs growth.

This important for survival knowledge, is acquired mainly by the spin-offs through networks. Thus, networks and the ability of spin-offs to integrate and utilize knowledge from the external environment, the so called absorptive capacity is of great importance for their growth. At the same time, academic spin-offs should be engaged in entrepreneurial activities in order to effectively exploit resources and seize entrepreneurial opportunities. This conduct of alertness is known as entrepreneurial behavior and in the present study is described as the spin-offs innovativeness, proactiveness and risk taking and the entrepreneur's belief that a group can perform successfully all the entrepreneurial activities needed for survival.

Although networks are critical for the survival of spin-offs, contradictory results exist so far regarding the way they develop to support spin-offs. Moreover, as networks are the means of the knowledge incoming flows to spin-offs, little is known about the relation between networks and the ability of the firm to utilize knowledge. Moreover, the relation of the firms' entrepreneurial behavior seems to be related to the absorptive capacity of the firm. However, there is no literature so far that tries to unveil this relation. For this reason, the present thesis is exploring the development of academic spin-off networks as they are growing older, regarding its relational characteristics. To be more specific, the content of this study concerns how networks ties and networks contacts background of academic spin-offs progress as they age. Additionally, the concept of realized absorptive capacity is explored and the impact of entrepreneurial behavior and this network development on it. Last but not least, the concept of realized absorptive capacity is explored in order to realized how is it developed as spin-off grow older and whether there is a moderating effect of the spin-off age to the relation between networks and realized absorptive capacity.

In order to shed light to these relations the following research questions were answered:

"How do the networks of academic spin-offs develop as they grow older and what is the impact of entrepreneurial behavior, network development and spin-off age on their realized absorptive capacity?"

and the respective sub-questions:

SQ1: How are the networks related to academic spin-offs and how do they develop as spin-offs are getting older?

SQ2: How are the networks related to the realized absorptive capacity?
SQ3: How is the entrepreneurial behavior related to the realized absorptive capacity of academic spin-offs?

SQ4: How does the realized absorptive capacity develop as spin-offs are getting older and what is the impact of spin-offs age to the relation between networks and realized absorptive capacity?

The exploratory research employed though quantitative analysis based on data collected in 2011 which are related to the academic spin-offs located in Delft and in Wageningen and have been emerged from TU Delft and Wageningen University respectively. Because of the limited number of observations, the quantitative research is divided in two main statistical models. The first one is employed with bivariate correlations and the second one with multiple regression analysis.

Results suggested that there is strong and negative relation between the strength of ties and the sponsorship-based relations with the academic spin-off age and a strong and positive relation with the realized absorptive capacity. Moreover, entrepreneurial behavior of spin-off has found to be a strong predictor of realized absorptive capacity. Particularly, entrepreneurial orientation and entrepreneurial team efficacy, the two components of entrepreneurial behavior in this study have been proved to have a strong and positive relation to the realized absorptive capacity. Last but not least, the academic spin-off age has strong and positive relation with the realized absorptive capacity, whereas it also has a moderating effect to the relation between sponsorship-based relations and realized absorptive capacity. The impact of the first one to the ability of the firm to transform and exploit knowledge is getting negative when the age of spin-offs is involved.

These findings have both academic and managerial implications. They provide insights to the contradictory results in the literature regarding the development of networks as spin-offs grow and new knowledge regarding the relation between networks and realized absorptive capacity. Last but not least, they shed light to the unexplored field of entrepreneurial behavior in terms of relation with the realized absorptive capacity. These findings increase the awareness of entrepreneurs about the influence of their contacts on their ability to exploit knowledge whereas deepens their understanding on the way they should operate in order to optimize knowledge utilization. Last but not least, findings of this thesis provide beneficial knowledge to incubator managers and policy makers.

Even though this study has its limitations and it is far from flawless, it can be claimed that this study has fulfilled its initial purpose; to improve the knowledge regarding networks, absorptive capacity and entrepreneurial behavior for academic spin-offs. It contributes to the literature with the novel knowledge and suggests research on the field of academic entrepreneurship that so far was somehow neglected.
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INTRODUCTION

1.1 Background
The evolution of technology in combination with the currently high educational systems worldwide fosters a constant increasing number of start-ups to emerge in the entrepreneurial ecosystem. Many universities, corporations and individuals are founding new ventures in order to commercialize high technology services and products. However, these newly established companies are characterized by considerable lack of resources and capabilities, which are critical for their growth (Lechner et al., 2006). As typically mentioned by Vohora et al. (2004), “the novelty of these established companies and the lack of the entrepreneurs experience, give rise to the liability of newness” which refers to the constraints that start-ups have to overpass at the early stage of growth and become an established company in the market (Brüderl and Preisendörfer, 1998; Vohora et al., 2004; Lechner et al., 2006).

This issue is particularly pertinent to start-ups that emerge from an academic environment by founders without business skills, the so called academic spin-offs (Pirnay et al., 2003; Khodaei et al., 2014).

But how can academic spin-offs overcome their growth issues? How do they grow and turn into well-established companies in the market? Emerging firms are relying on their networks in order to acquire the resources needed (Brüderl & Preisendörfer, 1998). Various studies highlighted the importance of networks in entrepreneurship (Birley, 1985; Johannisson, 1988; Hite and Hesterly, 2001; Elfring and Hulsink, 2003; Greve and Salaff, 2003; Soetanto and van Geenhuizen, 2010). It has been either proposed or found that the entrepreneurial networks are contributing to the acquisition of resources for sustainable competitive advantage.

But as academic spin-offs are growing, their business needs of new resources and information are changing. As a result, these continuously changing business needs are forcing the development of their networks. The development of the academic spin-off networks refers to changes for, both their relational and structural characteristics, in which firms adapt and align their networks to gain critical resources for survival (Hite and Hesterly, 2001).
However, academic spin-offs should be engaged in entrepreneurial activities in order to effectively exploit resources and seize entrepreneurial opportunities (Barney et al., 2001; Simsek et al., 2003) that are available through networks. This conduct of alertness is called entrepreneurial behavior (Shane and Venkataraman, 2000; Kuratko et al., 2005) and it is described by the spin-offs innovativeness, proactiveness and risk taking (Lumpkin and Dess, 1996), and the entrepreneur’s belief that a group can perform successfully all the entrepreneurial activities needed for survival (Durham et al., 1997).

At the same time, one of the key resources for academic spin-offs’ growth is the knowledge from the external environment (Tsai, 2001, Grant, 1996; Zahra et al., 2009). Based on the social capital theory and the resource based view of the firm (Lee, et al, 2001), knowledge coming from the external networks is considered to be a prime resource that affects start-ups growth. These dynamic networks are contributing to the learning of the academic spin-offs and the issue of the academic spin-offs absorptive capacity arises, as it represents the skills and the knowledge of the organizations to exploit and integrate knowledge from the external environment (Cohen & Levinthal, 1990; Zahra and George, 2002). The routines involved in the concept of the realized absorptive capacity are related to the structural and the relational embeddedness of the academic spin-offs to the networks (Zahra and George, 2002; Ebers and Maurer, 2014). Thus, the realized absorptive capacity determines the degree of knowledge utilization by the academic spin-off from the evolving networks, which consequently affects their growth.

1.2 Problem identification

After the increase of start-ups foundation in the entrepreneurial environment, intensive research is employed in the entrepreneurial field. There are many studies whose purpose is to shed light to the way newly founded firms, like the academic spin-offs are embedded in their networks and how these networks develop as they grow older. At the same time, other studies have tried to clarify the concept of entrepreneurial behavior, which is important for the effective exploitation of resources available in these networks. At the same time, there are studies that have analyzed the contribution of the absorptive capacity to the growth of firms (Zahra and George, 2002). Despite the extensive literature regarding these concepts though, there are still knowledge gaps that should be explored. These gaps are presented in Table 1.

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Table 1: Knowledge gaps of the present literature

The first gap of knowledge in the literature so far is concerning the development of networks for academic spin-offs from the relational perspective, which refers to the nature of relations of
academic spin-offs with external networks (Granovetter, 1973). There are many studies that tried to unveil the background mechanisms of the development of relations. But so far, there are opposing findings that describe the development of spin-off networks regarding this perspective (Hite and Hesterly, 2001; Elfring and Hulsink, 2007). There are studies which support that spin-offs are mainly operating within networks with strong ties during the emerging phases, whereas ties are getting weaker in later phases (Hite & Hesterly, 2001; Soetanto & van Geenhuizen, 2010; Stam et al., 2014). On the other hand, there are studies which suggest that weak ties are developing during the emerging phase (Steier and Greenwood, 2000) and strong ties after the establishment of the firm (Greve and Salaff, 2003). From the relational perspective, besides strength of ties, the background of contacts involved in networks has been also highlighted. The embeddedness in different clusters of information is essential for instrumented entrepreneurial activities (Granovetter, 1973; Renzulli et al., 2009) and it has been proposed to stimulate the knowledge transfer (Reagans and McEvily, 2003). Lechner et al. (2006) analyzed the different types of networks (social, reputational etc.) that stimulate small firm performance. Moreover, the importance of networks contacts background has been stressed in numerous studies (McEvily and Zaheer, 1999; Reagans and McEvily, 2003; Rodan and Galunic, 2005; Stam et al., 2014). However, it is not clear so far how the networks backgrounds are changing as spin-offs firms are growing older and even more for spin-offs founded in university environment.

Thus, the academic spin-off networks are evolving throughout their growth and they affect the type of resources they acquire through them. Especially for knowledge, academic spin-offs should have advanced absorptive capacity to integrate efficiently external knowledge obtained by the networks (Gilbert et al., 2008; Yli-Renko et al., 2001; Reagans and McEvily, 2003). This ability to integrate external knowledge will give the academic spin-offs the potential to learn, identify new entrepreneurial opportunities and gain first mover advantages (Khodaei et al., 2014). There are various studies that try to unveil the favorable conditions for absorptive capacity stimulation. Some studies underline the benefits that derive from absorptive capacity and its importance for the small entrepreneurial firms (Deeds, 2001; Gray, 2006; Muscio, 2007; de Jong and Freel, 2010; Zahra et al., 2009) and still others the connection of absorptive capacity with the firm embeddedness described above (Gilbert et al., 2008; Yli-Renko et al., 2001; Rindfleisch and Moorman, 2001; Reagans and McEvily, 2003; Wu and Chen, 2012; Ebers and Maurer, 2014). However, there is no research so far that examines the impact of relational embeddedness to the realized absorptive capacity for small firms and even more for spin-offs that emerged from academic settings. This indicates the second knowledge gap that this study will attempt to fill.

At the same time, for the efficiently exploitation of knowledge coming from external networks, specific behavior that fosters this process should be adopted by the entrepreneurial team. However, there is limited literature concerning knowledge and entrepreneurial behavior. Li et al. (2009) describes the relation of entrepreneurial orientation and the processes of creating new knowledge, whereas Keh et al. (2007), highlights the interaction of entrepreneurial orientation and utilization of knowledge. However, there is no published literature so far that touches upon the relation of realized absorptive capacity and entrepreneurial behavior and even more specifically for academic spin-offs. Besides the working paper of Khodaei et al., (2014) which unveils the antecedents of absorptive capacity for academic spin-offs, it seems to be a knowledge gap regarding the relation of entrepreneurial behavior and the realized absorptive capacity. Accordingly, this fact indicates the fourth knowledge gap of the present study.
Taking into account the second knowledge gap, there is much space for exploration of the realized absorptive capacity in academic spin-offs setting. For this reason, the role of the academic spin-off age will be explored regarding the networks and the realized absorptive capacity. As mentioned earlier, there is limited literature that deals with the realized absorptive capacity for small firms. There is no study found so far, that examines the development of the realized absorptive capacity as the spin-offs are getting older, which means the ability of the firm to transform and exploit knowledge as it ages. Under the same principle, there is no literature so far that examines the relation of networks and the realized absorptive capacity as the firms are getting older. Thus, the fourth knowledge gap is related to the spin-off age with the realized absorptive capacity and the possible moderating role of the age to the relation between the networks and the realized absorptive capacity.

From the four knowledge gaps presented above, the problem that the present study is dealing with can be stated as:

> It is unclear from the academic literature so far, how the networks ties and the networks contact background of academic spin-offs change as they grow older and what is the relation of the networks on their realized absorptive capacity. Moreover, it is unknown whether the entrepreneurial behavior is related to the realized absorptive capacity and whether there is an impact of the spin-off age either directly to the realized absorptive capacity or to the relation with the networks and the realized absorptive capacity.”

### 1.3 Relevance

The investigation of the networks, the entrepreneurial behavior and the realized absorptive capacity for academic spin-offs will have various implications both to the academic and managerial world.

As far as the academic world is concerned, the results of the present research will provide interesting insights about the way networks are adapting to the needs of academic spin-offs. To be more specific, as the field of entrepreneurship is advancing, insights regarding the networks development for academic spin-offs will be helpful to clarify this phenomenon, as there are contradictory results so far. Moreover, the benefits of the entrepreneurial networks and realized absorptive capacity are well known so far. There is vast literature that touches upon these two concepts and highlights the importance of knowledge for firm performance. However, as there are no many studies relating these two, a combinative exploration of them will be interesting, as it will unveil the dynamics of this relation. Moreover, the investigation of the entrepreneurial behavior, not only under the opportunities recognition perspective but also and the better exploitation of knowledge through networks, will give beneficial understanding about the way the entrepreneurial behavior is related to the realized absorptive capacity. Last, but not least, an exploratory analysis on the impact of academic spin-off age to the realized absorptive capacity and to its relation with the networks, will shed light to the way spin-offs are utilizing knowledge throughout the different stages of growth, whereas it will unveil the dynamics of the relation between the networks and the realized absorptive capacity. To sum up, the results of the present study will induce to the broadening of the knowledge basis for academic spin-offs. Especially nowadays, with the increasing foundation of spin-offs and the
entrepreneurial activities in general, the knowledge derived from this research will be beneficial for the society as well.

Having a better understanding on the mechanisms that operate behind the aforementioned concepts, the proposed research will have managerial implications as well. By this research, it will become clear how networks can be most beneficial throughout the growth of academic spin-offs. Being aware of the numerous benefits that the networks offer, especially from the relational perspective, it will be advantageous to spin-offs to develop managerial strategies. These strategies can be related to network characteristics that will be helpful to exploit the resources and especially knowledge, to the highest level. Moreover, investigating the possible relation between development of networks throughout growth with the transformation and exploitation of knowledge, it will provide insights to academic spin-off management to tackle their networks in a favorable way for knowledge integration. Under the same principle, having a deeper understanding of the relation of entrepreneurial behavior with the realized absorptive capacity, spin off management teams can adopt specific conduct that will be favorable for the integration of the new knowledge. Last but not least, insights regarding the relation between networks and realized absorptive capacity, as the spin-offs are growing older,

Thus, when academic spin-off management is conscious about the interrelation of realized absorptive capacity with network relational characteristics and entrepreneurial behavior they will increase the possibility to utilize external knowledge and consequently the possibilities of growth and survival.

1.4 Research questions

During this research, the gaps indicated above in the literature will be addressed by analyzing the development of the academic spin-off networks as they are growing older. Moreover, it will be examined the relation of networks characteristics and entrepreneurial behavior with the realized absorptive capacity. Thus, the research topic can be expressed as the following main research question:

"How do the networks of academic spin-offs develop as they grow older and what is the impact of entrepreneurial behavior, network development and spin-off age on their realized absorptive capacity?"

In order to answer the main research question, four additional sub-questions should be answered in advance, corresponding to the main knowledge gaps presented above. All four of them will be answered through extended literature review in the beginning and then through analysis with empirical results later on. The main research questions and the sub-questions of this study are depicted in Figure 1, whereas the description of the sub questions follows.

SQ1: How are the networks related to academic spin-offs and how do they develop as spin-offs are getting older?

The answer to this question aims to provide insights about the way networks develop in terms of relational characteristics, as the spin-offs are growing older. In order to find answer to this question a review on the existing literature will be conducted. The definitions and characteristics of networks
and academic spin-offs will be given to have a deep understanding of these concepts, whereas the way the networks are involved in entrepreneurship for small firms will be included. Moreover, the literature review will include the major studies related to development of firms networks. Having defined the theoretical frameworks of the development of networks and the various proposals and results so far, an empirical analysis will follow. The relational characteristics of the networks will be examined as spin-offs are ageing. Based on these results, interesting recommendations will be given both for the academic and managerial settings.

Figure 1: The research questions

SQ2: How are the networks related to the realized absorptive capacity?

The second research sub-question is about the relation between networks and realized absorptive capacity. In the beginning, an extended ligature review will be conducted in order to define the concept of the absorptive capacity. This review will provide insights to grasp what the absorptive capacity is and how it determines the ability to integrate external knowledge within the organizational environment. At this point, it should be mentioned that there is a difference between the absorptive capacity and the realized absorptive capacity mentioned above. The latter is one of the dimensions of the overall absorptive capacity. However, discussing solely about the one dimension would be insufficient and rather odd. For this reason, a literature review first for the overall absorptive capacity will be given. After examining the absorptive capacity, the connection of this concept with the networks will be examined through quantitative analysis. The quantitative analysis will increase the perception of the relation between the networks and the realized absorptive capacity, as it depicts part of the real world.
SQ3: How is the entrepreneurial behavior related to the realized absorptive capacity of academic spin-offs?

The third sub-question is about the relation of the entrepreneurial behavior and the realized absorptive capacity. In the beginning, an extended literature review will define the concept of entrepreneurial behavior and its main characteristics. As far as the relation of this concept with the realized absorptive capacity is concerned, there is limited literature that examines this topic. However, being already aware of the main characteristics of these two concepts, a proposed relation will be given. This relation will be examined with empirical data used for the present study.

SQ4: How does the realized absorptive capacity develop as spin-offs are getting older and what is the impact of spin-offs age to the relation between networks and realized absorptive capacity?

Answering the fourth sub-question of the present study, interesting insights regarding the study of the realized absorptive capacity and its relation with the networks for the academic spin-offs as they grow will be provided. To be more specific, the development of the realized absorptive capacity will be examined, throughout the various ages of spin-offs included in the empirical data. Thus, a depiction of the real world will be provided in order to gain deep understanding of the realized absorptive capacity for the academic spin-offs as they age. Moreover, the potential effect of ageing to the relation between the networks and the realized absorptive capacity will be examined. Based on the literature and the relation of the networks and the realized absorptive capacity, the moderating effect of the spin-off age will be empirically explored. Thus, this study will provide a better overview of the main relations as the academic spin-offs grow older.

The way the main concepts are interconnected will be examined both with literature review and analysis of empirical data. A generic model that depicts the under analysis interrelations is depicted in Figure 2.
1.5 Structure
In the present chapter, the background, the problem identification and the relevance of this research was presented, whereas the research questions provided gave an overview of the research context. This context is divided in five additional chapters. The second chapter contains an extended literature review, giving the definitions and characteristics of the main research concepts and insights in order to provide answers to the first four research questions. The third chapter provides a clear overview of the conceptual model emerged from the literature review. The relations of the research concepts and the hypothesis that will be tested are included. In chapter four, the methodology of the research is described, including the description of research methods and empirical data that will be used. The fifth chapter describes all the results emerged from the analysis of the hypotheses provided in chapter three and under the methodology described in chapter four. Last but not least, chapter six provides the conclusions drawn from the aforementioned analysis. As in all research studies, the limitations, reflections and suggestions for further research are also provided in the end of the report.
LITERATURE REVIEW

2.1 Introduction
This chapter is a review of the current literature, relevant to the main research concepts. As stated in the previous chapter, the focus of this research is the networks of academic spin-offs as they grow older and the impact of these networks changes and the entrepreneurial behavior on their absorptive capacity.

Thus, in order to fully grasp the concepts that the present thesis are dealing with, the academic spin-off will be discussed. Being aware of the main research concepts, the placing of the thesis to the theory is essential. As networks are used by the academic spin-offs to gather different types of resources that are missing, the resource-based view of the firm and the social capital theory will be discussed. Following, the definition of networks with their main characteristics will be given, whereas various resources and benefits that derive from the networks will be discussed. Later on, a discussion of the entrepreneurial behavior, which is embedded in networks will shed light on the attitude of exploiting network resources. Last but not least, an extended literature review on the absorptive capacity will be presented, in order to gain a detailed overview of the way networks and entrepreneurial behavior can affect the academic spin-off absorptive capacity.

2.2 Academic spin-offs
The evolution of technology in conjunction with the currently high educational systems worldwide enables a constant increasing number of start-ups to emerge in the entrepreneurial ecosystem. As argued by Etzkowitz (1998), universities are integrating stimulation of the economy as part of their mission. Thus, more and more companies, universities or independent individuals with bright ideas are founding new ventures in order to commercialize high technology services and products in niche markets (Powers and McDougall, 2005; Vohora et al., 2004, Walter et al., 2006).

In many countries, including Europe, North America and Asia, academic spin-offs are the core of many public policies for the stimulation of national and local economies (Wright et al., 2006; van Geenhuizen and Soetanto, 2009) by creating profits from the commercialization of research (Vohora et al., 2004). Although relations of the academic world to the commercial one existed long time ago, university research did not act as leverage to the economy till the World War II (Powers and
McDougall, 2005). Later on, in the 1960’s an increasing number of academic spin-offs started emerging in North America and especially in Palo Alto California, from the Stanford University (Smilor et al., 1990). Especially in the 1980s, there was a remarkable increase in university entrepreneurial activities, like spin-offs and licensing (Powers and McDougall, 2005).

As has been already mentioned, local economy stimulation can be employed by the foundation of academic spin-offs; but in order to have a better understanding of the mechanisms behind academic spin-offs, a clarification through the definition is needed. Throughout the literature, there are many definitions for academic spin-offs and even more terms that describe them. One general and broad definition was proposed by Smilor et al. (1990) which determines the academic spin-off as a firm with “(1) the founder as a faculty member, staff member, or student who left the university to start a company or who started the company while still affiliated with the university; and/or (2) a technology or technology-based idea developed within the university”. Another definition suggested by Wright et al. (2006) identifies academic spin-offs “as a start-up company whose formation is dependent on the formal transfer of intellectual property rights from the university and in which the university holds an equity stake”. Still another definition by Walter et al., (2006) describes the academic spin-offs as “business ventures that (1) are founded by one or more academics who choose to work in the private sector (at least part-time), and (2) transfer a core technology from the parent organization”.

Even though a lot of research has been conducted, there is no clear definition so far. This means that academic spin-offs is a fuzzy concept with various scientific perspectives. As stated by Pirnay et al., (2003), there are around ten definitions in the literature that attempt to describe academic spin-offs, but none of them are defining them with clarity. In the thesis, the generalized definition of Pirnay et al., (2003) combined with the definition given by van Geenhuizen and Soetanto (2009) is adopted.

As mentioned above, besides the entrepreneurship purpose of formation of academic spin-offs, academic spin-offs are stimulating the local economies. They are a mean for technology transfer (Walter et al., 2006), source of employment and way to strengthen relationships within local business communities (Pérez and Sánchez, 2003; van Geenhuizen and Soetanto, 2009). The relationships among local businesses are getting closer, as most of the times, academic spin-offs are operating within clusters, the so called incubators (Hackett and Dilts, 2004). The incubators are organizations, designed to accelerate the growth of newly founded firms by providing them support through resources and services (National Business Incubation Association, 2009). These incubators provide embeddedness to knowledge clusters, which has been found to affect the performance of the firms operating in them (Gilbert et al., 2008). In other words, the effects of networks for knowledge diffusion have been recognized by the present policies. The general way networks are contributing to the success of start-ups and to entrepreneurship in general is described in following sections.

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1 Throughout the academic literature there are multiple terms to address a newly founded firm that emerges from an academic environment. Pérez and Sánchez (2003) have used the term ‘university spin-off’; Vohora et al. (2004) and Wright et al. (2006) have used the term ‘university spin-out’; van Geenhuizen and Soetanto (2009) have used the term ‘academic spin-off’. Throughout this thesis, the academic spin-off term will be used.
2.3 Theoretical perspectives

As the survival and success of academic spin-offs rely on the ability of the firm to exploit their external networks to find appropriate resources (Birley, 1985; Johannisson, 1988; Hite and Hesterly, 2001), the resource-based view of the firm and the social capital theory are of great importance for the understanding of background mechanisms. For that reason, the theoretical framework of the thesis is placed within these theories as they both describe the importance of resources which acquired through networks.

2.3.1 The resource-based view of the firm

The resource-based view of the firm is one of the most important theoretical perspectives of the strategic management (Noteboom et al., 2007) and has received considerable attention that last years in the fields of strategic management and entrepreneurship (Powers and McDougall, 2005). This theory considers companies as a bundle of resources that affect their competitive advantage (Wernerfelt, 1984; Barney, 1991) and, by implication their overall performance (Wernerfelt, 1984; Barney, 1991; Lee et al., 2001). As stated by Wernerfelt (1984), this theory is based on the seminal work of Penrose (1959), which till then was neglected because of the difficulty of including non-numerical resources in models, such as the technological skills.

Additionally, other authors suggested that the resource-based view of the firm highlights the fact that resources are owned and controlled by the firm. The rarer, more inimitable and non-substitutable these resources are, the greater the chances for firms to gain strong competitive advantage (Gulati et al., 2000; Barney 1991). These resources are mainly developed or acquired by the firm's external networks (Gulati et al., 2000). The relevance of the networks to the resource-based view of the firm was also highlighted by Lavie (2006). The focus of this study, compared to the one of Barney (1991), is mainly steered to the relations within a network rather than the nature of resources. Particularly, Lavie (2006) suggested that the nature of the relations may matter more than the nature of the exchanged resources themselves.

But what can be considered as a resource and why is it that critical for the competitive advantage of a firm? The resources of a firm can be either tangible or intangible assets, and provide to firms the skill to implement their strategies (Barney, 1991). The firms' resources can be assets, capabilities, organizational processes, firms' specific attributes information or knowledge. Most of the time in real life, these resources are coming from the firm's social networks and usually these networks themselves can be considered as inimitable and non-substitutable resources (Gulati et al., 2000). The resources coming from the networks are called network resources and derive from the embeddedness of firms in networks and explain their strategic behavior in alliances (Gulati, 1999; Ahuaj, 2000).

To sum up, the resource-based view of the firm is the theory that deepens to the analysis of resources to accommodate and sustain competitive advantage and consequently survival and success for firms (Wernerfelt, 1984; Barney, 1991; Lee et al., 2001), like the academic spin-offs. This theory describes resources as the main attributes which has been proved to be significant for a company and emphasizes firm idiosyncratic resources, especially resources that reside within organizations. Especially for spin-offs, the resource-based view of the firm suggests that entrepreneurial strategies should be pursued for the accumulation of intangible resources for survival or growth (Lee et al., 2001), which consequently form the main predictors and determinants of their performance (Powers and McDougall, 2005).
2.3.2 The social capital theory
As has been already mentioned, newly founded firms like academic spin-offs are relying on social networks to acquire essential resources for survival (Birley 1985; Johannisson, 1988; Brüderl and Preisendörfer, 1998; Hite and Hesterly, 2001; Yli-Renko et al., 2001; Inkpen and Tsang, 2005; McEvily and Marcus, 2005; Witt, 2004; Lechner et al., 2006; Elfring and Hulsink, 2007; Stam et al., 2014). One of these resources is knowledge (Tsai, 2001, Grant, 1996; Zahra et al., 2009). The degree of social networks usage for acquisition and exploitation of knowledge is dependent on the amount of social capital integrated in these relations with external networks (Inkpen and Tsang, 2005; Yli-Renko et al., 2001). But what is the social capital and how does it contribute to the knowledge integration by an academic spin-off?

The concept of social capital was first used in communities studies to describe the value of resources integrated in the social interaction within communities (Burt, 2000; Yli-Renko, at al., 2001). However, a more extensive research on social capital started during the 1980s (Yu, 2013). Since then, many definitions for the social capital were introduced. Inkpen and Tsang (2005) identified Bourdieu’s (1986) study as the first systematic analysis of social capital. Bourdieu (1986) defined social capital as the “the aggregation of actual and potential resources within a specific network, where the network is composed of relationships that involve mutual acquaintance and mutual recognition”. Coleman (1988) defined social capital as “a function of social structure producing advantage”, whereas Putnam (1993) gave a more dedicated to the society definition, which describes social capital as “features of social organization such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated action”. Other authors, like Nahapiet and Ghoshal (1998), explained social capital in a similar way. They defined it as “the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit”. Still others, like Soetanto and van Geenhuizen (2010), gave a more general definition of social capital from World Bank (1999), which explains the concept of social capital as “institutions, relationships and norms that shape the quality and quantity of a society’s social interactions” and highlighted the social capital as a “glue” that holds the society together.

Taking into account the different perspectives of the above definitions and the literature review by Inkpen and Tsang (2005), two different patterns for social capital emerge. The first one is derived from social networks theorists who highlighted the personal benefits that people gain from social capital, whereas according to other scientists’ point of view, social capital is a public good that benefits all people involved in these interrelations. From this distinction, individual social capital and organizational social capital distinction followed (Renzulli et al., 1999; Inkpen and Tsang, 2005), where the individual dimension is focused on relations among persons (Coleman, 1988) and the organizational one is focused on interactions among organizations. However, these two dimensions are not independent from each other (Inkpen and Tsang, 2005), as the organizational social capital can derive from the individual dimension and the other way around. However, no matter how these two dimensions of social capital are interrelated, the social capital in general describes the fact that better connected people enjoy higher returns (Burt, 2000).

Independently of these dimensions of social capital, there are many researchers who linked the social capital theory and the social network theory (Borgatti and Foster, 2003; Inkpen and Tsang, 2005; Lee, et al., 2001; Soetanto and van Geenhuizen, 2010; Yli-Renko, et al., 2001; Renzulli et al., 2009; Yu, 2013; Burt, 2000). The most of definitions of social capital given above imply existence of networks for the development of both individual and organizational social capital. Thus, the essential
role of networks to entrepreneurship is understood (Soetanto and van Geenhuizen, 2010; Burt, 2000). The social capital theory is a fundamental theory that gives explanation to various theories concerning networks. For this reason, the social capital theory is the base of the weak ties theory (Granovetter, 1973; 1983), and the structural holes theory (Burt, 2000).

After all, the social capital theory suggests that external networks are the mean to attain all critical resources for survival. Especially for small firms, like academic spin-offs the social capital theory implies adoption of entrepreneurial strategies focusing on development of networks with external resource holders in order to succeed (Lee et al., 2001). For this reason, a constantly increasing number of companies are pursuing strategies that focus on the development of valuable networks and the exploitation of interrelations for survival and growth.

The value creation that derives both from the resource-based view of the firm and the social capital theory has different roots (Lee et al., 2001). The resource-based view of the firm theory is stressing the importance of internal resources and capabilities, whereas the social capital theory highlights the relational characteristics with external entities. For the present study, the two theories are combined; spin-offs should develop firm-specific assets while attaining complementary resources externally through their networks. To be more specific, the knowledge from the resource-based view of the firm is recognized as an important internal asset, whereas from the social capital theory additional knowledge inflows for the external environment.

2.4 Networks
The newly founded firms like academic spin-offs are relying on their networks to acquire their missing resources that will contribute to their survival (Birley 1985; Johannisson, 1988; Brüderl and Preisendörfer, 1998; Hite and Hesterly, 2001; Yli-Renko et al., 2001; Inkpen and Tsang, 2005; McEvily and Marcus, 2005; Witt, 2004; Lechner et al., 2006; Elfring and Hulsink, 2007; Stam et al., 2014). In this section, the main attributes of networks for a company will be discussed. The influence of networks to the entrepreneurship will be explained whereas terms like relational and structural embeddedness will be clarified.

2.4.1 Networks definition and the main characteristics
The interconnection of individuals is a concept that lies to the inner need of human being for socialization. Since the early formation of societies, people are interconnected in structures in order to survive and achieve welfare. These structures consisting of a set of actors and a set of relationships among them are the first structures of what is called nowadays networks (Hoang and Antonic, 2003; Borgatti and Foster, 2003). According to Hoang and Antonic (2003), networks are defined as “consisting of a set of actors and some set of relationships that link them”.

There are different types of concepts that describe a network. As stated above, entities that are linked within a network are called actors and they can be either individuals, teams, organizations or concepts (orgatti and Foster, 2003). When an actor is the central actor of a network, it is a called “Ego” (Weinstein and Deutschberger, 1963; Granovetter, 1983) whereas the rest of entities in this network are called "alters" (Weinstein and Deutschberger, 1963; Borgatti and Foster, 2003). Most of the times, network analyses are employed from the ego perspective, which is an arbitrarily chosen individual or in general entity as a central focal actor and the under analysis network is called "Ego-network" (Granovetter, 1983; Borgatti and Foster, 2003). The actors within a network are connected to each other. These connections among actors are called "ties" and they can be either weak, strong
or absent (Granovetter, 1973; Borgatti and Foster, 2003). The interaction between two actors within a networks that are connected through a tie, is called "dyad".

2.4.2 Networks and entrepreneurship

The first systematic analysis of the networks started in the 1930s by psychologists, to describe and analyze the behavior of individuals integrated in groups (Borgatti et al, 2009). Initially, the science of analyzing networks was called "sociometry" (Granovetter, 1973; Burt, 2002; Borgatti et al, 2009), because at the moment it had been studied as a part of social psychology. In the 1970s, the study of networks focused in sociology and anthropology, whereas later on in economics, biology and physics (Borgatti et al, 2009).

In the 1990s, a new area of research emerged in entrepreneurship. Entrepreneurs are tied in social networks and the entrepreneurial processes are not isolated by the social ones (Hoang and Antoncic, 2003). In other words, entrepreneurs can rely on networks to find resources, such as equipment, space and finances but also advise information and reassurance (Birley, 1985; Johannisson, 1988; Greve and Salaff, 2003; Soetanto and van Geenhuizen, 2010; Elfring and Hulsink, 2003). It has been proved that networks contribute not only to the acquisition of resources for survival and success but also to the increase of firm performance (Walter et al, 2005), innovation performance (Zaheer and Bell, 2005; Leyden et al, 2014), economic performance (Uzzi, 1996; 1997) and knowledge acquisition (Yli-Renko et al, 2001; Wu and Chen, 2012). Moreover, firms are relying upon networks by forming strategic alliances (Podolny and Page, 1998; Gullati, 1998) to acquire capabilities for competitive advantage (Foss, 1999; McEvily and Marcus; 2005; Mahmood et al., 2011).

Based on the literature review employed by Hoang and Antoncic (2003) regarding the importance of networks to the entrepreneurial settings, three key constructs of theoretical and empirical work emerged; the network content, the network governance and the network structure. These three pillars were distinguished in order to explain the process of network development during the entrepreneurial activity and the impact of networks on entrepreneurial outcomes. As far as the networks content structure is concerned, it is highlighted the importance of intangible resources, such as information, advice and legitimacy. The network governance refers to mutual trust and "implicit and open-ended" contracts that firms within a network pursue in order to acquire their critical resources. Last but not least, network structure describes the notion that the positioning in a network has an impact on the flows of resources. In details, it refers to the network size, the actor’s centrality in the network (where the actor is positioned compared to the other actors in the network), the diversity of resources, the strong and weak ties that actors possess within a network and the structural holes that emerge through the interconnection of them.

The importance of networks for entrepreneurship is also evident through various studies that have been employed to explore its impact to the success and survival of emerging firms (Brüderl and Preisendörfer, 1998; Bosma et al., 2004; Witt, 2004; Soetanto and van Geenhuizen, 2010, Scholten et al., 2014). Various studies on networks for emerging firms have used networks to explain why some new firms survive while some others not (Witt, 2004). The emerging firms are relying on their networks, either social or business networks in order to acquire the resources needed. The concept of support from networks is also known as “network compensation hypothesis” and it was introduced by Brüderl and Preisendörfer (1998) in order to describe the lack of resources for the newly founded firms and the support they gain through their networks. In details, founders use their personal network of private and business contacts to acquire resources and information that they would not (or not as cheaply) be able to acquire on markets. Hence, the larger and more diverse network an
entrepreneur is operating within, the more support he gets from this and for this reason is more successful than entrepreneurs with smaller networks (Witt, 2004).

Additional studies have deepened the analysis and examined how network structure is developed through the growth of start-ups and what is the impact of specific ties to the resources acquired through networks. Hite and Hesterly (2001) for example, proposed the pattern of network development for new firms throughout their growth regarding the network density, whereas Elfring and Hulsnik (2007) examined the network development throughout various entrepreneurial processes of emerging organizations. One step further was the study employed by Soetanto and van Geenhuizen (2010), which proved the propositions of Hite and Hesterly (2001), whereas Scholten et al. (2014) has proved the positive relation of the number of bridging ties to the growth of academic spin-offs.

However, it should be mentioned that the interconnectedness of individuals and firms does not always have a positive impact to the performance of firms regardless of their size or age (Uzzi, 1996). There are studies discussing that the structure of network may also have negative impact to their performance, or negative impact under specific circumstances (Rowley et al., 2000; Lechner et al., 2006). Still other studies have highlighted the non-linear connection of specific attributes of network structures with innovation and financial performance (Jack, 2005; Lowik et al., 2012).

In order to fully grasp the concepts of the moderating influence of networks to the entrepreneurial settings, it is important to discuss in details the way networks characteristics are interrelated to business settings. The integration of networks to entrepreneurial processes is discussed in the following section.

2.4.3 Embeddedness
Under the same lines of social capital theory, the integration of social activities to the economic world was expressed as embeddedness and it was introduced by Granovetter (1985) in economics. According to Uzzi (1996), “Embeddedness refers to the process by which social relations shape economic action in ways that some mainstream economic schemes overlook or misspecify when they assume that social ties affect economic behavior only minimally or, in some stringent accounts, reduce the efficiency of the price system”. Thus, the concept of embeddedness refers to the notion that economic behavior is integrated in a larger social context, such as the economics as a branch of sociology (Borgatti and Foster, 2003).

Granovetter analyzed embeddedness to show a different perspective of the economic exchanges, as integrated in a social environment. In other words, embeddedness clarifies how social structure affects economic life (Uzzi, 1997). Polanyi (1957) was the first to describe social structure of market through the embeddedness perception, whereas Schumpeter (1950) and Granovetter (1985) explained the effect of social structure to economic action, especially in the context of interfirm networks. After these, many studies focused on different fields including entrepreneurship, marketing channels and acquisitions (Uzzi, 1997).

The connections of organizations are defining the type of network in which they are embedded. The companies that keep arm-length ties perform exchanges that produce a market-like structure, whereas when they maintain embedded ties their pattern produces a network (Uzzi, 1996; Granovetter, 1985). Empirical studies have highlighted the benefits of embedded ties, which are associated with often and more exclusive business relationships (Borgatti and Foster, 2003).
Embedded ties offer fine-grained information and joint problem solving, whereas trust is a strong condition of communication among the interrelated organizations (Uzzi, 1996, 1997). This provides to firms reducing monitoring costs, rapid decision making and rapid organizational learning and adaptation (Uzzi, 1996). Moreover, it has been found that embedded ties are offering access to information for potential customers, suppliers to increase both their financial and innovative performance (Borgatti and Foster, 2003; McEvily and Marcus, 2005).

There are two different approaches of embeddedness; the relational embeddedness and the structural embeddedness. The first one is describing the advantages deriving from information available through networks, whereas the second one highlights benefits from the positioning of actors in a network (Rowley et al., 2000). As stated by Gulati (1998), the relational embeddedness “or cohesion perspectives on networks stress the role of direct cohesive ties as a mechanism for gaining fine-grained information”. Similarly, the structural embeddedness “or positional perspectives on networks go beyond the immediate ties of firms and emphasize the informational value of the structural position these partners occupy in the network” (Gulati, 1998). Although these two approaches are distinct, there is a degree of overlapping as the control benefit can arise from the manipulation of information (Burt, 1992). In the present thesis, emphasis will be given to the relational perspective of the embeddedness of the firms in networks.

No matter what is the type of the embeddedness and the various benefits that derives from each of them there is always risk of over-embeddedness (Uzzi, 1996, Lechner et al., 2006; Elfring and Hulsink, 2003; 2007). The concept of over-embeddedness explains the drawback of relying on networks, where the embedded ties are more than the arm-length ties for an organization (Elfring and Hulsink, 2003; 2007). As companies are relying more on embedded ties, they became blind to novel concepts and are “locked-in” (Johannisson, 1988; Elfring and Hulsink, 2003; 2007).

2.4.4 Relational Embeddedness

As has been already mentioned, relational embeddedness refers to the direct relation of an ego (focal entity in a network) with his acquaintances, and is defined as ties. One of the most important concepts grounded in this type of embeddedness is the strength of ties, for which the theory of weak ties has been emerged (Granovetter, 1973). The strength of a tie is defined as “the combination of time, the emotional intensity, the intimacy (mutual confiding) and the reciprocal services which characterize the tie” (Granovetter, 1973). The theory is describing the benefits that an ego enjoys in a network, through the development of weak ties and it is called the Weak Tie theory (Granovetter, 1973, 1983). According to this, distant and infrequent relationships are efficient for knowledge sharing because they provide access to novel information by bridging otherwise disconnected groups and individuals in an organization. On the other hand, strong ties are likely to lead to redundant information because they tend to occur among a small group of actors in which everyone knows what others know (Granovetter, 1973, 1985; Hansen, 1999).

As discussed earlier, ties between an ego and the rest of the actors in a network can be either strong or weak and according to their nature are contributing differently to an ego. Strong ties are the relation between two similar people in a longer term and intense relationship (Elfring and Hulsink, 2003). Krackhardt (1992) highlighted the importance of strong ties through the theory of Granovetter (1973). He argued that strong ties tend to bond similar people to each other who cluster together such that they are all mutually connected. It has been proposed and found through several studies, that strong ties are offering various benefits to individuals and organizations involved. At this point, it should be mentioned that individuals and organizations activities within networks are
considered similar and for this reason are examined together, as there is little theoretical distinction between networks of individuals and networks of firms (Hoang and Antoncic, 2003).

To begin with, strong ties are contributing to the economies of time\(^2\) (Uzzi, 1997), they are easily available and are likely to be useful in conditions of uncertainty and insecurity (Krackhardt, 1992). This means that firms, especially the newly founded ones are relying on family and friends for financial resources, while at the same time entrepreneurs are able to keep their personality and originality of their venture (no compromises needed to obtain their resources for survival) (Johannisson, 1988). Moreover, strong ties are developing trust, transfer of fine-grained information and joint problem solving (Uzzi, 1996; Rowely et al., 2000, Elfring and Hulsink, 2003). Trust coming from strong ties is reducing the possibilities of opportunistic behavior (Krackhardt, 1992) and provides important feedback by outsiders of a firm (Elfring and Hulsink, 2003). Besides fine-grained information, the proximity that strong ties are offering to the participant actors stimulates diffusion of complex and sensitive knowledge, especially the tacit one (Hansen, 1999; Rindfleisch and Moorman, 2001). Last but not least, as Krackhardt (1992) supported, strong ties are enhancing commitment, loyalty and friendship between actors, which is critical for the ability of an organization to deal with major crises (Elfring and Hulsink, 2003).

From the social network analysis emerged that as the strong ties are characterized by high similarity then these strong relationships between one focal actor with two other members of a network tend to lead to at least one weak tie between the two other actors (Granovetter 1973, Lechner et al., 2006). In other words, weak ties in a network emerge from two strong ties of a focal actor. However, the benefits that weak ties offer are totally different to these of strong ties. Weak ties offer great amount of diverse information to the involved actors (Rindfleisch and Moorman, 2001). In addition to this, weak ties are making the actors in a network flexible and mobile, as they are exposed constantly to new information and resources (Granovetter, 1973; Hansen, 1999) and they can always find alternative approaches to solve their at times issues. Besides flexibility, weak ties are offering diffusion of novel concepts and ideas, whereas the diffusion in employed through smaller paths in a network, fact that reduces time and cost of the diffusion (Granovetter, 1973). Last but not least, weak ties are providing opportunities to meet new people, enhance the entrepreneurial opportunities recognition, the acquisition of competitive capabilities and hence the creation of more significant innovations (Elfring and Hulsink, 2003). In other words, weak ties are acting as leverage for entrepreneurship.

One special type of weak tie in a network, which has been under analysis in many studies, is the concept of bridging ties. Bridging ties, according to McEvily and Zaheer (1999) are the ties “that link a focal firm to contacts in economic, professional, and social circles not otherwise accessible to the firm”. As has been stated by Rindfleisch and Moorman (2001), there is a structural tendency for strong ties to cluster in dense cliques and weak ties are the links between these cliques. These ties are channels through which ideas or information, social distant from the focal actor (ego) may reach him, as these ideas and information are outside of his own friendship circle (Granovetter, 1973). For this reason, bridging ties are considered to be an important attribute for entrepreneurial firms. For instance, Scholten et al., (2014) have found that the number of bridging ties is positively related to the growth of academic spin-offs. This happens because bridging ties are helping the entrepreneur to increase his search scope and thus he has more diverse opportunities and then chooses the most promising ones (Scholten et al., 2014).

\(^2\) Economies of time is the ability of a firm to capitalize quickly on market opportunities (Uzzi, 1997).
Having already discussed the various benefits the different types of ties can offer, it is clear that in reality, individuals and organizations are relying both on strong and weak ties. This happens as the benefits deriving from ties, are different for each of the two categories, but all of them critical. To be more specific, while strong ties are important for the establishment of a firm for instance, and for reaching its first considerable results, the same ties will not be sufficient for further development (Lechner et al., 2006). The initial networks that provide protection against uncertainty (Krachkardt, 1992) and financial resources (Elfring and Hulsink, 2003) will not be helpful when the firm is established and has to recognize entrepreneurial opportunities and conceive novel concepts (Lechner et al., 2006). Ideal entrepreneurial networks include a mix of both ties, corresponding to the needs of the firms (Elfring and Hulsink, 2003).

In other words, it seems that firm networks are evolving from emergence to early growth, in order to adapt to the firm’s changing resources needs. To be more specific, there is a shift from identity-based networks (egocentric networks with personal or social ties) to calculative networks (egocentric networks with market-like ties) as the spin-offs evolve from emergence to early growth (Hite and Hesterly, 2001). Besides the nature of network ties that evolve according to the firm’s needs, other studies have highlighted this phenomenon also from the relational perspective based on the contacts background. A study employed by Lee et al. (2001), has made a distinction of two types of networks; one with sponsorship-based linkages and another with partnership-based linkages, in order to conceptualize the social capital of spin-offs. Networks with sponsorship-based linkages are characterized by unilateral relationships, as the sponsor commits unilateral support without receiving explicit rewards, whereas networks with partnership-based linkages involve long-term bilateral relations in which partners provide and receive resources (Lee et al., 2001). Another study employed by Lechner et al. (2006) analyzed specific network types (social, reputational, marketing information, co-opetition networks and co-operative networks) which imply the acquisition of different types of resources and information through them, and stressed the importance of relational mix among the various types of networks for the development of a new entrepreneurial firm.

To sum up, relational embeddedness describes the relation of a focal actor (company or an individual) in a network. The relation can be either through strong or weak ties and the benefits he enjoys are varying according to the different nature of these ties. Especially in the case of a firm, both types of ties are types are critical; strong ties during the merging phase and weak ties for the early growth phase. However, besides the relations within a network, the position of an actor in the network is also important. This is described by the structural embeddedness and is discussed below.

### 2.4.5 Structural embeddedness

The structural embeddedness refers to the positioning of an ego within his network. This type of embeddedness describes the position of the ego so important as to regulate the benefits he gets from it and stresses the importance of network structure, which has been proved to have significant effects on firms, such as the increase of their performance (Gulati et al., 2000; Zaheer & Bell, 2005). There are two main contradicting views in structural embeddedness; the closure concept and the structural holes (Ahuaj, 2000; Stam et al., 2014). The closure concept is based on the notion developed by Coleman (1988) and it refers to creation of social capital within a close network with embedded ties. According to this, it is advantageous for an emerging entrepreneurial firm to rely on close networks, as they create mutual trust among actors (Coleman, 1988). The second concept that is related to structural embeddedness is the structural holes. According to Burt (2000), a structural hole is happening when two actors are connected with a third one but are not connected together. In
other words, actors belong to a network with disconnected clusters that build them to obtain non-redundant information (Ahuaj, 2000).

Besides structural holes and the concept of close networks, there are more network attributes that have moderating influence to firm performance. Network characteristics such as diversity, have been found to have moderating effect to firm activities (Rowley et al., 2000; Reagans and McEvilly, 2003; Zaheer and Bell, 2005). Besides diversity, there are additional network characteristics like network cohesion and network range. According to Reagans and McEvilly (2003), network cohesion refers to "the extent to which a relationship is surrounded by strong third-party connections", whereas network range refers to the "extent to which network connections spans institutional, organizational or social boundaries".

2.5 Entrepreneurial behavior

From the literature review so far, it is understandable that networks have been a mean of providing resources to newly founded firms (Birley, 1985; Johannisson, 1988; Greve and Salaff, 2003; Soetanto and van Geenhuizen, 2010; Elfring and Hulsink, 2003) and stimulation of financial and innovation performance (Uzzi, 1996; 1997; Walter et al., 2005; Zaheer and Bell, 2005; Leyden et al., 2014). Besides the resources and the results of these to the performance of newly founded firms, entrepreneurs are relying on networks also to identify opportunities, broaden their general knowledge base (either for markets or partners) and in general employ activities that will contribute to the survival and the success of them (Walter et al., 2006).

In other words, spin-off founders have to be engaged in activities in order to take advantage of all resources and opportunities available through networks (Barney et al., 2001). This embedded in interfirm networks conduct that spin-off founders exhibit (Simsek et al., 2003) in order to effectively exploit resources and seize entrepreneurial opportunities describes the entrepreneurial behavior. Specifically, entrepreneurial behavior is defined as the concept that involves all actions that are taken by firms members and is related to discovery, evaluation and exploitation of entrepreneurial opportunities (Shane and Venkataraman, 2000; Kuratko et al., 2005).

It has been reported by many researchers, that entrepreneurial behavior is determined by various aspects; there are studies that highlight the personal traits and the sociocultural background of entrepreneurs (Miller, 1983; Zahra, 1993), whereas others support that entrepreneurial behavior is determined by the firm structure and environment (Zahra, 1993). Still others support that entrepreneurial behavior is influenced by the decision making of companies and strategy factors (Miller, 1983). However, no matter what the determinants of entrepreneurial behavior are, there are undoubtedly various benefits that derived from the adoption of this behavior from organizations (Kuratko et al., 2005). One of the main notions about the entrepreneurial behavior that comes up since the 1990s (Kuratko et al., 2005) is that entrepreneurial behavior is beneficial to companies of all types and sizes (Miller, 1983; Lumpkin and Dess, 1996; Walter et al., 2006) and it stimulates growth and economic performance (Zahra, 1993; Kuratko et al., 2005; Walter et al., 2006).

By definition, entrepreneurial actions are characterized by newness. The entrepreneurial behavior of firm members involves use of new resources, interaction with new customers and involvements with new markets (Kuratko et al., 2005). At the same time, studies have highlighted the critical role of entrepreneurial behavior for firms performance (Zahra, 1993; Kuratko et al., 2005); especially in hostile and technologically sophisticated environments, similar to those in which academic spin-offs are operating. Taking into account that entrepreneurial behavior contributes to the bridging of
academic research and business world, the importance of it for the growth and success of academic spin-offs is well understood (Walter et al., 2006).

Academic spin-offs founders employ entrepreneurial activities to success in already established markets with new products and services or even create new markets with their innovative solutions. In order to be involved in such newness of things, entrepreneurial teams of academic spin-offs should operate entrepreneurially in order to absorb as much knowledge as possible and thus reassure awareness and survival (Walter et al., 2006). But what are the components of entrepreneurial behavior? How is it exactly depicted in terms of processes and concepts? The present study depicts the entrepreneurial behavior by taking into account two main concepts; the entrepreneurial orientation and the entrepreneurial team efficacy. In order to fully grasp the benefits and in general the way entrepreneurial behavior is contributing to spin-offs management of knowledge, the entrepreneurial orientation and the entrepreneurial team efficacy are analyzed following.

2.5.1 Entrepreneurial orientation
The entrepreneurial orientation has emerged as a key construct within the literature of management and entrepreneurship the last years, aiming to shed light to the behavior of firms adopt in order to survive and success (Sciascia et al, 2014). In general, entrepreneurial orientation specifies the characteristics of an entrepreneurial oriented firm and it has been investigated as an explanation of firm performance (Wiklund and Shepherd, 2003). Entrepreneurial orientation refers to firm’s strategic orientation, capturing specific entrepreneurial aspects of decision-making styles, processes and practices (Lumpkin and Dess, 1996).

There are multiple terms and definitions that aim to describe precisely the concept of entrepreneurial orientation. The debates exist so far are related to its dimensionality and the interdependence of these dimensions (Sciascia et al, 2014). For the present study, the definition proposed by Covin and Slevin (1990) is adopted. This definition is mainly based on the seminal study of Miller (1983) and describes the entrepreneurial orientation as “the processes, structures and behaviors of firms that are characterized by innovativeness, proactiveness and risk taking”. In other words, entrepreneurial orientation involves goals and engagements of key players that act in a dynamic environment in order to create a new-venture (Lumpkind and Dess, 1996), or to entry into new or established markets with new or existing products and services (Walter et al., 2006).

According to its definition, entrepreneurial orientation consists of 3 dimensions; innovativeness, proactiveness and risk taking (Miller, 1983; Covin and Slevin, 1990). The dimensions of innovativeness refers to the tendency of a firm to support new ideas, novelty, experimentation and creative processes that derive from already established practices and technologies (Miller, 1983; Lumpkin and Dess, 1996; Wiklund and Shepherd, 2003) and indicates the commitment of firms to introducing new products and services to the marketplace (Covin and Slevin, 1990; Kreiser, 2011). The proactiveness dimension refers to initiatives taken by firms for anticipating and pursuing new business opportunities and for participating in emerging markets (Miller, 1983; Walter et al., 2006). In general, it is considered as a posture of acting on future wants and needs through strategic moves (Covin and Slevin, 1990; Kreiser, 2011), creating by this first-mover advantages over competition (Lumpkin and Dess, 1996; Wiklund and Shepherd, 2003). Risk taking, the third dimension of the concept, refers to the proclivity of firms to support projects when there is no reassurance for their success (Covin and Slevin, 1990; Walter et al., 2006). In other words, as it was described by Wiklund and Shepherd (2003), “it largely reflects the organization’s willingness to break away from the tried-
and-true and venture into the unknown”. These entire three dimensions may vary independently of one another (Stam and Elfring, 2008) as these attributes of attitude that they represent, offer unique contributions to the firm’s strategy (Lumpkin and Dess, 1996; Wiklund and Shepherd, 2003). However, all three dimensions are viewed as a whole, which means that they represent collectively the firm’s overall level of entrepreneurial orientation (Covin and Slevin, 1990; Lumpkin and Dess, 1996; Kreiser, 2011).

There are various studies in the literature that describe the impact of entrepreneurial orientation to firm development. As has been mentioned earlier, the concept of entrepreneurial orientation emerged as an antecedent of firm performance (Sciascia et al, 2014). Empirical results suggest that entrepreneurial orientation improves firm performance (Covin and Slevin, 1990; Lumpkin and Dess, 1996; Lee et al., 2001; O’Shea et al., 2005; Walter et al., 2006; Keh et al., 2007; Li et al., 2009) by increasing the company's proactiveness and risk taking, and by promoting product process and service innovations (Lumpkin and Dess, 1996; Walter et al., 2006). Especially for academic spin-offs, entrepreneurial orientation can be considered critical for the survival of them, as it represents all the activities that includes newness (O’Shea et al., 2005; Walter et al., 2006), such as commercializing a new product or a service without reassurance of success. Last but not least, entrepreneurial orientation has been proved to have indirect effects in relations of the firm performance with other concepts, such as the absorptive capacity and knowledge resources (Wales et al., 2013; Sciascia et al, 2014).

2.5.2 Entrepreneurial team efficacy
Having already described the entrepreneurial orientation that depicts the proclivity of entrepreneurs for entrepreneurial activities, the second pillar of entrepreneurial behavior in the present study is the entrepreneurial team efficacy and it refers to the effectiveness regarding the realization of these activities intentionally (Chen et al., 1998; Gully et al., 2002).

Entrepreneurial team efficacy or collective efficacy, as stated by Guzzo et al. (1993) is defined “as the individual's belief that a group can perform successfully” (Durham et al., 1997). The concept of entrepreneurial team efficacy derived from the self-efficacy, which emerged from the social learning theory (Prodan and Drnovsek, 2010) and refers to “an individual’s belief in their personal capability to accomplish a job or a specific set of tasks” (McGee et al., 2009). Several studies indicate that the concept of entrepreneurial team efficacy is as important at group level as self-efficacy is at individual one (Bandura et al., 1997; Durham et al., 1997; Feltz and Lirgg, 1998; Arnold et al., 2001) and they differ only at level of agency; self-efficacy is an individual-level concept, whereas team efficacy is a group-level phenomenon (Feltz and Lirgg, 1998). The concept of team efficacy was introduced as an extension of self-efficacy by Bandura (1997), in order to explain group choices, efforts and persistence. For this reason, it will be beneficial for the present study to give first a short description of the main characteristics of self-efficacy.

The entrepreneurial self-efficacy is an individual’s belief in their personal capability to accomplish a job or a specific set of tasks (Durham et al., 1997; Chen et al., 1998; Hmieselski and Baron, 2008; McGee et al, 2009). Its construct measures a person’s belief regarding their capabilities for attaining success and control cognitions in order to effectively manage challenging goals during entrepreneurial tasks (McGee et al., 2009; Prodan and Drnovsek, 2010). Individuals with high self-efficacy tend to set challenging goals with high returns, to persist more on the achievement of them even in stressful environments and recover quickly from failure (Bandura,1997; Chen et al.,1998; McGee et al, 2009). Self-efficacy is closely related to intentional actions. For this reason it can be
used to predict and study entrepreneurial behavior (Chen et al., 1998). Thus, entrepreneurs with higher self-efficacy tend to lead firms that they grow more quickly and more profitable compared to firms of entrepreneurs with low self-efficacy (Hmieleski and Baron, 2008).

As far as the entrepreneurial team efficacy is concerned, the same principle is applied. Teams with high efficacy outperform and persist longer than teams with low efficacy (Bandura, 1997). In general, entrepreneurial team efficacy is related to specific tasks (Durham et al., 1997) and goals that were set to attain them successfully (Chen et al., 1998; Feltz and Lirgg, 1998; Arnold et al., 2001). Hence, team efficacy is significantly related to the commitment of goals (Durham et al., 1997; Chen et al., 1998) and firm performance (Hmieleski and Baron, 2008; Hmieleski and Corbett, 2008; McGee et al., 2009).

Generally speaking, the concept of self-efficacy and consequently team-efficacy as well, is especially pertinent for academic spin-offs (Prodan and Drnovsek, 2010). By definition, academic spin-offs are founded mostly by graduates or university employees or even external entrepreneurs exploiting university knowledge (Pirnay et al., 2003; Soetanto and van Geenhuizen, 2009). These founders are people with high-level of technical knowledge, but most of the times they lack the necessary business skills to bring technology closer to markets. Thus, great effort, shifting roles, persistence and commitment to tasks are required for the founders to operate in unknown fields. At the same time, given that entrepreneurial self-efficacy is the perceived certainty of performing specific roles and tasks and that the most of spin-offs are operating through teams (Prodan and Drnovsek, 2010), the importance of entrepreneurial team-efficacy for academic spin-offs is understood.

To sum up, entrepreneurial behavior in the present study is depicted by the entrepreneurial orientation and the entrepreneurial team efficacy. Overall, the entrepreneurial behavior, that the founders of academic spin-offs exhibit, is critical for success and survival of them, as it is the way to effectively exploit resources and seize entrepreneurial opportunities. Entrepreneurial orientation depicts the tendency of firms for innovativeness, proactiveness and risk taking, whereas entrepreneurial team efficacy, the group commitment and confidence for attaining entrepreneurial goals.

2.6 Absorptive capacity

There are various critical resources either tangible or intangible, which are taken into account in entrepreneurship as they have been proved to provide to companies the competitive advantage in order to be established in the markets they operate and thus survive or succeed. One of the intangible resources critical for their performance is knowledge (Tsai, 2001, Grant, 1996; Zahra et al., 2009), and it is highly dependent to the amount of social capital embedded in firms social relations (Yli et al., 2001). Thus, based on the resource-based view of the firm and the social capital theory, knowledge coming from external networks is considered to be a critical resource (Lee et al., 2001), for sustained competitive advantage (Yli et al., 2001; Schildt et al., 2012), as it is difficult to imitate (Wiklund and Sephers, 2003) and for innovation processes regarding development of new products and services (Cohen and Levinthral, 1990; Tsai, 2001; Ebers and Maurer, 2014).

However, knowledge is sticky and difficult to diffuse (Tsai, 2001), either within or outside of an organization. For that reason, the last two decades, there is an increasing interest on the ability of companies to acquire and exploit external or internal knowledge (Escribano et al., 2009; Flatten et al., 2011). This ability of a firm, which refers to "the set of organizational routines and processes by
which firms acquire, assimilate, transform and exploit knowledge”, is called absorptive capacity (Zahra and George, 2002).

2.6.1 Absorptive capacity definition and the main characteristics
The concept of absorptive capacity originated from the observation that R&D investments for a firm do not only contribute to new inventions and artifacts but also improve its ability to internalize knowledge from the external environment (Cohen and Levinthal, 1990; Lane et al., 2006; Schildt et al., 2012). Based on the seminal work of Cohen and Levinthal (1990), the firm’s ability to "recognize the value of new, external information, assimilate it and apply it to commercial ends" is called absorptive capacity. This study focused on the cumulative and path-dependent nature of knowledge while they elaborate the role of prior knowledge as a determinant for organizational learning (Zahra and George, 2002; Lane et al., 2006; Todorova and Durisin 2007; Schildt et al., 2012). Later on, Lane and Lubatkin (1998) introduced the term "relative absorptive capacity" to highlight that absorptive capacity in a dyad level (individual perspective, “student firm”-receiver and “teacher firm”-sender) is relative and dependent on the teacher. To be more specific, the absorptive capacity of a “student” depends on the type of knowledge transmitted, by the similarity between "student" and "teacher" in organizational terms and the student familiarity with the “teacher's” organizational problems (Lane and Lubatkin, 1998; Lane et al., 2006). Van den Bosch et al., (1999), extended this thinking by examining the moderating impact of firm environments and its ability to cope with these and focused mainly to the iterative learning process between a firm and the external sources of knowledge (Lane et al., 2006).

Besides the variant aforementioned perspectives that studies focused on, the present research will be based on the study by Zahra and George (2002). They adopted a process perspective and argued that internal knowledge sharing and integration is critical for the absorptive capacity of a firm which they define it as a dynamic capability3. According to their definition mentioned above, the absorptive capacity encompasses four dimensions; the acquisition, the assimilation, the transformation and the exploitation of the knowledge (Zahra and George, 2002).

The acquisition refers to “the firm’s capability to identify and acquire external knowledge, which is important for the company's operations” whereas the three attributes that characterize it are the intensity the speed and the direction (Zahra and George, 2002). The second dimension is the knowledge assimilation and refers to "the firm's routines and processes that allow it to analyze, process, interpret and understand the information obtained from external sources”. In other words, as the external knowledge contains specific heuristics that may differ from the ones used by the company, some time is needed for the comprehension of the knowledge (Zahra and George, 2002). The assimilation dimension refers to the “firm’s capability to develop and refine the routines that facilitate combine existing knowledge and the newly acquired and assimilated one”. This dimension stimulates the entrepreneurship within the firm and contributes to the opportunities recognition whereas it changes the way the firm sees itself in the competitive landscape (Zahra and George, 2002). Last but not least, the exploitation dimension “is based on the routines that allow the firm to refine, extend and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations”. This dimension represents the firm’s ability to exploit

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3 Dynamic capability is defined by Teece et al. (1997) as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" and is based on the notion that organizations are able to change in a systematic and fruitful way (Romme et al., 2010).
and integrate knowledge into its operation and the outcome of this dimension is the development of “new goods, processes, knowledge or new organizational forms” (Zahra and George, 2002).

These four dimensions of the absorptive capacity can be grouped in two others, the potential absorptive capacity and the realized absorptive capacity (Zahra and George, 2002). The potential absorptive capacity encompasses the first two dimensions of acquisition and assimilation, makes the firm aware of the external knowledge and represents the capability to value and acquire this knowledge (Cohen and Levinthal, 1990). The realized absorptive capacity refers to the rest two dimensions described above, the transformation and exploitation and describes the firm’s capability to leverage the acquired and assimilated knowledge. These two subsets of absorptive capacity are separate from each other but have complementary roles. To be more specific, although for a company both subsets coexist, an enhanced realized absorptive capacity does not imply enhanced performance, as the realized dimension is needed to transform and exploit the acquired and assimilated knowledge. This variation of the two subsets for a firm is represented by the efficiency factor (the ratio of realized to potential absorptive capacity) and describes the variation of the company ability to create value from the external environment (Zahra and George, 2002).

This grouping of the four dimensions of acquisition, assimilation, transformation and exploitation, in potential and realized absorptive capacity was made by Zahra and George (2002), in order to depict the absorptive capacity as a coherent dynamic capability which is able to leverage organizational change and evolution. However, in the literature review objections have been aroused concerning this grouping. One of the main studies that criticize this distinction is the one by Todorova and Dursin (2007), who underlined that the actual components and definitions of the two dimensions given by Zahra and George (2002) are inconsistent. For instance, as the dimensions of assimilation and transformation are alternative components (Zahra and George, 2002) transformation can replace the assimilation dimension in the potential absorptive capacity. Thus, the exploitation dimension left for the realized absorptive capacity cannot be described by the initial given definition of realized absorptive capacity anymore. To support this notion, they also highlighted the study of Jansen et al. (2005) which they prove empirically by a confirmatory factor analysis that the dimensions of absorptive capacity are the aforementioned four. For this reason, studies are using the four dimensions of absorptive capacity in order to use variables in their empirical analysis with high construct validity (Todorova and Dursin, 2007).

2.6.2 Absorptive capacity and entrepreneurial networks
From the dimensions described, it is evident that the absorptive capacity definition describes the interaction that is needed for knowledge to be diffused to the interconnected partners. This interconnection presupposes involvement in networks, which most of the times are called interfirm networks (Mowery et al., 1996). As Ahuja (2000) stated, firm’s collaborative links provide access to knowledge spillovers, which refers to knowledge flows between firms. The networks in other words provide linkages of communication between firms and their direct and indirect partners and their role is to be a facilitator of information and knowledge (Ahuja, 2000; Mowery et al., 1996).

Knowledge is also being transferred in intrafirm networks, where the centrality of the actors plays significant role to innovation and business performance (Tsai, 2001; Gao et al., 2008). The knowledge transfer is a social process within communities and it is contributing to new technologies and goods on the one hand (Borgatti and Foster, 2003; Hurmelinna-Laukkanen et al., 2012) and fosters corporate entrepreneurship for threshold firms to the other (Zahra et al., 2009).
But how is knowledge managed within networks? What are the network conditions that foster knowledge diffusion? There are studies that have linked the concept of knowledge diffusion and absorptive capacity with networks (Gilbert et al., 2008; Yli-Renko et al., 2001; Reagans and McEvily, 2003) and they have found that the stronger the ties within a network the easier the diffusion of knowledge within it. Moreover, knowledge diffusion is stimulated by the existence of prior common knowledge (Cohen and Levinthal, 1990), network cohesion and network range (Reagans and McEvily, 2003). The strength of ties (relational embeddedness) and the knowledge acquisition is also examined by Rindfleisch and Moorman (2001) and by Wu and Chen (2012), who in both studies concluded that there is a positive relation between relational embeddedness and knowledge acquisition and diffusion. Besides this, there is an enhancing mediating role of absorptive capacity between relational embeddedness and innovation (Wu and Chen, 2012). Last but not least, the study employed by Ebers and Mauer (2014), sheds light to the relation between relational embeddedness and absorptive capacity. During this study, it has been found that the potential and realized absorptive capacity is positively related to the relational embeddedness both with the internal and the external environment, and then the absorptive capacity is enhancing innovation (Ebers and Mauer, 2014).

Besides the studies that examine the relation of networks with knowledge (and consequently with the absorptive capacity), there are studies describing the role of absorptive capacity for small and medium-sized enterprises and newly founded firms. A study that investigated the absorptive capacity of small and SMEs is employed by Gray (2006) and it stressed the importance of absorptive capacity to the successful adoption of innovations and entrepreneurial growth. Moreover, absorptive capacity has a relevant impact on the ability of the SMEs to establish and collaborations with external organizations (Muscio, 2007; de Jong and Freel, 2010) whereas is positively related to the firms responsiveness to the changes in external environment (Liao et al., 2003) and to the amount of entrepreneurial wealth created by high technology start-ups (Deeds, 2001). Last but not least, Zahra et al., (2009) investigated the role of absorptive capacity to sustain corporate entrepreneurship in threshold firms. They proposed that absorptive capacity enables executives to develop new skills and capabilities, which in turn will foster the corporate entrepreneurship activities and thus achieve success (Zahra et al., 2009).

### 2.6.3 Absorptive capacity and entrepreneurial behavior

Besides networks, absorptive capacity is also related to entrepreneurial behavior. This is explained by the involvement of human factor in both concepts. However, there is limited literature connecting the core concept of absorptive capacity with entrepreneurial behavior. Nevertheless, entrepreneurial behavior is connected with knowledge processes that exist within firms.

One study relevant to this is conducted by Li et al. (2009) and describes the relation of entrepreneurial orientation and the processes of creating new knowledge. All three dimension of entrepreneurial orientation is fostering the creation of new knowledge. Innovativeness, which is described as tendency of the firm to support new ideas and projects for the creation of new products (Lumpkin and Dess, 1996) is requiring new knowledge. People involved in these activities are combining their prior knowledge and experience and transform old knowledge in new one. For the risk taking dimension, which depicts the daring of firms to commit in new projects (Lumpkin and Dess, 1996), new knowledge is also required. The newness of projects requires combination of prior knowledge and experience and interaction of people from the external environment for ad-hoc solutions. Thus, new knowledge is created for the new projects to be supported. Last but not least,
the proactiveness dimension which represents tendency for anticipating and pursuing new opportunities (Lumpkin and Dess, 1996), new knowledge is created. As soon as the entrepreneurial team recognizes a new opportunity, then interacts with customers and retailers for ideas and support. These, combined with their prior knowledge, creation of the new one happens (Li et al., 2009).

Another study employed by Keh et al. (2007), highlights the interaction of entrepreneurial orientation and utilization of knowledge. Under the same principle described for the previous study, processes that describe the dimensions of entrepreneurial orientation require knowledge. For instance, the decision-making processes involved in the aforementioned dimensions of entrepreneurial orientation involve necessary knowledge. To sum up, all three dimensions of entrepreneurial orientation increase knowledge flows and knowledge exploitation.

Thus, it seems that absorptive capacity with its four dimensions is a critical concept for the management of knowledge within organizations of various sizes, as each dimension offers distinct benefits and describes different processes, and it is related with both the entrepreneurial networks and entrepreneurial behavior.

Nevertheless, the dimensions of the absorptive capacity are not equally represented in all organizations. As stated by Andersén and Kask (2012), the level of realized absorptive capacity can differ significantly from the level of the potential one. Based on the notion that the absorptive capacity is a dynamic capability, the level of its two dimensions (potential and realized) is explained by presence or absence of decision making. The choice or not to initiate absorptive capacity processes is based on the cognitive structures of the management team (Andersén and Kask, 2012). At the same time, knowledge from networks is coming through the dyadic relations. As, there are numerous of dyadic relations in network, it is practically impossible for the firm to fully focus on all these relations (e.g. focusing to all the dyadic relations in a network is extremely time consuming) (Noteboom et al., 2007). Thus, the potential absorptive capacity can be absent or to lower level that this of the realized one, because the management was not able to focus to all the relations through networks. But the knowledge from other relations can be exploited as long as it is decided in advance. This brings us to the final conclusion that the realized absorptive capacity will be undoubtedly present and for that reason the present study will be focused on the realized absorptive capacity.

2.6 Conclusion
Throughout this chapter, the main research concepts of the present thesis have been discussed. Taking into account their specific qualities, it is evident that it is a high degree of interaction between them. Networks are contributing significantly to the innovation and financial performance of academic spin-offs, whereas embedded to these networks entrepreneurial behavior is of great importance for the effective exploitation of the resources provided. At the same time, the absorptive capacity is contributing significantly to the utilization of new knowledge, which fosters the corporate entrepreneurship activities and consequently success and survival. The precise dynamics of the interaction among the concepts are presented in the following chapter.
CONCEPTUAL MODEL

3.1 Introduction
This chapter describes the hypotheses and the conceptual model, which form the core of this study. In chapter 2, the main research concepts were discussed through the current literature in this academic field. Concepts like academic spin-offs, networks, entrepreneurial behavior and absorptive capacity are interconnected to each other and they set the basic setting for academic spin-offs to exploit networks in order to find resources, among them knowledge. The way these research concepts are interrelated is translated into hypotheses and it is discussed below. Later on, the conceptual model is proposed and depicts all the basic connections among the research concepts.

3.2 Academic spin-offs and networks
Academic spin-offs are newly founded firms that emerge from an academic environment. They are established by inexperienced individuals with lack of resources who should transform scientific findings into viable products and services (Vohora et al., 2004). These emerging firms need basic resources (Lechner et al., 2006; van Geenhuizen and Soetanto, 2009), which are critical to operate and succeed in the markets. The study conducted by van Geenhuizen and Soetanto (2009), which was related to the key obstacles of academic spin-off growth, indicated that the main resources missing are knowledge, skills, infrastructure and investment capital mainly generalized in market related, management, finance, physical and government fields.

From the resource-based view of the firm and the social capital theory, knowledge possessed by involved in networks individuals is an important source that affects start-ups growth (Lee, et al, 2001, Bosma et al., 2014). To be more specific, the resource-based view of the firm suggests that start-ups should follow strategies to accumulate intangible resources for survival and growth. Additionally, the social capital theory suggests that start-ups should pursue managerial strategies focused on the development of valuable networks with external resources holders in order to succeed (Lee et al., 2001). Thus, the resource-based view of the firm highlights the importance of knowledge as an intangible and hard to imitate resource (Lee et al., 2001) whereas the social capital theory is focused on the knowledge as a resource that is coming from the interrelation of the firms through the external networks. These two theoretical perspectives are completing each other, in
order to define the theoretical framework of the present research. Therefore, this combination of perspectives suggests that networks and the knowledge that derives from them are of high importance for the growth and survival of academic spin-offs (Bosma et al., 2004; Stam et al., 2014; Scholten et al., 2014).

As academic spin-offs are freshly established firms, they lack not only critical resources for growth and survival, but also reputation and credibility (Shane and Cable, 2002). This fact is raising more issues for academic spin-offs to obtain the essential for survival resources, which in theoretical construct is known as “liability of newness” (Brüderl and Preisendörfer, 1998; Vohora et al., 2004; Lechner et al., 2006) and “liability of smallness” (Witt, 2004; Lechner et al., 2006). As firms growing older, they gain external legitimacy by creating and developing relationships and obtaining support from its clients, creditors and suppliers (Freeman et al., 1983). Thus, new firms suffer from lack of external legitimacy, which in other words is called liability of newness and refers to the constraints that start-ups have to overpass the early stage of growth and become an established company (Vohora et al., 2004). As far as the liability of smallness is concerned, new companies are small and they lack of financial resources and support combined with weak inexperienced management (Freeman et al., 1983). Both issues are particularly relevant to start-ups that emerge from an academic environment, as they are managed by people with academic background but inexperienced in entrepreneurship.

Thus, academic spin-offs should overcome these impediments in order to acquire the critical for survival resources from their external environment, which occurs through essential for their survival and growth networks (Brüderl and Preisendörfer, 1998; Witt, 2004; Bosma et al., 2004). Based on the social capital theory and the resource-based view of the firm, entrepreneurs are tied in social networks and their entrepreneurial activities are not distinct from their social ones (Hoang and Antoncic, 2003). Thus, academic spin-offs are embedded in networks and they rely on these to obtain necessary resources to grow (Birley, 1985; Johannisson, 1988; Greve and Salaff, 2003; Soetanto and van Geenhuizen, 2010; Elfring and Hulsink, 2003).

3.2.1 Academic spin-offs age and strength of ties
Nevertheless, the social networks related to the academic spin-offs are not fixed, but dynamic (Granovetter, 1985; Greve and Salaff, 2003). As the academic spin-offs are growing, the social networks are evolving alongside their operations and needs (Hite and Hesterly, 2001). From the relational embeddedness perspective, there are many studies that have analyzed the development of networks for start-ups and they investigated whether start-ups are relying on strong or weak ties (Steier and Greenwood, 2000; Hite & Hesterly, 2001; Greve and Salaf 2003; Elfring and Hulsink, 2007; Soetanto & van Geenhuizen, 2010), as both types of ties have different implications to the knowledge transferred through them (Hansen, 1999). When academic spin-offs operate in networks with strong ties, there have more chances to overcome the liability issues, as they rely on family, friends and trustworthy relations (Birley, 1985; Johannisson, 1988) and thus it is easier to obtain resources and share knowledge. On the other hand, weak ties can give a larger search breadth that provides these firms with more and non-redundant information and thus more possibilities for opportunities recognition (Scholten et al., 2014) and entrepreneurial behavior in general.

For this reason, it is expected that young academic spin-offs are more likely to rely on strong ties because of their liability issues (Stam et al., 2014). The trust and the reciprocity that are entailed in the nature of strong ties (as they are connections with family, friends and close acquaintances) reduce the concerns for opportunistic behavior among the potential recourse providers (Krackhardt,
Later on, as the academic spin-offs are growing, they rely more on weak ties for non-redundant knowledge (Granovetter, 1973; 1983). Besides, weak ties entail less emotional attachment, which provides to the firms flexibility to search for new and additional knowledge that can support their growth (Stam et al., 2014). In other words, the strength of ties within a network will be decreased, as academic spin-off is growing. Thus, based on this line of reasoning, the first hypothesis will be:

**Hypothesis 1:** The strength of ties in an academic spin-off's network is negatively related to the age of the firm.

### 3.2.2 Academic spin-offs age and networks contacts background

Besides the strength of ties, networks contact background seems to play an important role to the utilization of new knowledge (Rodan and Galunic, 2005). The background of the contacts has been highlighted in many studies, in terms of diversity. Birley (1985) has highlighted the importance of the diversity by suggesting that diverse networks (with members from different backgrounds) are beneficial for the new firms, as they increase the scope of the resources and enable the entrepreneurs to quickly locate them (Stam et al., 2014). Besides this, it has been observed that diversity fosters knowledge transfer within networks (Reagans and McEvily, 2003) and the acquisition of competitive capabilities (McEvily and Zaheer, 2009; Stam et al., 2014).

Yet, the background of contacts has been an under research topic for many studies. Various distinctions of networks have been employed based on the contacts backgrounds. Hite and Hesterly (2001) identified two types of networks in order to explain the phenomenon of the network development for spin-offs, the identity-based and the calculative networks. They used this distinction based on the contacts background to describe the shift from the identity-based to calculative networks, as spin-offs evolve from emergence to early growth. The same phenomenon of networks development was also examined by Lechner et al. (2006). They identified five different types of networks based on the contacts background (social, reputational, marketing information, co-opetition and co-operative networks). However, the development was not based on the growth of the firm but according to the entrepreneurial activities of spin-offs. No matter what, the importance of the existence of various networks has highlighted and was typically named as "relational mix" (Lechner et al., 2006).

Another study relevant with networks distinction based on the contacts background was employed by Lee et al. (2001). They have made a distinction of two types of networks; one with sponsorship-based linkages and another with partnership-based linkages, in order to conceptualize the social capital of spin-offs. According to Lee et al. (2001), sponsorship-based relations are “unilateral relationships as the sponsor commits unilateral support to a business venture without receiving explicit rewards”, whereas partnership-based relations are “cooperative, bilateral relationships in which partners give and take resources and maintain long-term ties”. The main distinction is mainly based on the explicitness of the rewards for the involved actors and was employed to conceptualize the social capital oh high-tech firms.

The present study will be based on this distinction of networks according to contacts background, including however some adjustments regarding the explicitness of rewards, in order to correspond to the data of the study. To be more specific, the distinction of the contacts background is also determined by the involvement of the third parties to the decision making of the spin-offs. Thus, contacts that are involved in the decision making processes and have expectations from these
decisions are regarded as partnership-based relations, whereas the sponsorship-based relations are relations that provide support and they do not interfere to the spin-offs operations.

Thus, contacts that belong to this type of networks are coming from government agencies or other organizations that provide resources to the spin-offs in order to help them during the vulnerable stage of emergence (Lee et al., 2001). For this study, the contacts are coming from the incubator, other spin-offs and consultancy firms or they are close acquaintances such as family and friends. Thus it seems that young ventures can acquire support and gain legitimacy for further exploitation of scarce resource (Lee et al., 2001). In other words, the sponsorship-based linkages of this network will help the young spin-offs to overpass the issue of the liability of newness. Thus, it is expected that the academic spin-offs are relying less on sponsorship-based relations as they are growing older. Thus it can be hypothesized that:

**Hypothesis 2: The Sponsorship-based relations in an academic spin-off’s network are negatively related to the age of the firm.**

On the other hand, there are networks with partnership-based linkages that are characterized by bilateral relationships with external components (Lee et al., 2001). External components refer to actors from the external environment of spin-offs, such as other firms in the industry, universities or venture associations (Lee et al., 2001). For the purposes of this study, the partnership-based relations encompass contacts from universities and the industry. Thus, this type of linkages offers to the spin-offs additional complementary resources in order to achieve their goals and develop new entrepreneurial opportunities (Lee et al., 2001). In other words, the partnership-based relations are developing more as the firm has already overpassed its liability of newness issues (e.g. lack of credibility or legitimacy). This means that the spin-offs are relying more on this type of linkages in the later phases of growth. Thus, for the academic spin-offs as well, it is expected to rely on networks with more partnership-based relations as they are growing older. For this reason, it is proposed that:

**Hypothesis 3: The Partnership-based relations in an academic spin-off’s network are positively related to the age of the firm.**

### 3.3 Academic spin-off networks and realized absorptive capacity

Knowledge has been found to be a critical resource (Lee et al., 2001), for sustained competitive advantage (Yli et al., 2001; Schildt et al., 2012) and thus survival. But knowledge is a resource difficult to manage (Davenport and Prusak, 1998). For this reason, there is an increasingly interest from the academics for the knowledge management capabilities. This capability is called absorptive capacity and refers to the ability of organizations to acquire, assimilate, transform and exploit knowledge from the external environment (Zahra and George, 2002).

At the same time, academic spin-offs are founded by inexperienced in entrepreneurship academics, whose purpose is to exploit the scientific knowledge for commercial ends (Vohora et al., 2004; Soetanto and van Geenhuizen, 2010). Academic spin-offs are knowledge intensive settings as highly educated people are involved, whereas the whole concept behind their foundations came up from highly intensive knowledge environments (universities). However, combining scientific findings with external market and technical knowledge is a key to the success of these firms. Hence, absorptive capacity is claimed to play a critical role in combining resources effectively in order to build new capabilities (Khodaei et al., 2014).
The four dimensions of the absorptive capacity can be grouped in two others, the potential absorptive capacity and the realized absorptive capacity (Zahra and George, 2002). However, there are many critics regarding the two dimensions of absorptive capacity both in contextual and definitional terms (Todorova and Dursin, 2007; Andersén and Kask, 2012). The two dimensions are not present in equal levels in organizations (Andersén and Kask, 2012). It has been claimed that potential absorptive capacity is the most of the times in lower levels that the realized one, as it demands full awareness of the management team, which is practically impossible (see section 2.6.3). Moreover, according to our understanding, the transformation and exploitation of knowledge is especially pertinent for the academic spin-offs, as it is the dimension that actually utilizes the knowledge and increases the possibilities to bring high-end results and thus survival and growth. For this reason, the present study will be focused on the realized absorptive capacity.

3.3.1 Strength of ties and realized absorptive capacity
For academic spin-offs, networks play a central role for their survival. Right after their establishment, they rely on strong ties to acquire the important for survival knowledge, as they include trust and intimacy. The emotional attachment that characterizes these relations broadens the range of topics discussed and thus the incoming knowledge (Ebers and Maurer, 2014). Founders in the academic spin-offs are transforming knowledge to exploit it later by maintaining and reactivating knowledge. In order to achieve this, prior knowledge in a given field is needed (Cohen and Levinthal, 1999; Ebers and Maurer, 2014). Especially when complex and non-codified knowledge is involved, common language and shared experiences are required for the translation of it (Khodaei, et al., 2014). This means, that the transformation of the new knowledge will be efficiently achieved when the interaction with close people is employed, as they possess common knowledge and experience. In other words, strong ties are expected to stimulate the process of transformation, as the academic spin-off founders are interacting with friends and close associates. This means, that the strong ties are beneficial for the transformation of the newly acquired knowledge.

At the same time, the exploitation of the transformed knowledge refers to the extension and elaboration of existing competencies or creating new ones by incorporating acquired and transformed knowledge into its operations (Zahra & George, 2002). The efficiency of this process is highly dependent on the integration of the specialized knowledge in the primary operations (Khodaei et al., 2014). Academic spin-offs founders are possessing high specialized knowledge in given fields. This fact in combination with reliable knowledge by trustworthy people the strong ties are providing, it makes it more likely for the academic spin-offs to utilize this type of knowledge (Ebers and Maurer, 2014). Thus, it is expected that strong ties are acting as leverage for the exploitation of knowledge in the academic spin-offs. Accordingly, it is proposed that:

**Hypothesis 4:** The strength of ties in academic spin-off’s networks is positive related to the realized absorptive capacity of the firm.

3.3.2 Network contacts background and realized absorptive capacity
The background of network contacts has been highlighted by many studies to increase the scope of the resources and enable the entrepreneurs to quickly locate them (Reagans and McEvily, 2003; Stam et al., 2014). As has been already mentioned, the main distinction for the present study regarding the types of networks is the networks with sponsorship-based relations and the other with partnership-based relations.
As far as the sponsorship-based relations is concerned, the contacts background can be either from sponsorship-type organizations, like governmental organization providing grants, or incubators providing resources in favorable terms (Lee et al., 2001). However, sponsorship-based relations for the academic spin-offs of the present study are based on close acquaintances, like friends or family, contacts from the incubator, from other spin-offs or from consultancy firms. The main characteristic of these close relationships is that both parties are sharing common knowledge and experience. However, the common knowledge and experience are considered to be critical facilitators of knowledge exchange (Cohen and Levinthal, 1990). Even when the relations are not that close, the sponsorship-based relations are containing people from different backgrounds, which offer non-redundant knowledge because of the diverse backgrounds. This diversity has been observed to foster the knowledge transfer within networks (Reagans and McEvily, 2003) and the acquisition of competitive capabilities (McEvily and Zaheer, 2009; Stam et al., 2014).

For the academic spin-offs, to take advantage of all the resources provided, a developed capability of exploitation of the knowledge is required. As they are connected with close acquaintances with common knowledge and experience, great amount of incoming knowledge flows in the spin-offs. Even the relations that are not characterized by intimacy (e.g. consultancy firms) there is abundance of resources provided under favorable conditions (Lee et al., 2001). This means that either through intimacy or not, great amount of knowledge is coming from the sponsorship-based relations. Moreover, the sponsorship-based relations are providing diverse and non-redundant knowledge coming from diverse backgrounds. Thus, the academic spin-off should have advanced capability for knowledge transformation and exploitation. In other words, a high degree of realized absorptive capacity is needed. For this reason, it is expected that the sponsorship-based relations are stimulating the transformation and exploitation of the incoming knowledge. Thus:

**Hypothesis 5:** The Sponsorship-based relations in an academic spin-off’s network are positively related to the realized absorptive capacity of the firm.

As far as the partnership-based relations are concerned, they are characterized by infrequent and formal interaction, as they entail contacts from unrelated backgrounds (Lee et al., 2001). To be more specific, the partnership-based relations encompass are relations with people coming from universities and other firms from the industry. This means that they can be people with different types of backgrounds. Diversity in contacts backgrounds increases the scope of resources available to the academic spin-offs (Stam et al., 2014).

Under the same principle, when an academic spin-off are embedded in diverse networks the scope of the available knowledge coming from diverse contacts background increases (Rodan and Galunic, 2005; van Geenhuizen and Soetanto, 2007). This increase of the knowledge range is giving awareness to the academic spin-off entrepreneurs of where specific knowledge is spotted. Thus, as entrepreneurs are recognizing consciously valuable knowledge are getting more willing to transform it and exploit it. In other words, the network diversity increases the ability of the academic spin-off entrepreneurs to value the incoming knowledge in order to transform it and exploit it in later phases. According to this line of reasoning, it is expected that:

**Hypothesis 6:** The Partnership-based relations in an academic spin-off’s network are positively related to the realized absorptive capacity of the firm.
3.4 Entrepreneurial behavior and realized absorptive capacity

Entrepreneurial behavior is defined as the concept that involves all actions that are taken by firms members and is related to discovery, evaluation and exploitation of entrepreneurial opportunities (Shane and Venkataraman, 2000; Kuratko et al., 2005). In other words, entrepreneurial behavior involves exploration of new opportunities. In order to be involved in such newness of things, entrepreneurial teams of academic spin-offs should operate entrepreneurially in order to absorb as much knowledge as possible and thus reassure awareness and survival (Walter et al., 2006).

For the present study, entrepreneurial behavior is depicted by the entrepreneurial orientation and the entrepreneurial team efficacy. Entrepreneurial orientation is defined as “the processes, structures and behaviors of firms that are characterized by innovativeness, proactiveness and risk taking” (Miller, 1983), whereas entrepreneurial team efficacy or collective efficacy, as stated by Guzzo et al. (1993) is defined "as the individual's belief that a group can perform successfully" (Durham et al., 1997). Entrepreneurial orientation depicts the tendency of firms for innovativeness, proactiveness and risk taking, whereas entrepreneurial team efficacy, the group commitment and confidence for attaining entrepreneurial goals.

3.4.1 Entrepreneurial orientation and realized absorptive capacity

The entrepreneurial orientation of firms motivates the firm to leverage knowledge from the external environment and combine it with the existing one (Winklund and Shepherd, 2003). This combination of the new and old knowledge creates new ideas and requires advanced transformation capability. At the same time, innovativeness indicates the commitment of firms to introducing new products and services to the marketplace (Covin and Slevin, 1990; Kreiser, 2011). In order to do so, companies have to exploit new ideas and knowledge in general to create these artifacts. This process presupposes advanced exploitation capability. For the dimension of proactiveness, which refers to the posture of acting on future wants and needs through strategic moves (Covin and Slevin, 1990), advanced ability to exploit new knowledge is needed, as the firm should be able to realize the right timing for action. Without new knowledge, the alertness of firms is impossible. Last but not least, the dimension of risk taking refers to the commitment of new projects without reassurance of positive results (Khodaei et al., 2014). This action presupposes decision making (for the commitment to the project or not), which as has been mentioned by Keh et al., (2007), extensive knowledge utilization is needed. Thus, the risk taking dimension requires both knowledge transformation and exploitation abilities from the firm. In general, taking into account the aforementioned description of the dimensions of the entrepreneurial orientation, it is expected to be a relation between the entrepreneurial orientation and the realized absorptive capacity. Thus, it is proposed that:

Hypothesis 7: The entrepreneurial orientation of academic spin-off is positively related to the realized absorptive capacity.

3.4.2 Entrepreneurial team efficacy and realized absorptive capacity

As stated earlier, the entrepreneurial team efficacy is the group commitment and confidence for attaining entrepreneurial goals. In general the entrepreneurial team efficacy represents the motivation of the entrepreneurial team to realize goals. It depicts in the individual level the tendency to set challenging goals with high returns, to persist more for the achievement of them even in stressful environments and recover quickly from failure (Bandura, 1997; Chen et al., 1998; McGee et al., 2009). In other, words entrepreneurial team efficacy presupposed persistence and strong motivation. Given that transformation and exploitation capacity is expected to be related to the level
of motivation of employees (Liao et al., 2003; Gray, 2006), it seems that the entrepreneurial team efficacy is related to the realized absorptive capacity. To be more specific, Dyer and Singh (1998) have given emphasis on motivation in order to propose a broader relational view of absorptive capacity (Lane and Koka, 2006). From the dynamic capability perspective, Dyer and Singh (1998) proposed that the level of motivation is affecting the degree of exchange and exploit knowledge. Thus, entrepreneurial teams with high motivation and persistence for their goals realization are likely to be very willing to exploit new incoming knowledge. This means that academic spin-offs with entrepreneurial team efficacy are more likely to develop the capability to transform and exploit the knowledge. Hence, it is expected to be a relation between the entrepreneurial team efficacy and the realized absorptive capacity. Thus:

**Hypothesis 8:** The entrepreneurial team efficacy of academic spin-off is positively related to the realized absorptive capacity.

### 3.5 Academic spin-off age and realized absorptive capacity

From the literature review so far, it is highlighted the evolutionary nature of networks alongside the growth of the firm. This means that it is expected to be a significant relation between the network characteristics and the age of the firm. Given that the networks are also expected to have a significant relation with the realized absorptive capacity, it will be very interesting to examine the possible relation of the academic spin-off age with its realized absorptive capacity.

As the firms are growing older, the founders and the entrepreneurial team in general are gaining experience regarding both the way they interact with external entities or among them. This means that the more the academic spin-offs are growing, the more the level of experience possessed by the entrepreneurial team. Cohen and Levintal (1990) in their seminal work pinpointed that experience is stimulating knowledge utilization. This notion was also adopted by Zahra and George (2002), who have proposed experience as an antecedent of absorptive capacity. To be more specific, they proposed that as the firms are gaining more experience regarding their routines, it is easier for them to preserve the transformation and exploitation capability of knowledge. Thus, it is expected that as the academic spin-offs are growing older and gain experience, they can transform and exploit knowledge easier. Accordingly, it is hypothesized that:

**Hypothesis 9:** The age of academic spin-off is positively related to the realized absorptive capacity.

Besides the direct effect of academic spin-off age on the realized absorptive capacity, it is expected that it can moderate the relation between the relational networks characteristics with the realized absorptive capacity.

As it has been discussed, as academic spin-offs are growing, their business needs of new resources and information are changing. As a result, these continuously changing business needs are forcing the development of their networks. The development of the academic spin-off networks refers to changes, in which firms adapt and align their networks to gain critical resources for survival (Hite and Hesterly, 2001).

From the relational embeddedness perspective, there are many studies that have analyzed the development of networks for start-ups and they investigated whether start-ups are relying on strong or weak ties (Steier and Greenwood, 2000; Hite & Hesterly, 2001; Greve and Salaf 2003; Elfring and
Hulsink, 2007; Soetanto & van Geenhuizen, 2010), as both types of ties have different implications to the knowledge transfer (Hansen, 1999). It is has been proposed by many studies and it is also expected by this one, that the strength of ties is negatively related to the age of the firm. At the same time, it is expected that the strength of the ties is positively related to the realized absorptive capacity. However, as companies are growing older, and receive knowledge from strong ties, it is expected to be a redundancy to knowledge and thus a decrease in the realized absorptive capacity. For this reason:

**Hypothesis 10**: The strength of ties in an academic spin-off’s network is negatively related to the realized absorptive capacity as the firm is growing older.

Besides strength of ties, the development of networks as spin-offs are growing older is reflected to the networks contact background as well. As mentioned earlier, it is expected that as spin-offs are growing older, the Sponsorship-based relations in networks are decreasing as they cannot cover the constantly changing needs neither face the different challenges. Accordingly, it is expected that as the firms are growing older and they still rely on the Sponsorship-based relations, knowledge redundancy is expected, which consequently will affect negatively the ability of the firm to transform and exploit the knowledge. On the contrary, as firms are ageing, it is expected to have more Partnership-based relations in their firm. Having already overpassed the liability and credibility issues, companies are relying more on partnerships with other firms or key organization like universities, to broad their locus of knowledge. As they broad their knowledge scope, more and new knowledge is inflowing the firm. Hence, it is expected to have a positive impact on their ability to transform and exploit knowledge. Thus, for the Sponsorship-based relations and the Partnership-based relations it is expected that:

**Hypothesis 11**: The Sponsorship-based relations in an academic spin-off’s network are negatively related to the realized absorptive capacity as the firm is growing older.

**Hypothesis 12**: The Partnership-based relations in an academic spin-off’s network are negatively related to the realized absorptive capacity as the firm is growing older.
3.6 The conceptual model

Based on the literature review and the hypotheses formulation presented earlier in this chapter, the importance of networks and the entrepreneurial behavior for the academic spin-offs and the impact of them to their realized absorptive capacity are understood. The detailed interconnections between the concepts of this thesis are outlined in the Figure 3 below:

Figure 3: The conceptual model
METHODOLOGY

The present chapter presents the methodology approach that will be used, to reach the objectives of the present study. In the beginning, the research strategy to obtain results for the analysis will be explained. Afterwards, the data used for the analysis will be discussed, its main characteristics and the translation of data into operational measures. Last but not least, the main methods to conduct the analysis will be presented.

4.1 Research approach

In order to answer the research questions and reach the research objective discussed in Chapter 1, a desk research will be employed. As stated by Vershuren and Doorewaard (2010), desk research is the research strategy where the researcher is using material that was not gathered by himself or herself, but uses material produced by others. It is characterized by (1) the use of existed material, (2) the absence of direct contact with the research object and (3) the use of the material in a different perspective than at the time of its production. There are two main variants of desk research; (1) the literature review and (2) the secondary research, which are combined. The advantages of the present research approach is that the researcher is able to find data in a short time and also test the multiple relations between them, however there is the disadvantage that the under analysis data were collected for other than the purpose of the later research (Vershuren and Doorewaard, 2010).

For the present thesis, the desk research approach was followed. An extended literature review was conducted and the main research concepts were analyzed. After this, the basis of the theoretical framework that supports the conceptual model was set. Having defined the theoretical framework of the research, it is possible to formulate the hypotheses that will be tested with the secondary empirical data. This means, that a quantitative analysis will be employed.

The advantage that the present research has over the general desk research approach is that the provided data from the TSE sector in TUDelft, has been collected for studies similar to the present. However, there is shortage of data that forces the analysis to be distinguished in two main models. The first model examines the development of the network as spin-offs are growing and it will be employed with bivariate correlations. The second model examines the impact of network characteristics to the realized absorptive capacity and the impact of entrepreneurial behavior for the realized absorptive capacity as well. Last but not least, the development of realized absorptive
capacity as they academic spin-offs are growing older is examined and the moderating effect of the age to the relation of networks and the realized absorptive capacity. This analysis will be employed by multiple regression analyses. In order to employ this, nine specific variables were used. The main features of the models and the data used will be used are discussed in the following sections. Till then, the two statistical models with the analysis methods are presented below in Table 2.

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<th>Statistical Model 1</th>
<th>bivariate correlation</th>
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<th>Statistical model 2</th>
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Table 2: The analysis methods for the two statistical models

4.2 Data used

The data used to test the hypothesis of the present study, are empirical secondary data that has been already collected in 2011. This dataset belongs to the Technology, Strategy and Entrepreneurship sector in the Technology, Policy and Management faculty and is related to the academic spin-offs that are located in Delft and in Wageningen and have been emerged from TU Delft and Wageningen University respectively.

The research will be based on young technology-based spin-offs that commercialize knowledge created in academic environment and they are no older than 7 years old. This means that the generalization of findings can be drawn for academic spin-offs that are no more than 7 years old and the products and services commercialized are high technological artifacts coming from academic knowledge. Moreover, the region is the Netherlands, so the generalization will be achieved for academic spin-offs that operate within well developed countries in European Union. Last but not least, with regards to industry sectors, generalization can be achieved to spin-offs belonging to information technology, medical technology, clean technology, industrial solutions and agribusiness and food.

The data was collected through an annual online survey that is realized every year by the management of the incubators. The survey employed was a closed items survey through questionnaires. Questionnaires included questions where the responses were codified in a seven-point Likert scale and some open questions were included for simple information such as dates and ages. The quality of the data was tested in previous studies, but no indication of bias was found (Khodaei et al., 2014).
As far as the extent of the dataset is concerned, there are 31 valid responses by academic spin-offs from Wageningen University and 65 responses from TUDelft, which means 96 responses in total. However, in order to fulfill the very purpose of the study, 60 observations will be used to analyses the first model and 52 responses for the second one. This happens because academic spin-offs that participated either have not completed the questionnaires or the responses that they gave were too extreme to stay in the active dataset. For instance, there were observations where the respondents blindly indicated all the dimensions of variables to the highest value of the scale (e.g., There are responses which companies indicate extreme scores in all dimensions of specific variables, such as absorptive capacity). These observations were taken out to avoid bias in the results.

The data are coming from responses by the entrepreneurs of spin-offs who most of the times were the founders as well. Additional complementary secondary data, such as the industry that the spin-offs operate or their foundation years, was collected from organization material (e.g., booklets), databases (from the TSE department) and internet websites (e.g., LinkedIn and spin-off websites).

### Statistical Model 1

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<td>TUDelft: 39</td>
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### Table 3: The two Statistical Models of the analysis

#### 4.3 Construction of variables

#### 4.3.1 Strength of ties

The first network variable that will be used is the strength of ties. The ties between an ego and the rest of actors in a network can be either strong or weak and according to their nature are contributing differently. In order to specify the strength of each tie for spin-off in the network, the intimacy, frequency, and duration of every contact was measured. This means that three items were used for the measurement of these characteristics. The intimacy and frequency were measured in a seven-point Likert scale, whereas the duration of the relationship was an open question, where participants had to indicate the number of years that knew each person. The way of measurement is based on the Granovetter's theory (1973) that the strength of ties depends on sum of intimacy, frequency, and duration of every contact. The networks of spin-offs involve maximum 5 contacts. The participant was asked to specify initials of the name of every contract, to increase the reliability of answers and then, how many years he knows the person (duration), how frequent they interact.
(frequency) and how well he knows him/her (intimacy). In other words, there are in total 15 variables that describe the strength of ties for every network (see Appendix A).

However, in order to sum up the three dimensions of tie strength, a standardization of the responses was necessary, as the scale measurement are different. The standardization involves transformation of a variable to a z-score. The mean of score are turning into 0, and its standard deviation becomes 1. This happens, because if summation was with the unstandardized variables, then the score from variable that describes the years of contact with the person would have dominated to the other two variables which values are from 0 to 7. The standardization of variables presented an acceptable degree of reliability (Cronabch’s a = 0.847).

In order to create an integrated variable that depicts the strength of all ties in the network, the strength of each tie was first calculated. As all three variables have positive direction. For this reason we can calculate the strength of each tie by summing up the three dimensions that describe strength of each tie. Thus, the strength of ties is resulting by the formula:

\[
\text{Strength of each tie} = Z_{\text{frequency}} + Z_{\text{intimacy}} + Z_{\text{duration}}
\]

Then having calculated the strength of each tie in the network, the integrated variable that depicts the total strength of ties for every spin-off network resulted by the formula:

\[
\sum_{i=1}^{n} \text{strength of each contact tie}
\]

where n is the number of contacts for every network.

4.3.2 Sponsorship-based relations
The Sponsorship-based relations is the variable that depicts relations with close acquaintances in the network that are willing to contribute to the spin-off growth with resources, such as finances, new knowledge etc. As has been mentioned in Chapter 3, the distinction of the two types of networks contacts background is mainly based on the study employed by Lee et al. (2001). According to them, the distinction is employed by the explicitness of rewards between the involved members of the relations. In addition, for this research the distinction is also determined by the involvement of the contacts in the spin-off operations.

Based on these, the Sponsorship-based relations variable is measured by four indices related to the contacts background; family/friends, incubator, consultancy firms and other spin-offs. Close acquaintances like family and friends are providing spin-offs with resources without expecting benefits as exchange. The same is applied for incubator and other firms, but not for consultancy firms, as they are getting paid for the support they offer. However, as they are not involved in decision making and they do not have any expectations besides the financial incentives to support them, they can be grouped in the sponsorship-based relations. On the other hand, entities that belong to the Partnership-based relations are involved in the operation of spin-offs as their expectations and rewards are directly influenced by the decision making of spin-offs.

Under the same manner that the strength of ties variables was measured, the maximum number of contacts was 5 (see Appendix A). Having 4 backgrounds related to the sponsorship-based relations, the number of variables depicting this construct is 20. The reliability analysis indicated that the measurement is reliable (Cronbach’s a = 0.617) and as all of them are characterized with positive direction, the integrated variable Sponsorship-based relations came up by the summations of the
number of contacts that belongs to every background. Thus, the sponsorship-based relations variable emerges from the formula:

\[
\sum \text{contacts from family/friends} + \sum \text{contacts from incubator} + \\
\sum \text{contacts from consultancy firms} + \sum \text{contact from other spinoffs}
\]

4.3.3 Partnership-based relations
The partnership-based relations variable is measuring the relationships with the university and the industry to reach strategic agreements for further development, such as R&D projects or technology exchange programs (Lee et al., 2001). This variable is constructed with exactly the same way to the previous one and involves 10 measurement items. The reliability analysis indicated that this construct does not reach the acceptable reliability level (Cronbach's α = 0.559). However, it will be used as there is no alternative variable that can be constructed with the available data.

\[
\sum \text{contacts from university} + \sum \text{contacts from industry}
\]

4.3.4 Entrepreneurial orientation
The entrepreneurial orientation variable is measuring the ability of entrepreneurs to scan their environment to find new opportunities in order to strengthen their competitive position. The measurement of entrepreneurial orientation was based on a seven-point Likert scale as introduced by Covin and Slevin (1990). This scale examines the three dimensions of entrepreneurial orientation; innovativeness, risk taking and proactiveness. Each dimension is measured by three variables. As these variables measure the three dimensions of the object, the final construct is integrated in one and derives from the summation of these dimensions.

\[
\sum \text{innovativeness} + \sum \text{risk taking} + \sum \text{proactiveness}
\]

The reliability analysis led to the exclusion of three variables from the first three dimensions of entrepreneurial orientation. However, the greatest score that derive from the reliability analysis was not possible to reach the adequate level of reliability (Cronbach's α = 0.516).

4.3.5 Entrepreneurial Team Efficacy
The second dimension of entrepreneurial behavior is the entrepreneurial team efficacy. The team efficacy depicts the engagement to entrepreneurial activities and results in stronger opportunity recognition. The measurement of the team efficacy was employed by a seven-point Likert scale that has been already used by previous studies (Kickul et al., 2009; McGee et al., 2009). Seven items measured the ability of the start-up team to perform and be engages in entrepreneurial activities. The participants were asked to indicate their confidence for their team performance regarding entrepreneurial activities (see Appendix A).

In order to examine the number of variables that can derive from the measurement of the items, exploratory factor analysis was employed. For the factor analysis, Principal Component Analysis (PCA) was applied with orthogonal rotation\(^4\). The factor analysis extracted one single factor with loadings from .747 to 869. Thus, the team efficacy variables emerged from the addition of the seven

---

\(^4\) Varimax rotation and Kaiser Normalization
indices of team efficacy\(^5\) whereas the reliability analysis indicated acceptable level (Cronbach’s a = 0.91).

### 4.3.6 Realized Absorptive capacity

The measure of the realized absorptive capacity depicts the ability of spin-offs to transform and exploit knowledge that was acquired and assimilated from the external environment. At this point it should be mentioned that the dataset is including variables that depict the potential absorptive capacity as well. The initial purpose of the data collection was to depict all the four dimensions of the absorptive capacity (acquire, assimilate, transform and exploit). For this reason, an exploratory factor analysis was employed to realize the various dimensions of this variable.

The items used to measure the absorptive capacity are based on existing items and measures of related constructs using a seven-point Likert scale. Three items were used from the study by Lichtenhaler and Lichtenhaler (2009), four items from Zahra et al., (2007) and nine items from Jansen et al. (2005). However, since the items were used for large companies, they were adapted to the scale of spin-offs. In total, there are 16 items that measure all the four dimensions of absorptive capacity, however, in order to decrease the complexity of the present analysis, the absorptive capacity will be analyzed in the two dimensions; the potential and realized absorptive capacity (see Appendix A).

In order to get these two dimensions, exploratory factor analysis was employed. The exploratory factor analysis was realized with Principal Component Analysis (PCA) and orthogonal rotation\(^6\). The outcomes of the Kaiser-Meyer-Olkin test of 0.713 (> 0.50) and Bartlett’s test of sphericity (\(X^2 = 439.8, p=0.000\)) suggests that the application of factor analysis is justified.

The first factor analysis indicated that one item should be taken out, as its factor loading was less than 0.3. From the 15 items left, the second factor analysis suggested that there are three items that measure the potential absorptive capacity that tend to group with the measures from the realized one, and some of them with high factor loadings (eg. 0.832). For this reason, these three items were taken out. The third factor analysis employed, clearly suggested the two factors for the absorptive capacity with factor loadings >.41. For a detailed view of the results of the factor analysis see table XI.

Thus, the potential absorptive capacity involves five measurement items that depict the acquisition and assimilation, whereas the realized absorptive capacity includes seven items that measured the transformation and exploitation ability of the spin-off. As far as realized absorptive capacity is the main variable that will be analyzed in the present study, the last 7 measures are contributing to an overall reliable variable (Cronbach’s a = 0.718). Last but not least, the realized absorptive capacity variable resulted from the multiplication of each measurement by the corresponding factor loadings, which then was added up and divided the number of involved items. The realized absorptive capacity variable emerges from the formula:

\[
0.410 \cdot \text{Item6} + 0.655 \cdot \text{Item7} + 0.490 \cdot \text{Item8} + 0.700 \cdot \text{Item9} + 0.745 \cdot \text{Item10} + 0.354 \cdot \text{Item11} + 0.809 \cdot \text{Item12}
\]

\(^5\) All of the loadings emerged from the exploratory factor analysis are very close to 0.8. Thus, a simple summation was used instead of weighted average.

\(^6\) Varimax rotation and Kaiser Normalization
Factor analysis for absorptive capacity

<table>
<thead>
<tr>
<th>Potential absorptive capacity</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>0.878</td>
<td></td>
</tr>
<tr>
<td>Item 2</td>
<td>0.891</td>
<td></td>
</tr>
<tr>
<td>Item 3</td>
<td>0.856</td>
<td></td>
</tr>
<tr>
<td>Item 4</td>
<td>0.756</td>
<td></td>
</tr>
<tr>
<td>Item 5</td>
<td>0.779</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Realized absorptive capacity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 6</td>
<td>0.410</td>
<td></td>
</tr>
<tr>
<td>Item 7</td>
<td>0.655</td>
<td></td>
</tr>
<tr>
<td>Item 8</td>
<td>0.490</td>
<td></td>
</tr>
<tr>
<td>Item 9</td>
<td>0.700</td>
<td></td>
</tr>
<tr>
<td>Item 10</td>
<td>0.745</td>
<td></td>
</tr>
<tr>
<td>Item 11</td>
<td>0.354</td>
<td></td>
</tr>
<tr>
<td>Item 12</td>
<td>0.809</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Factor analysis results for absorptive capacity

4.3.7 Age of academic spin-off

In this model the independent variable used is the age of academic spin-offs. The age varies between 1 and 7 years old. The starting point of calculating the age is the foundation year as registered in the Chamber of Commerce. The measurement of this variable is straightforward. The years of foundation is subtracted from the year of the data collection (2011) and described by the formula:

\[
\text{Age} = 2011 - \text{year of foundation}
\]

4.3.8 University

Last but not least, the variable University indicates the environment that the spin-off emerged. As has been already mentioned spin-off in this particular study come either from Wageningen University or TUDelft. The University variable is a variable that for value ‘0’ indicates that the academic spin-offs comes from Wageningen University, whereas the value ‘1’ indicates that comes from TUDelft.

As stated in section 4.1, the analysis of the thesis is employed by two statistical models. The first one is examining the development of spin-off networks throughout their growth, whereas the second one the impact of the network and the entrepreneurial behavior on the realized absorptive capacity. Besides the data that vary for the analysis of the aforementioned models, the variables and the methods that will be used to reach the purpose of this thesis vary, as well.

Under the same principle, the independent, dependent and control variables that will be used to employ the present analysis are not the same for every statistical model. For this reason, the following table sums up the type of variables for the two models.


### Statistical Model 1

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Dependent variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Strength of ties</td>
</tr>
<tr>
<td></td>
<td>Sponsorship-based relations</td>
</tr>
<tr>
<td></td>
<td>Partnership-based relations</td>
</tr>
</tbody>
</table>

### Statistical Model 2

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Dependent variable</th>
<th>Control variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength of ties</td>
<td>Realized Absorptive Capacity</td>
<td>Age</td>
</tr>
<tr>
<td>Sponsorship-based relations</td>
<td></td>
<td>University</td>
</tr>
<tr>
<td>Partnership-based relations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entrepreneurial Orientation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entrepreneurial Team Efficacy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Type of variables for the Statistical Models

#### 4.4 Data Descriptives

In order to have a clear overview of the datasets that will be used for the two statistical models of the analysis, the descriptives of the variables used are presented in this section. For the Statistical Model 1 the descriptives of the variables used are presented in table 6 and for the Statistical Model 2 in the table 7.

<table>
<thead>
<tr>
<th>Age of academic spin-off</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
<td>3</td>
<td>1.73</td>
</tr>
</tbody>
</table>

Table 6: Descriptives for statistical Model 1

<table>
<thead>
<tr>
<th>Age of academic spin-off</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>52</td>
<td>2.58</td>
<td>1.36</td>
</tr>
</tbody>
</table>

Table 7: Descriptives for statistical Model 2
4.5 Analysis Methods

Based on the different statistical models that will be realized to examine the networks, the entrepreneurial behavior and the realized absorptive capacity for academic spin-offs as they grow, two different methods will be used, according to the two models of the study.

For Statistical Model 1, a bivariate correlation analysis will be employed. Bivariate correlation is the statistical method that indicates the possible fluctuation between two or more variables. In other words, the correlation indicates the covariance between variables. As the variance represents the average amount that a group of data varies from the mean, accordingly the covariance refers to this average amount of variance for every variable from the mean. When two variables are related, then it is expected that the changes in one variable are met with similar changes to the other (Field, 2009).

For Statistical Model 2, multiple regression analysis will be employed. The multiple regression analysis is the statistical method that predicts values from a dependent variable from multiple independent variables. The multiple regression analysis is a multivariate technique that is used very often in business research (Uma and Roger, 2003). The relation of the predicted variable with the independent variables is predicted in a linear way. This means that the data are summarized in straight line. This summation of data in a straight line is called regression model and can be described as the equation which involve the independent variables that describe the dependent one (Field, 2009).

Both statistical methods and in general the whole statistical analysis involved in the research is employed with the statistical program IBM SPSS Statistics 20.

4.6 Conclusion

In this chapter the methodology of the analysis was described. It seems that there will be two different statistical models according to the dataset provided. This happened because of inconsistent responses to the questionnaires by the participants. For the two statistical models, different types of variables are involved. Besides, different methods will be used to analyze the proposed conceptual model, namely correlation and multiple regression analyses. A summary of the two statistical models and the respective characteristics and methods is presented in Appendix B.
RESULTS
The present chapter presents all the analysis that was employed according to the methodology described in Chapter 4. The analysis will be distinguished in two general statistical models. One to analyze the relation of academic spin-off age with the networks, in terms of strength of ties and the background of the contacts and the second model for analysis of the relation between spin-off networks and entrepreneurial behavior with the realized absorptive capacity. Last but not least, second statistical model entails the analysis of the moderation effects of academic spin-off age to the relation between the networks and realized absorptive capacity. In the end, a discussion upon the results of the analysis will be presented.

5.1 Statistical Model 1 – Bivariate Correlation Results
The analysis of Statistical Model 1 is employed with bivariate correlation, in order to test the Hypothesis 1, 2 and 3. As mentioned in the previous chapter, the option of this method mainly happened because of shortage of data. But besides this, there are conditions that should be satisfied in order to opt for the specific bivariate correlation. The first condition that should be examined before opting for which tests are the appropriate for the dataset used, is whether the data used are parametric or not. Accordingly, there should be used parametric or non-parametric statistical tests. In case non-parametric data are tested in parametric tests, inaccurate results will be generated (Uma and Roger, 2003). In general, there are four assumptions that should be satisfied for a dataset to be parametric namely normality of data, homogeneity of variance, interval data and independence of measures (Field, 2009).

For the present analysis the Kolmogorov-Smirnov test was employed in order to test the normality (the first assumption) of the data. Generally speaking, the significance of variable indicates a deviation from normality. In this test then, the more significant the results the less normal they are (Field, 2009). The Kolmogorov-Smirnov test indicated that for the variables Age of academic spin-off, Sponsorship-based relations and Partnership-based relations indicated high significance (p<.001). This means that the dataset for these variables are non-parametric. As far as the Strength of ties is concerned, the data is normally distributed (non-significant). The Kolmogorov-Smirnov test suggested that three out of four variables are representing data that are non-parametric. For this
reason, non-parametric test will be used. The histograms that present the degree of normality of the data are presented in Appendix C.

Thus, based on the shortage of data and the conditions described above, the Spearman’s correlation coefficient will be examined. The Spearman’s correlation coefficient is a non-parametric statistic and thus can be used when the data have violated parametric assumptions; like the data did for this analysis. The results of the correlations between the variables are presented in the table below.

<table>
<thead>
<tr>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age of academic spin-off</td>
<td>3</td>
<td>1.73</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Strength of ties</td>
<td>0.99</td>
<td>8.31</td>
<td>-0.301*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3. Sponsorship-based relations</td>
<td>2.75</td>
<td>2.41</td>
<td>-0.320*</td>
<td>0.571**</td>
<td>-</td>
</tr>
<tr>
<td>4. Partnership-based relations</td>
<td>1.95</td>
<td>1.73</td>
<td>-0.200</td>
<td>0.357**</td>
<td>0.282*</td>
</tr>
</tbody>
</table>

†, p < .10; *, p < .05; **, p < .01; N = 60 (two-tailed)

Table 8: Correlation coefficients of statistical model 1

The Spearman’s coefficient from the table above suggests that the Age of the academic spin-off is significantly (p<0.1) and negatively related to the strength of ties. This suggests support for the Hypothesis 1. In order to realize the way network ties are weakening as the company is growing older a graph of the relation between them is presented below.

Figure 4: The negative relation of Strength of ties with the Age of academic spin-off

The second Hypothesis is proposing the negative relation between the Age of academic spin-off with the Sponsorship-based relations. The coefficient suggests that there is a significant (p<0.1) and negative relation between these two variables. Thus, Hypothesis 2 is supported. Last but not least, the coefficient for the relation between Age of academic spin-off and Partnership-based relations
suggests that there is no significant relation between these two variables. For this reason, Hypothesis 3 is rejected.

5.2 Statistical Model 2 – Multiple Regression Analysis Results
The analysis of the Statistical model 2 of the study is employed with multiple regression analysis. The multiple regression analysis examines multiple effects of several independents variables to an independent one.

The starting point of multiple regression analysis is the conceptual model (and the hypotheses derived from that model) that researcher has developed in an earlier stage of the research process (Uma and Riger, 2003). For this reason, 7 regression models were employed. Models 1, 2 and 3 test Hypotheses 4, 5, 7, 8, 9, and 11. Model 4 examines Hypotheses 6 and 12, whereas model 5 tests Hypothesis 10. The interpretation of these models indicates the support or the rejection of the aforementioned hypotheses. In all models, the dependent variable is the Realized Absorptive Capacity.

Model 1 investigates the relation of Realized Absorptive capacity with the control variables, Age of academic spin-off and University. The next step, which is model 2, is the introduction of the entrepreneurial behavior variables; Entrepreneurial Orientation and Entrepreneurial Team Efficacy, whereas for model 3, the networks variables Strength of ties and the Sponsorship-based Relations. Model and the moderation effect of the Age of the academic spin-off to the relation between Sponsorship-based and Realized Absorptive Capacity is tested. Following, model 4 investigates besides the three aforementioned variables Entrepreneurial Orientation, Entrepreneurial Team Efficacy and Strength of ties, the relation between the Partnership-based relations and the Realized Absorptive Capacity and the moderation effect of the Age of the Academic spin-off to this relation. Last but not least, model 5 tests the moderation effect of Age to the relation between the Strength of ties and the Realized Absorptive Capacity.

As far as the moderating effects of the resent study are concerned, from the theory on statistical tests, the Age of academic spin-offs is called moderator, whereas the Strength of ties, the Sponsorship-based relations and the Partnership-based relations are called predictors (Kim et al., 2001). The Realized Absorptive Capacity is the dependent variable. The moderator variable can be considered when the relation between a predictor and dependent variable is strong, but it can also be considered when there is an unexpectedly weak or inconsistent relationship between a predictor and a dependent variable (Baron and Kenny, 1986; Jin-Sun et al., 2001). In general, the moderating effects are typically expressed as interaction between predictor and moderator variable. The moderating effects can be tested with various ways, such as multiple regression analysis, Structural equation modeling (SEM) or Analysis of Variance (ANOVA) (Kim et al., 2001). As has been already mentioned, the moderating effect will be tested with the method of the multiple regression analysis. In order to enter the moderation effect in the multiple regression analysis, product terms need to be created and represent the interaction between the predictor and the moderator (Frazier et al., 2004). The product terms are simply emerging by multiplying together the moderator and the predictor variable (Baron and Kenny, 1986; Frazier et al., 2004).

But before creating the multiple regression models and start testing data, some assumptions stand for the multiple regression analysis. By definition, multiple regression is a linear statistic model that predicts the relation of a number of predictor variables for an outcome variable (Field, 2009). The relation between the predictors and the outcome variable is liners. This leads to the assumption that
the data tested through regression models are normally distributed (Frazier et al., 2004). For this research, as has been mentioned in the previous section are not normally distributed. In this case, transformation should be employed before introducing them in the statistical tool. However, there are critics on how effectively transformation of data will remedy the non-normality of the data distribution. For this reason, in the recent study no transformation of the data employed. However, in order to reassure that the results are accurate, non-parametric regression was employed as well. In general, non-parametric tests are usually suggested when data derive from individual perception assessment and they can be considered robust (Wasserman, 2007). Some draft results indicated that the significance in relations remain the same. For this reason, following it is presented the analysis employed by the multiple regressions without transformed data.

In general, as many variables are included in the multiple regression models there is the risk of multicollinearity\(^7\). In order to avoid the multicollinearity, the bivariate correlation analysis was employed (see Appendix C). This condition is satisfied as long as there is no strong relation between two or more variables. Strong relation means coefficients above .80 or .90 (Field, 2009). For the variables that will be introduced in the regression models it seems there is no coefficient this high, besides the three coefficients that describes the correlation between Strength of Ties and the variable that describes the moderation effect of the Age of Academic Spin-off in the relation between the Strength of Ties and the Realized Absorptive Capacity, the correlation between the Partnership-based relations and the variable that describes the Age of the Academic Spin-off in the relation between the Partnership-based relations and the Realized Absorptive Capacity and the same for the Partnership-based relations. These four variables are significantly and strong related (both coefficients more than .8), as the moderation effect variables for all three cases in this study is represented by the multiplication of the moderating variable with the one that causes the effect, in this case the Strength of Ties and the Partnership-based relations. However, it cannot be argued that the condition of the multicollinearity is not satisfied, as high coefficients between moderating effects and relevant variables are expected (Dunlap and Kemery, 1987)

Besides multicollinearity, endogeneity\(^8\) may arise. As stated by Antonakis et al. (2010), endogeneity is the phenomenon when causal effects of variable x to variable y are not based on three classical assumptions: x precede y, x is reliably correlated with y and this relation is not explained by other causes. For the present study, causality is examined based on the first assumption. As far as the network variables effect on the realized absorptive capacity is concerned, network precedes realized absorptive capacity, as for this study have been considered as means of knowledge exchange in order to be later transformed and exploited. Moreover, the entrepreneurial behavior precedes realized absorptive capacity as well. Based on the definition given, entrepreneurial behavior consists of the entrepreneurial orientation and the entrepreneurial team efficacy. However, the both dimensions of entrepreneurial behavior depict the cognition of entrepreneurs (see Appendix B). As realized absorptive capacity describes ability of behavior, by definition cognition precedes behavior. For this reason, entrepreneurial behavior precedes the realized absorptive capacity.

\(^7\) Multicollinearity is the condition when two or more predictors in a multiple regression analysis are highly linearly related (Farar and Glauber, 1967) and exists when there is a strong correlation between two or more predictors in a regression model (Field, 2009).

\(^8\) Endogeneity arises because of measurement error, simultaneity and omitted variables (Antonakis et al., 2010)
Thus, with the conditions described above and the diagnostics tests that will be explained later during the presentation of the results, reliable conclusions can be drawn, which are presented in the last section of this Chapter.

5.2.1 Results for models 1, 2 and 3

The multiple regression models 1, 2 and 3 examine the entrepreneurial behavior and the network effects for spin-offs coming from the two universities. The first variables entered in the multiple regression analysis are the control variables Age of academic spin-off and University, for this reason this models is named “Control”. The results do not indicate any significant relationship of them with the Realized Absorptive Capacity and the model in general is not significant.

The second step, which is model 1 is realized by entering the variables Entrepreneurial Orientation and Entrepreneurial Team Efficacy. From Table 7, it is evident that Entrepreneurial Orientation variable is significantly (p<.05) and positively related to Realized Absorptive Capacity. Furthermore, the Entrepreneurial Team Efficacy is very significantly (p<0.01) and positively related to the Realized Absorptive Capacity. Overall, the results for Model 1 suggests that the entrepreneurial behavior variables involved are very significantly (p<0.01) predicting the Realized Absorptive Capacity.

<table>
<thead>
<tr>
<th>Realized Absorptive Capacity</th>
<th>Control $\beta$</th>
<th>Model 1 $\beta$</th>
<th>Model 2 $\beta$</th>
<th>Model 3 $\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of academic spin-off (H9)</td>
<td>.023</td>
<td>.001</td>
<td>.022</td>
<td>.314*</td>
</tr>
<tr>
<td>University</td>
<td>-.010</td>
<td>-.069</td>
<td>.007</td>
<td>.071</td>
</tr>
<tr>
<td>Entrepreneurial Orientation (H7)</td>
<td></td>
<td>.280*</td>
<td>.230*</td>
<td>.272*</td>
</tr>
<tr>
<td>Entrepreneurial Team Efficacy (H8)</td>
<td></td>
<td>.529**</td>
<td>.539**</td>
<td>.520**</td>
</tr>
<tr>
<td>Strength of ties (H4)</td>
<td></td>
<td>.232†</td>
<td>.223†</td>
<td></td>
</tr>
<tr>
<td>Sponsorship-based relations (H5)</td>
<td></td>
<td>.048</td>
<td>.603**</td>
<td></td>
</tr>
<tr>
<td>Moderation of Age to Sponsorship-based relations (H11)</td>
<td></td>
<td></td>
<td>-.701**</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>.000</td>
<td>.441</td>
<td>.443</td>
<td>.551</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>-.041</td>
<td>.382</td>
<td>.371</td>
<td>.481</td>
</tr>
<tr>
<td>F-ratio</td>
<td>.012</td>
<td>7.427**</td>
<td>6.107**</td>
<td>7.896**</td>
</tr>
</tbody>
</table>

†, p < .10; *, p < .05; **, p < .01; N = 52

Table 9: Results for regression models 1, 2 and 3
The third step, is model 2 and is realized by introducing the network variables, Strength of ties and Sponsorship-based relations. From table 7, it is evident that Strength of ties is significantly (p<0.1) and positively related to the Realized absorptive capacity whereas the Sponsorship-based relation is not. For the control and the entrepreneurial behavior variables nothing has changed. Overall, model 2 is significant (p<0.05).

For model 3, the fourth step of the multiple regression analysis, is realized by adding the moderating effect of Age to the relation between the Sponsorship-based relations and the Realized absorptive capacity. From the results it seems that by adding the moderation effect, the Age of academic spin-off is significantly and positively related to the Realized absorptive capacity. Entrepreneurial Orientation and Entrepreneurial Team Efficacy remain significantly related to the Realized absorptive capacity, as it happened in model 3. As far as the network variables are concerned, Strength of ties remains significantly (p<0.1) and positively related to the realized absorptive capacity as well. However, a change happened for the variable Sponsorship-based relations, as it is very significantly (p<.01) and positively related to the independent variable, whereas the moderating effect of Age to the relation between the Sponsorship-based relations and the Realized absorptive capacity is also very significantly (p<.01) and negatively related to the Realized absorptive capacity. In general, Model 3 is very significantly (p<0.01) predicting the Realized absorptive capacity.

Besides the standardized beta coefficients, the R-square, adjusted R-square and F-ratio are reported in the end of each table. The R-square represents the amount of variance explained by the predictors for the dependent variable, whereas the adjusted R-square depicts the loss of predictive power. Last but not least, F-ratio measures how much the model has improved prediction of the outcome compared to the level of inaccuracy in the model and it can be either significant or not (Field, 2009).

For the present models, R-square ranges from .000 for the first step, to .551 in the last one, whereas the adjusted R-square ranges from -.041 to .481. Both R-square and adjusted R-square values are very high. This indicates very good fit of data. However, these values are rather rare to reach. In this case, it is likely that besides the significances appeared in the models, the number of independent variables included in the models at the same time is favoring these two variables. The number of independent variables should correspond to the number of responses in a rate of one independent variable every 10 responses (Kvalseth, 1985; Field, 2009). In this case, as more than 5 independent variables many variables are examined⁹, the R-square and adjusted R-square tend to be not absolutely accurate, without violating though the general rules of the multiple regression analysis. Last-but not least, the F-value has an increasing trend from 0.12 to 7.896, and indicates that overall the examined variables are predicting well the dependent one.

Moreover, SPSS provides diagnostic tests that examine the multicollinearity for the multiple regression models. One of these diagnostics is the Variance Inflation Factor (VIF) that indicates whether a predictor has a strong linear relationship with another one (Field, 2009). As stated by Uma and Roger (2003), VIF should be below 5. For this model the VIF value for every predictor does not exceed 4.5. Someone could point out that this is very close to the cut off level for multicollinearity. However, this value was expected to be high for the moderating variable as all moderating variables tend to show multicollinearity (Frazier et al., 2004). Another statistic related to

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⁹ Taking into account that the degree of freedom is 52, the number of independent variables better not exceed the level of 5. This is the rule of thumb regarding the number of responses, which suggests that the...
VIF is tolerance. Tolerance is reciprocal of VIF and it should be always above 0.2 (Field, 2009). For these models the lowest values is .22 which verifies the absence of the collinearity within the data.

5.2.2 Results for models 4 and 5
The procedure of the realization of the models 4 and 5 was similar to the previous two. The first two steps are exactly the same model to models control and 1 and for practical reasons are not reported.

Model 4 is realized by introducing the networks variables as happened for model 2. Thus, it is examined the relation between Strength of Ties and Partnership-based relations to the Realized absorptive capacity. The numerical results are depicted in the table 8 below. By introducing the Partnership-based relations the relation between the Entrepreneurial orientation and the realized absorptive capacity is less significant (P<0.1) compared to that of model 2. However, the table suggests the same for Team Efficacy, which is very significantly (p<0.01) and positively related to the independent variable. Moreover, Strength of ties seems to have a stronger relation (p<0.05) in model 4 with the realized absorptive capacity whereas the Age of academic spin-off is not significantly related to the realized absorptive capacity anymore. Regarding the new network variables introduced, the Partnership-based relations are not significantly related to the Realized Absorptive Capacity as well. However, overall the model is significantly (p<0.01) predicting the dependent variable.

The next step is model 5 and is employed by introducing the moderating effect of Age of the academic spin-off to the relation between the Partnership-based relations and the Realized absorptive capacity. From the table below it seems that there is no significant relation between this moderation effect with the dependent variable. The rest of the independent variable are remain the same significant, besides the relation of the Strength of ties with the Realized absorptive capacity, which their relation is stronger now.

Although, the new variable introduced is not indicating any significant relationship with the dependent variable, the overall results for model 5 suggest that it is very significant (p<.01), because of the high significance of the Strength of ties, the Entrepreneurial Orientation and the Team Efficacy. The R-square ranges from .000 to .456 whereas the Adjusted R-square from -.41 to .372. Last but not least, the F-value is decreasing from 6.092 to 5.393, indicating a bad prediction regarding the two variables entered in model 5, however an overall good model, as the F-ratio is significant (p < .01).

For Model 5 there are three values that violate the conditions of the multicollinearity. There are three VIF values greater than the cut off level (ranging from 3.14 to 5.89), namely the Age of academic spin-off, the Partnership-based relations and the Moderation of Age to the Partnership-based relations with the Realized Absorptive Capacity. As expected, the tolerance of these variables is also below 0.2. However, there is already awareness for the issue that arises here. From the correlation matrix (see Appendix C) that was examined for the assumption of multicollinearity before the realization of the multiple regression analysis, it was already evident that there will be collinearity issues for this data. However, as it is related to mediation effects, it cannot be concluded that the issue arisen here is considerable. Thus, overall the models 4 and 5 are reliable and conclusions can be safely drawn.
### Realized Absorptive Capacity

<table>
<thead>
<tr>
<th></th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age of academic spin-off (H9)</strong></td>
<td>.021</td>
<td>.184</td>
</tr>
<tr>
<td>University</td>
<td>-.001</td>
<td>.013</td>
</tr>
<tr>
<td>Entrepreneurial Orientation (H7)</td>
<td>.246†</td>
<td>.256*</td>
</tr>
<tr>
<td>Entrepreneurial Team Efficacy (H8)</td>
<td>.531**</td>
<td>.548**</td>
</tr>
<tr>
<td>Strength of ties (H4)</td>
<td>.256*</td>
<td>.281*</td>
</tr>
<tr>
<td>Partnership-based relations (H6)</td>
<td>-.044</td>
<td>.168</td>
</tr>
<tr>
<td>Moderation of Age to the Partnership-based relations (H12)</td>
<td></td>
<td>-.281</td>
</tr>
<tr>
<td><strong>R²</strong></td>
<td>.443</td>
<td>.456</td>
</tr>
<tr>
<td><strong>Adjusted R²</strong></td>
<td>.370</td>
<td>.372</td>
</tr>
<tr>
<td><strong>F-ratio</strong></td>
<td>6.092**</td>
<td>5.393**</td>
</tr>
</tbody>
</table>

†, p < .10; *, p < .05; **, p < .01; N = 52

**Table 10: Results for regression models 4 and 5**

#### 5.2.3 Results for models 6 and 7

The procedure of the realization of the models 6 and 7 was similar to the one of 4 and 5 and as stated the last two steps are not reported for practical issues.

This model examines the moderation effect of the Age of academic spin-offs to the relation between the Strength of ties and the Realized absorptive capacity. However, this happens in model 7. For model 6, the first step is to introduce the Strength of ties variable. The results from table 9 indicate that there the Entrepreneurial Orientation is significantly (p<0.05) and positively related to the dependent variable, whereas the Entrepreneurial Team Efficacy is very significantly (p<0.01) and positively related to this. Strength of ties are also significantly and positively (p<0.05) related to Realized absorptive capacity.

Model 6 is realized by introducing the moderation effect of the Age of academic spin-offs to the relation between the Strength of ties and the Realized absorptive capacity. The results from table 9 show that there is no significant relationship between the moderation effect and the dependent variable. The relation with entrepreneurial behavior variables are the same, whereas the Strength of ties is not significantly related to the realized absorptive capacity anymore. Once more, the relation
of University and the Age of academic spin-offs are remaining non-significant with the Realized absorptive capacity.

<table>
<thead>
<tr>
<th>Realized Absorptive Capacity</th>
<th>Model 6</th>
<th>Model 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of academic spin-off (H9)</td>
<td>.022</td>
<td>.033</td>
</tr>
<tr>
<td>University</td>
<td>.007</td>
<td>.006</td>
</tr>
<tr>
<td>Entrepreneurial Orientation (H7)</td>
<td>.228*</td>
<td>.234*</td>
</tr>
<tr>
<td>Entrepreneurial Team Efficacy (H8)</td>
<td>.538**</td>
<td>.535**</td>
</tr>
<tr>
<td>Strength of ties (H4)</td>
<td>.250*</td>
<td>.347</td>
</tr>
<tr>
<td>Moderation of Age to the Strength of ties (H10)</td>
<td></td>
<td>-.107</td>
</tr>
<tr>
<td>R²</td>
<td>.441</td>
<td>.443</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.382</td>
<td>.371</td>
</tr>
<tr>
<td>F-ratio</td>
<td>7.427**</td>
<td>6.107**</td>
</tr>
</tbody>
</table>

†, p < .10; *, p < .05; **, p < .01; N = 52

Table 11: Results for regression models 6 and 7

However, the overall model predicts significantly (p<0.01) the dependent variable. The R-square ranges from .000 to .443 whereas the Adjusted R-square from -.41 to .371. Last but not least, the F-value is decreasing from 7.427 to 6.107, showing a bad prediction regarding the two variables entered in model 7, but its significance indicates an overall good in fit model.

As far as the multicollinearity diagnostics results are concerned, it seems that the variables representing the moderation effect of Age of academic spin-offs to the relation between the Strength of ties and the Realized absorptive capacity and the Strength of ties are violating the assumptions regarding the values of VIF and tolerance. However, as has been already stated, multicollinearity issues emerge when moderating effects are included in multiple regression analysis. For this reason, as this issue is common for these types of analysis, there is no urgency of concern and overall the models 6 and 7 are not showing multicollinearity.
5.3 Discussion of Results
Throughout the previous sections the results of the two main statistical methods were described. The results indicated interesting significant relations between dependent and independent variables, either by bivariate correlation methods or through multiple regression analysis. Being aware of the analysis results, the purpose of this section is to interpret and translate them into valuable knowledge.

5.3.1 Interpretation of Bivariate Correlation Results
The Statistical Model 1, which was employed with bivariate correlation method (Spearman’s coefficient). This method is indicating rather straightforward whether they are rejected or not.

Hypothesis 1 examines the relationship between the academic spin-off age with the strength of ties. As far as this hypothesis is concerned, the analysis of the results suggested that there is a significant (p>.05) and negative relation between these two variables. In other words, the network ties of the academics spin-offs are getting weaker as the companies are growing older, fact that is described by Hypothesis 1. Thus, this hypothesis is supported. Hypothesis 2 examines the relationship between the sponsorship-based relations and the age of the academic spin-offs. It has been proved that there is a significant (p<.05) and negative relationship between these two concepts. Once again, the significant and negative relationship indicates that the spin-off networks are evolving as they are getting older. Thus, hypothesis 2 is supported. Last but not least, through the bivariate correlation method, results came up for the rejection of Hypothesis 3, as there were no significant correlation between the partnership-based relations and the realized absorptive capacity.

5.3.2 Interpretation of Multiple regression analysis
The Statistical Model 2, which was employed with multiple regression analysis suggested results for the support or rejection of the rest of the Hypotheses in the present study. The support or the rejection of the hypotheses tests is not straightforward as there are hypotheses involved in more than one model. Thus this discussion will shed light to the final outcome of the hypotheses tested.

Hypothesis 4 represents the positive relation of strength of ties in academic spin-off networks with the realized absorptive capacity of the firms. The variable of Strength of ties was included in multiple models. In the beginning it was introduced in models 2 and 3, in order to tests whether it can act as a predictor for the realized absorptive capacity in combination with the entrepreneurial behavior variables and the other characteristics of networks. It was suggested from the results, for both models that the relation between Strength of ties and Realized absorptive capacity is significantly (p<0.1) and positively related. The results of models 4, 5 and 6 indicated the same significant and positive relation, whereas the results derived from model 7 suggested that there is no significant relation. However, this happened with the introduction of the moderation effect of the Age of academic spin-off to the relation the Realized Absorptive capacity, which by the way represents Hypothesis 10. This non-significant aforementioned relation with the dependent variable is implying the rejection of Hypothesis 10, but it cannot be concluded that Hypothesis 4 is rejected as well. Strength of ties proved to be as a strong predictor of the Realized absorptive capacity, as it was supported in the rest five models involved.

Hypothesis 5 depicts the connection of the Sponsorship-based relations with the realized absorptive capacity. This hypothesis was tested in models 2 and 3 and in the first one it was supported and the latter one rejected. Taking into account that model 2 was one step earlier to model 3 and model 3 also included at this step the moderation effect of the age of spin-off to the relation between this
variable and the dependent one, it can be concluded that the Hypothesis 4 is supported as more variables to the multiple regression analysis are included. At the same time, the moderation effect of the Age of academic spin-off to the relation between the Sponsorship-based relations and the Realized absorptive capacity represents Hypothesis 11 and indicates the negative relation to the dependent variable. Thus, hypothesis 11 is also supported.

Hypothesis 6 is also depicts the connection of network variable with the realized absorptive capacity. To be more specific, hypothesis 6 suggests the positive relation of the Partnership-based relations with the realized absorptive capacity. It was tested in models 6 and 7 and the results suggested the rejection of it, as there was no significant relation between these two concepts. In parallel, in model 7 the moderation effect of the Age of academic spin-off to the relation between the Partnership-based relations and the realized absorptive capacity was tested, but there is no significant relation of this effect with the dependent variable. This relation is depicted by hypothesis 12 and according to the results, it is rejected.

The relation between the age of the spin-off with the realized absorptive capacity is depicted in hypothesis 9. This hypothesis is suggesting the positive relation between these two concepts. As the age is also a control variable for the present study, it was included in all seven models. However, in model 3 when it was tested alongside with the sponsorship-based relations and the moderating effect, proved to be significant. For this reason, hypothesis 9 is supported.

Last but not least, the entrepreneurial behavior variables, meaning entrepreneurial orientation and entrepreneurial team efficacy were proved to be the two strongest predictors for the realized absorptive capacity. These two variables were responsible for the overall significance of the entire models tested. Hypotheses 7 and 8 suggested positive relations with the realized absorptive capacity, which in all seven models were supported.
An overview of all hypotheses of the present study with the statistical results is presented in the table below:

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>The strength of ties in an academic spin-off’s network is negatively related to the age of the firm.</td>
<td>supported</td>
</tr>
<tr>
<td>The Sponsorship-based relations in an academic spin-off’s network are negatively related to the age of the firm.</td>
<td>supported</td>
</tr>
<tr>
<td>The Partnership-based relations in an academic spin-off’s network are positively related to the age of the firm.</td>
<td>rejected</td>
</tr>
<tr>
<td>The strength of ties in academic spin-off’s networks is positive related to the realized absorptive capacity of the firm.</td>
<td>supported</td>
</tr>
<tr>
<td>The Sponsorship-based relations in an academic spin-off’s network are positively related to the realized absorptive capacity of the firm.</td>
<td>supported</td>
</tr>
<tr>
<td>The Partnership-based relations in an academic spin-off’s network are positively related to the realized absorptive capacity of the firm.</td>
<td>rejected</td>
</tr>
<tr>
<td>The entrepreneurial orientation of academic spin-off is positively related to the realized absorptive capacity.</td>
<td>supported</td>
</tr>
<tr>
<td>The entrepreneurial team efficacy of academic spin-off is positively related to the realized absorptive capacity.</td>
<td>supported</td>
</tr>
<tr>
<td>The age of academic spin-off is positively related to the realized absorptive capacity.</td>
<td>supported</td>
</tr>
<tr>
<td>The strength of ties in an academic spin-off’s network is negatively related to the realized absorptive capacity as the firm is growing older.</td>
<td>rejected</td>
</tr>
<tr>
<td>The Sponsorship-based relations in an academic spin-off’s network are negatively related to the realized absorptive capacity as the firm is growing older.</td>
<td>supported</td>
</tr>
<tr>
<td>The Partnership-based relations in an academic spin-off’s network are negatively related to the realized absorptive capacity as the firm is growing older.</td>
<td>rejected</td>
</tr>
</tbody>
</table>

Table 12: Overview of the statistical results
CONCLUSIONS AND RECOMMENDATIONS

After the analysis presented in Chapter 5, it is about time to interpret the data and translate them in valuable knowledge for the real world. For this reason, the present chapter deals in the beginning with answering the research sub-questions described in Chapter 1, whereas the comparison with results in other studies is employed. After the concluded results of the analysis and the whole study in general, the limitation and possibilities for further research are presented. Last but not least, it is discussed the reflections on the way this study was approached.

6.1 Conclusions

The general objective of the present thesis was to provide insights regarding the role of academic spin-off networks and entrepreneurial behavior to the utilization of knowledge and consequently to their growth. In order to achieve this, an answer to the main research question should be given:

“How do the networks of academic spin-offs develop as they grow older and what is the impact of entrepreneurial behavior, network development and spin-off age on their realized absorptive capacity?”

However, as stated in the beginning, the answer to the main research question derives from answers of the related sub-questions, which are presenting following.

6.1.1 Academic spin-offs and networks

The first section that will give answer to the main research question is related to the relation of the academic spin-offs and the development of networks as they are getting older. In order to realize this, the first sub-question will be answered:

SQ1: How are the networks related to academic spin-offs and how do they develop as spin-offs are getting older?

The answer of the first question will be given by the literature review employed and presented in Chapter 2 and the results from the analysis of the empirical data.

It has been discussed by many studies that entrepreneurs are tied in social networks in order to obtain resources, such as equipment, space and finances but also advice, information and
reassurance (Birley, 1985; Johannisson, 1988; Greve and Salaff, 2003; Soetanto and van Geenhuizen, 2010; Elfring and Hulsink, 2003). It has been either proved or discussed, that networks are contributing to the general firm performance (Walter et al., 2005), innovation and economic performance (Uzzi, 1996; 1997; Zaheer and Bell, 2005; Leyden et al., 2014) and knowledge acquisition (Yli-Renko et al., 2001; Wu and Chen, 2012). Moreover, entrepreneurs through networks are forming strategic alliances (Podolny and Page, 1998; Gullati, 1998) to acquire capabilities for competitive advantage (Foss, 1999; McEvilly and Marcus; 2005; Mahmood et al., 2011).

But as academic spin-offs are growing, the social networks are evolving alongside their operations and needs (Hite and Hesterly, 2001). From the relational embeddedness perspective, many studies suggested that during their emerging phase, spin-offs are relying on strong ties to overcome liability issues (Steier and Greenwood, 2000; Hite & Hesterly, 2001; Greve and Salaf 2003; Elfring and Hulsink, 2007; Soetanto & van Geenhuizen, 2010), whereas in later phases they rely on weak ties to obtain other type of resources and share non-redundant knowledge (Scholten et al., 2014; Stam et al., 2014). Besides the strength of ties, the networks contacts background was examined. Based on the study employed by Lee et al. (2001), two groups of contact were discussed; sponsorship-based relation and partnership-based relations. As the first type of contacts provides resources unilaterally with the aim to support spin-offs, they rely on this type of linkages during the vulnerable stage of emergence. On the contrary, as spin-offs grow, they tend to rely more on Partnership-based relations, in order to create alliances and strategic partnership that will help them to grow and survive.

As far as the results from the empirical analysis are concerned, they indicated a significant and negative relation between the strength of ties and the age of academic spin-off. In other words, the network ties of academics spin-offs are getting weaker as companies are growing older. Academic spin-offs tend to rely on strong relationships, meaning frequent and informal, in order to attain the resources that will provide them support or their first entrepreneurial activities. As they are getting older, it is highly possible for entrepreneurs to turn to weaker relations, such as other entrepreneurs in order to find more complementary resources that will foster the growth of their firm. These results can be compared to the propositions provided from the studies employed by Hite & Hesterly (2001), Soetanto and van Geenhuizen (2010) and Stam et al. (2014), who supported that academic spin-offs are mainly operating within networks with strong ties during the emerging phases, whereas the ties are getting weaker in later phases.

From the networks contacts background perspective, it was supported that there is a strong and negative relation between the Sponsorship-based relations and the age of the firm. This time, in terms of contacts background, there is a high tendency by spin-offs to hinge to family, friends and organizations like incubators or consultancy firms in order to receive their major support. This contributes to benefits from the resources and thus increases the possibility to survive. As far as the Partnership-based relations are concerned, no conclusions can be drawn from the analysis, as the hypothesis depicted this relation was rejected.

6.1.2 Academic spin-off networks and realized absorptive capacity
The second step to answer the main research question is to provide answer for the sub-question, regarding the relation of networks with the realized absorptive capacity. The answer to this question will be provided by both literature review and results from the analysis employed.

SQ2: How are the networks related to the realized absorptive capacity?
According to the literature review from Chapter 2, it can be considered that networks, from the relational embeddedness perspective are related to the realized absorptive capacity, as they are means of knowledge integration for spin-offs. Regarding the strength of ties, emotional attachment and trust that characterizes these ties, broadens the range of topics discussed with acquaintances (Ebers and Maurer, 2014). Founders in the academic spin-offs are transforming knowledge to exploit it later on, by maintaining and reactivating knowledge, which requires prior knowledge (Cohen and Levinthal, 1999; Ebers and Maurer, 2014). This means, that the strong ties are beneficial for the transformation of the newly acquired knowledge.

Following the same thinking, sponsorship-based relations are giving incentives for knowledge exploitation, because of the trust and common experience that characterizes those linkages. Moreover, the diverse and non-redundant knowledge that comes from different backgrounds urges the transfer of it (Reagans and McEvily, 2003). As far as the partnership-based relations are concerned, they are linkages that characterized by infrequent and formal interactions, as they entail contacts from unrelated backgrounds (Lee et al., 2001). This means that they can be people with different types of backgrounds, which increase the scope of resources available to the academic spin-offs and their awareness of the availability of valuable knowledge (Stam et al., 2014). Thus, as entrepreneurs are recognizing consciously valuable knowledge are getting more willing to transform it and exploit it. To sum up, both sponsorship-based and partnership-based relations are stimulating the transformation and exploitation of the incoming knowledge.

At the same time, results described in chapter 4 indicate that there is a strong and positive relation between the strength of ties and the realized absorptive capacity. In other words, as the academic spin-offs are relying on close acquaintances, like friends and family, they gain knowledge from trustworthy resources. For this reason, there is a strong tendency for academic spin-offs to exhibit willingness of taking advantage of this knowledge attained, by transforming and exploiting it. The same result was also given by the study employed by Ebers and Maurer (2014), who examined the relational embeddedness of organizations and proved that is significantly and positively related to their both potential and realized absorptive capacity.

As far as sponsorship-based relations are concerned, results indicated positive and significant relation between this type of contact background and the ability of the firm to transform and exploit knowledge from the external environment. As knowledge is one of the critical for growth resources that is imported in the spin-off environment, developed ability to deal with this knowledge is needed. This ability to exploit new knowledge and transform it into new products and services depicts the whole concept of realized absorptive capacity. Thus, the results reflect that the more spin-offs are relying on sponsorship contacts for advice and management know-how, the more they develop their ability to translate this knowledge into tangible products. Unfortunately, results regarding the partnership-based relations indicated non-significant relation between them and the realized absorptive capacity, which means that no conclusions can be drawn.

6.1.3 Entrepreneurial behavior and realized absorptive capacity

To provide the answer for the main research question, the third sub-question should be answered as well, both from literature and the empirical results. The question that will be answered is:

SQ3: How is the entrepreneurial behavior related to the realized absorptive capacity?
Entrepreneurial behavior involves exploration of new opportunities. In order to be involved in such newness of things, entrepreneurial teams of academic spin-offs should operate entrepreneurially in order to absorb as much knowledge as possible and thus reassure awareness and survival (Walter et al., 2006). From the entrepreneurial orientation perspective, all three dimension of it require extensive knowledge utilization (Keh et al., 2007). As innovativeness indicates commitment for development of new solutions provided by spin-offs, new knowledge is required. Proactiveness refers to new wants and needs through strategic moves (Covin and Slevin, 1990). However, it is impossible for academic spin-offs to be proactive, if there is no advanced ability to exploit new knowledge, as the firm should be able to realize the right timing for proactive activities. Last but not least, the risk taking dimension, as it refers to commitment of new projects without reassurance of positive results, extended decision making processes are involved. Nevertheless, it would be impossible for a firm to pursue decision making processes without extensive knowledge utilization (Keh et al., 2007). From the entrepreneurial team efficacy perspective, motivation is the key of relation between this and the realized absorptive capacity. By definition, entrepreneurial team efficacy reflects the persistence and strong motivation of the spin-off team to obtain results (Bandura, 1997; Chen et al., 1998; McGee et al., 2009). At the same time, the level of motivation affects the degree of knowledge exchange and exploitation (Dyer and Singh, 1998). Thus, entrepreneurial teams with high motivation and persistence for their goals realization are likely to be willing to exploit new incoming knowledge.

In general, the relation of these concepts with the realized absorptive capacity is a concept that is rather unexplored in the academic world. Although there studies that connect the knowledge with the entrepreneurial orientation (Keh et al. 2007; Li et al., 2009), there are no studies that explicitly explore the relation of these concepts. For this reason, in order to provide more insights regarding the relation between entrepreneurial behavior and realized absorptive capacity, results from empirical analysis are provided. According to these, both entrepreneurial orientation and entrepreneurial team efficacy are strongly and positively related to the ability of the firm to transform and exploit knowledge. This means that as academic spin-offs are innovative, proactive and take risks and at the same time they have the confidence that they are able to commit effectively entrepreneurial activities, it is very likely that they will be more willing to transform and explore new knowledge.

6.1.4 Academic spin-offs age and realized absorptive capacity

In the end, an answer to the fourth research question will provide the last insights in order to answer the main one.

SQ4: How does the realized absorptive capacity develop as spin-offs are getting older and what is the impact of spin-offs age to the relation between networks and realized absorptive capacity?

The purpose of this question was to explore the possible effects of academic spin-off age to the realized absorptive capacity, either direct or indirect by exploring the moderating effect of the age to the relation between the relational characteristics of networks and the realized absorptive capacity. No literature has found that explicitly examines the realized absorptive capacity is changing as academic spin-offs grow-older. Cohen and Levintal (1990) underlined the role of experience to the stimulation of knowledge utilization. This notion was also adopted by Zahra and George (2002), who have proposed experience as an antecedent of absorptive capacity. In other words, as entrepreneurs are gaining experience, it is easier for them to preserve the transformation and exploitation
capability of knowledge. Empirical results suggested that there is a significant and positive relation of the academic spin-off age with the realized absorptive capacity. Thus, it seems that as the academic spin-offs are getting older, the experience possessed and the prior common knowledge included in their environment is likely to positively affect the ability of the firm to transform and exploit knowledge from the external environment.

As far as the moderating effect of age to the relation between the network relational characteristics and the realized absorptive capacity is concerned, there are many studies that described the development of networks (Steier and Greenwood, 2000; Hite & Hesterly, 2001; Greve and Salaf 2003; Elfring and Hulsink, 2007; Soetanto & van Geenhuizen, 2010). As has been already mentioned, the strength of ties are negatively related to the age of academic spin-offs, but positively related to the realized absorptive capacity. However, as the companies are growing older, and receive knowledge from the strong ties, it is likely to be a redundancy of knowledge and thus a decrease in the realized absorptive capacity.

Besides the strength of ties, the development of networks as spin-offs grow older is reflected to the networks contact background as well. As has been suggested from the empirical results, the sponsorship-based relations in networks tend to decrease as they cannot cover the constantly changing needs. Accordingly, it is expected that as the firms are growing older and they still rely on the sponsorship-based relations, knowledge redundancy is expected. On the other hand, it is expected that as partnership-based relations are increasing during the later phases of growth, new and diverse knowledge is introduced in spin-offs. Thus, as spin-offs grow older, there is a tendency for the realized absorptive to increase.

Based on the results of the empirical analysis, it seems that academic spin-off age is moderating the relation between sponsorship-based relations and realized absorptive capacity. Although in the beginning of the analysis we concluded that sponsorship-based relations are affecting positively the ability of the firm to transform and exploit knowledge from networks, when the firm is still relying on sponsorship-based relations as it is ageing, the realized absorptive capacity tend to decrease. This can be explained by the knowledge redundancy that occurs. As the spin-offs get older and they still rely on the same type of backgrounds to integrate new knowledge, this useful in the beginning of knowledge at their emergence are isolating them from new opportunities and further development.

Concerning the partnership-based relations, there is no moderating effect of the age between to the relation of this type of contacts with the realized absorptive capacity. The same applies for the strength of ties, as no significant moderation effect of the spin-off age was spotted between the strength of ties and the realized absorptive capacity. For this reason, no conclusions can be drawn.

To sum up and also give a definite answer to the main research question from the literature review and the results of the empirical analysis, it is suggested that academic spin-offs networks are relying on networks with more strong ties than weak ones in the beginning of their foundation, whereas as they are getting older the weak ties are more than the strong ones. As far as the contact of background is concerned, academic spin-offs are relying on sponsorship-based relation to attain the initial goals and overpass their liability of newness. One of these critical resources for survival is knowledge. The ability of the firm to transform and exploit knowledge is highly related to the relational characteristics of networks. The strength of ties is urging the utilization of new knowledge by the academic spin-offs, whereas the same principle applies when spin-offs are relying on networks with sponsorship-based relations. At the same time, the entrepreneurial behavior of academic spin-offs in terms of entrepreneurial orientation and entrepreneurial team efficacy is
stimulating the transformation and exploitation of new knowledge. The same happens when spin-offs are growing older; the greater the age of the firms, the greater their realized absorptive capacity. However, as the firms are ageing and they are still relying on networks with sponsorship-based relations their realized absorptive capacity is rather limited.

6.2 Academic contributions and managerial implications

The aforementioned results that derived from the analysis of the empirical data in conjunction with the extended literature review presented in Chapter 2 provide fruitful insights both to academic and managerial settings. The contribution of the present study results to the academic literature and the real world are presented below.

6.2.1 Academic contributions

The main purpose of the present thesis is to contribute with new insights to academic knowledge. For this reason, four knowledge gaps were identified (see Chapter 1). Hence, the academic contributions of the present study will be discussed, based on these knowledge gaps.

The first knowledge gap highlighted the lack of knowledge regarding the network development of academic spin-offs from the relational embeddedness perspective. Two main characteristics were analyzed; the strength of ties and the networks contacts background. As far as the strength of ties is concerned, many studies tried to unveil the way spin-off networks develop as they grow, but so far, there are opposing results. Some studies suggested that spin-offs rely on strong ties during the emerging phase whereas are getting weaker in later phases (Hite & Hesterly, 2001; Soetanto & van Geenhuizen, 2010; Stam et al., 2014), whereas other studies suggested that weak ties are developing during the emerging phase (Steier and Greenwood, 2000) and strong ties after the establishment of the firm (Greve and Salaff, 2003). In the present study, results suggested that there are more strong ties than weak in networks after the foundation of the academic spin-offs and the ties are getting weaker as the firms are establishing in the market and are in agreement with the first notion. Hence, these results shed more light to the academic literature regarding the network development for spin-offs, and even more for spin-offs emerged from academic settings. From the network contacts background perspective, there is one study by Lechner et al. (2006) that examined the impact of the contacts background to small firm performance, but it is not related to development according to growth. In this case, results suggested that academic spin-offs are relying on networks with more sponsorship-based relations in the beginning, whereas these relations are decreasing as firms are being established. This type of network distinction is a continuation of Lee et al. (2001) study and increase the understanding on the networks development on the topic of contacts background.

The second knowledge gap underlined the lack of knowledge which is related to the relation between the strength of ties and contacts background with the realized absorptive capacity. In general, there is limited literature that examines this relation. Results from analysis suggest that strong ties and sponsorship-based relations tend to stimulate the realized absorptive capacity of the firms. These findings provide a deep savvy for the academic world, as they unveil critical antecedents of realized absorptive capacity for academic spin-offs. A very recent study employed by Ebers and Maurer (2014) journal, indicated that strong ties are stimulating both potential and realized absorptive capacity. Nevertheless, the novelty of the present results lays on the fact that the under analysis companies are no more than 3 years old, whereas in the study by Ebers and Maurer (2014), the average age of the firms is 68 years old. From the networks background perspective, there is no study in the literature so far that examines the impact of contacts background to the realized
absorptive capacity. Thus, results regarding the network relational characteristics can be considered as substantial contribution to the present literature, as they shed light to the unexplored academic field of absorptive capacity for small firms and even more for small firms that emerge from academic settings.

The third knowledge gap highlighted in the beginning of the report is the lack of knowledge concerning the entrepreneurial behavior and the realized absorptive capacity. Besides the unpublished working paper by Khoadei et al. (2014), there is no literature so far that relates the entrepreneurial behavior with the absorptive capacity. Based on the components of entrepreneurial behavior, it seems that the contribution to the literature is twofold. The analysis indicated that entrepreneurial orientation is affecting significantly the realized absorptive capacity. Conceptually, this is a new insight regarding the entrepreneurial orientation, which so far was examined only as an antecedent of firm performance (Covin and Slevin, 1990; Lumpkin and Dess, 1996; Lee et al., 2001; O'Shea et al., 2005; Walter et al., 2006; Keh et al., 2007; Li et al., 2009). As far as the entrepreneurial team efficacy is concerned, results unveiled a positive relation of this concept with the absorptive capacity. Zahra et al. (2009), mentioned board effectiveness as a precursor of corporate entrepreneurship activities in threshold firm in combination with the absorptive capacity. However, the fact that entrepreneurial team efficacy considers to have a positive impact on the realized absorptive capacity, gives a novel and deeper understanding of the concept and even more incentives for further research in the future for not only the team efficacy itself, but also the self-efficacy, which this concept is based upon.

Last but not least, the fourth knowledge gap suggested the exploration of the direct impact of academic spin-off age to the realized absorptive capacity and the moderation effect of it to the relation between the network relational characteristics and the realized absorptive capacity. Results indicated that as spin-offs grow older it is very likely for them increase their ability to transform and exploit knowledge. As there are no studies that examine this type of relation, the study can be acknowledged to provide considerable contribution to the academic knowledge, as it deepens the understanding of the realized absorptive capacity for academic spin-offs throughout their growth. As far as the moderating effect of age to the relation between the networks characteristics and the realized absorptive capacity is concerned, results suggested that as the spin-offs grow and they still rely on sponsorship-based relations, the absorptive capacity of the firm is limited. This knowledge can be considered as a great asset for the literature, because it increases awareness of academic knowledge regarding the relation of networks and realized absorptive capacity.

6.2.2 Managerial implications
Besides the contribution to the academic literature, the knowledge derived from the present study has practical implications as well. As spin-offs emerging from academic settings are constantly increasing, knowledge regarding the academic spin-off networks and their ability to integrate knowledge can be considered of substantial importance for entrepreneurs, incubator management and policy makers.

Results from the study suggested that spin-off networks are related to the realized absorptive capacity of the firm. Basic relational characteristics, as strength and contact background has been proved to influence the ability of the firm to transform and exploit knowledge from the external environment. This knowledge increases entrepreneurs’ awareness regarding their contacts outside their firm and thus enables them to devise meaningful strategies for growth. To be more specific, when entrepreneurs know in advance that strong ties and sponsorship based relations tend to
increase the ability of the firm to transform and exploit knowledge in the beginning, they can be confident that knowledge coming from close acquaintances or incubators for instance will be beneficial for their growth. At the same time, as soon as they are aware of the negative impact that close relations may have to the ability to integrate knowledge in later phases, new strategies that include networking can be defined, in order to increase their possibilities for new partnerships and thus new knowledge utilization. The same applies for the positive impact of the entrepreneurial behavior with the realized absorptive capacity. Being aware of this relation, entrepreneurs can integrate innovative structure to their firm or proactive thinking or even some more “courage” regarding their entrepreneurship activities in order to increase the possibilities of better knowledge transformation and exploitation. Moreover, entrepreneurs can also include in their team members, who trust and feel confident that they will be able to realize the spin-offs goals for better knowledge exploitation. Thus, strategies related to public relations, resources acquisition and way of working can be pursued in order to optimize knowledge utilization.

As far as the management of incubators is concerned, findings of this study can provide beneficial insights regarding the coaching techniques and in general the support that incubator provides. Based on the results regarding the relation of the networks with the realized absorptive capacity, incubator management can provide assistance and consultancy based on up-to-date knowledge. For instance, being aware of the implications that the strong ties and the sponsorship-based relations has to the realized absorptive capacity of spin-offs, incubators managers can provide tailor made strategies of networking to spin-offs according to their age, or they can provide seminars regarding behavior stimulation for innovativeness, risk taking and proactiveness or even more consultancy on how to form a high-performance entrepreneurial team.

From the policy maker’s perspective, research results can contribute to effective policies regarding spin-offs and incubators. Awareness of policy makers on the mechanisms behind the relation of networks with the ability of the firms to integrate knowledge from the external environment can contribute to the formulation of specific policies regarding the consultancy and coaching offered within incubators. Based on this knowledge, policy makers can stimulate a favorable for spin-off growth environment in incubators by creating policies in forms of rules for better coaching from the incubator management, or by giving allowances to spin-offs coming from university settings to create incentives for effective network management and behavior adoption in order to increase the possibility of better knowledge utilization and consequently growth and success.

6.3 Limitations and further research
Although this research has found many statistically significant relations between the research concepts various limitations can be spotted. The first one is related to the concept of absorptive capacity. Usually, studies are dealing with both dimensions of absorptive capacity; potential and realized. In the present study, only the second dimension of it was examined. Although to my understanding the dimension of exploitation is pertinent for newly founded firms, as it represents the dimension that converts knowledge to explicit concepts (e.g innovative products and services), including the dimension of potential absorptive capacity will be beneficial for a deeper perception of absorptive capacity. However, initial tests were employed including the potential absorptive capacity, but no correlations were spotted. For this reason, it was excluded from the study. Thus, under different circumstances, the inclusion of potential absorptive capacity to the study will give the readers the opportunity to fully grasp the concept of absorptive capacity for academic spin-offs and its relations with the networks and the entrepreneurial behavior.
Another limitation of the present study is related to networks. As described in the literature review, there are two types of embeddedness for firms: relational and structural embeddedness. However, in the present study, only relational characteristics were examined. Attempts to include structural embeddedness were not fruitful, as initial results with network structural characteristics, such as diversity, didn’t indicate any significant correlation with the absorptive capacity. Thus, including the structural embeddedness in future research will give in-depth understanding of the way networks contribute to spin-offs growth. Additional structural characteristics can also be examined, such as network range or structural holes, in order to gain integrated insights of the way networks are related to the growth of spin-offs and their absorptive capacity.

Moreover, the number of responses that form the data set for the present study was limited. As there were participants that didn’t respond to all the concepts in the questionnaire, limited responses were available in the end. For this reason, the empirical analysis was distinguished in two main methods; bivariate correlation and multiple regression analysis. Statistically, multiple regression analysis is more reliable method than simple bivariate correlations, as the later one does not predict but only indicates relations, but the limited number of responses suggested the application of both of them. Thus, for future research, questionnaires can be formulated in a shorter way and thus participants would not quit the survey. One more limitation regarding the availability of data, is that the development of networks and realized absorptive capacity throughout the ageing of spin-offs, was not examined for the same spin-offs as they are growing older, but for different of them in various ages. The main idea pursuing this research was to compare data of same companies throughout the years. However, the limitations to the availability of data restricted the research methodology. As future research, data coming from multiple years for spin-offs could be collected. By this, it would be possible to track the actual development of both networks and realized absorptive capacity.

Last but not least, there are some limitations regarding the reliability and generalization of the findings. As far as the results are concerned, no validation was employed in order to reassure that they indeed depict the reality. This happened as the data are collected from 2011 and thus practically validation cannot be employed. However, additional qualitative approaches, like interviews could be realized to take insights from the entrepreneurs. As far as the generalization of the findings is concerned, it can be claimed that it is rather limited. As the data collected by spin-offs positioned in incubators, both in Delft and Wageningen, the data are dependent on the existence of coaching. As there are hundreds of spin-offs that have never been in that coaching intensive environment, neither have participated in knowledge intensive clusters like incubators. For this reason, this research can be extended to other spin-offs that are not incubated. Even further, this research can be realized with spin-offs that emerge from other environments, like corporations or simple entrepreneurs without strong academic background. Last but not least, the generalization of the results is limited to the information technology, medical technology, clean technology, industrial solutions and agribusiness and food industries. Future research can then include not only non-academic start-ups outside of incubators, but also start-positioned beyond these industries.

6.4 Reflections
Having already discussed the limitations and the further research, the reflections on the way this study is employed will give a draft assessment on the way of the analysis realization. Having a look at the construct of the variables, there are some of them that can be reconsidered. One of these variables is the age of academic spin-off. This variable was used to depict the development of the
company as it is getting older. However, it cannot be considered as an actual indicator of firm development. Additional data is needed to identify the growth phase of spin-offs, such as volume of sales, or number of employees or combination of both of them in calculative ways. The same is applied for the variable regarding the dimensions of absorptive capacity. Studies have proposed that the actual depiction of absorptive capacity is better employed by all four dimensions. However, in order to decrease the complexity of the analysis, the two dimensions were used. Last but not least, a challenge emerged when constructing the network contact background variables. During the process of grouping, consultancy firms seemed to be a special background contact, that according to the theory and the purpose of this thesis, did not correspond absolutely to neither sponsorship nor partnership-based relations. The best practice according to my understanding could be a third group that depicts relation with consultancy firms; however the complexity of the analysis would be increased noticeably.

As has been stated also in the limitations and further research, the analysis was employed with data that derived from limited number of responses. For this reason, additional or alternative methods of analysis could be applied. For instance, there are other statistical methods, like Structural Equation Modeling (SEM) or Partial Least Squares regression (PLS) that can help to employ quantitative analysis with lower response rates, like the present one. At the same time, qualitative analysis could be employed to compensate the limitation of the responses. Through qualitative methods, new insights concerning the research concepts could be gathered and essential results could be drawn. Moreover, methods could be used to test quantitatively the potential causality that exists among the variables of the study. In case causality issues were spotted, remedy strategies could follow like the Heckman two-step procedure.

6.5 Final Conclusions
Taking into account the aforementioned conclusions, contributions, limitations and reflections, this study provided a deep understanding of academic spin-offs growth, as absorptive capacity is considered by many studies key antecedent of growth and innovation. The relations explored unveiled background mechanisms behind the relational network characteristics and entrepreneurial behavior with the realized absorptive capacity as academic spin-offs grow older. The knowledge produced in this thesis, is relevant and follows recent studies published in Research Policy Journal and although there are various limitations, it provides undoubtedly considerable insights on the next steps of research in the field of academic entrepreneurship.
REFERENCES


APPENDICES

Appendix A

Questionnaire Items

A1. Strength of ties

Intimacy

<table>
<thead>
<tr>
<th>How many years do you know this person? (Person 1 ... 5)</th>
<th>.......... years</th>
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</thead>
</table>

Frequency

<table>
<thead>
<tr>
<th>How intense is the contact you have with this person? (1 = not really ... 7 = very well) (Person 1 ... 5)</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
</table>

Duration

<table>
<thead>
<tr>
<th>How well do you know this person? (1 = not really ... 7 = very well) (Person 1 ... 5)</th>
<th>1 2 3 4 5 6 7</th>
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</table>

A2. Network contacts background

What background does this person have? (Person 1 ... 5)

- University (Wageningen/TUDelft)
- Incubator (Starlife/Yes!Delft)
- Other start-up
- Industry
- Consultancy
- Family/friend
### A3. Entrepreneurial Behavior

**Entrepreneurial Orientation**

#### Innovativeness

| In general we favor a strong emphasis on R&D, technological leadership, and innovations (1 = not really ... 7 = very well) | 1 2 3 4 5 6 7 |
| Over the last years we had many new lines of products and services (1 = not really ... 7 = very well) | 1 2 3 4 5 6 7 |
| Changes in product or service lines have usually been quite dramatic (1 = not really ... 7 = very well) | 1 2 3 4 5 6 7 |

#### Proactiveness

| In dealing with competitors, we typically initiate actions (1 = not really ... 7 = very well) | 1 2 3 4 5 6 7 |
| In general we favour a strong emphasis on the marketing of tried and true products and services (1 = not really ... 7 = very well) | 1 2 3 4 5 6 7 |
| We typically adopt a very competitive, 'undo-the-competitor' posture (1 = not really ... 7 = very well) | 1 2 3 4 5 6 7 |

#### Risk taking

| In general we have a strong proclivity for high risk projects (with chances of very high returns) (1 = not really ... 7 = very well) | 1 2 3 4 5 6 7 |
| We believe that owing to the nature of the environment, bold, wide-ranging acts are necessary to achieve the firm's objectives (1 = not really ... 7 = very well) | 1 2 3 4 5 6 7 |
| We typically adopt a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities (1 = not really ... 7 = very well) | 1 2 3 4 5 6 7 |
Entrepreneurial Team Efficacy

How confident are you about the team members to (1 = not really ... 7 = very well):

<table>
<thead>
<tr>
<th>Task</th>
<th>1 2 3 4 5 6 7</th>
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<tbody>
<tr>
<td>Conceive a unique idea for a business</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Identify market opportunities for a new business</td>
<td>1 2 3 4 5 6 7</td>
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<tr>
<td>Write a formal business plan</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Raise money to start a business</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Convince others to work for you in your new business</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>Manage a small business</td>
<td>1 2 3 4 5 6 7</td>
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<tr>
<td>Grow a successful business</td>
<td>1 2 3 4 5 6 7</td>
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A4. Absorptive capacity

Acquisition

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<thead>
<tr>
<th>Task</th>
<th>1 2 3 4 5 6 7</th>
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<tr>
<td>We frequently scan the environment for new technologies</td>
<td>1 2 3 4 5 6 7</td>
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<td>(1 = not really ... 7 = very well)</td>
<td></td>
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<tr>
<td>We thoroughly observe technological trends</td>
<td>1 2 3 4 5 6 7</td>
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<tr>
<td>(1 = not really ... 7 = very well)</td>
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<tr>
<td>We observe in detail external sources of new technologies</td>
<td>1 2 3 4 5 6 7</td>
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<td>(1 = not really ... 7 = very well)</td>
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Assimilation

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<th>Task</th>
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<tr>
<td>We thoroughly collect industry information</td>
<td>1 2 3 4 5 6 7</td>
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<td>(1 = not really ... 7 = very well)</td>
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<tr>
<td>We can quickly interpret changing market demands</td>
<td>1 2 3 4 5 6 7</td>
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<td>(1 = not really ... 7 = very well)</td>
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<tr>
<td>New opportunities to serve our clients are quickly understood</td>
<td>1 2 3 4 5 6 7</td>
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<td>(1 = not really ... 7 = very well)</td>
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</table>
We analyze various combinations of attributes for your products
(1 = not really ... 7 = very well)

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We analyze different sequences for new product development and introduction
(1 = not really ... 7 = very well)

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Transformation

We regularly consider the consequences of changing market demands in terms of new products and services

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We record and store newly acquired knowledge for future reference

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We determine how customers will use our technologies

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Exploitation

We Identify different customer groups that might have an interest in our products
(1 = not really ... 7 = very well)

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We have a clear division of roles and responsibilities
(1 = not really ... 7 = very well)

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We easily implement technologies in new products
(1 = not really ... 7 = very well)

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We have a common language regarding our products and services
(1 = not really ... 7 = very well)

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We Identify different customer groups that might have an interest in our products
(1 = not really ... 7 = very well)

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Appendix B
Summary of the two main statistical models

<table>
<thead>
<tr>
<th>Statistical Model 1</th>
<th>Data set</th>
<th>Variables</th>
<th>Hypotheses</th>
<th>Methods</th>
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<tbody>
<tr>
<td></td>
<td>60 responses&lt;br&gt;Wageningen University: 21&lt;br&gt;TUDelft: 39</td>
<td>Independent&lt;br&gt;Age</td>
<td>Hypothesis 1&lt;br&gt;Hypothesis 2&lt;br&gt;Hypothesis 3</td>
<td>Bivariate Correlation analysis (Spearman's coefficient)</td>
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<td>Dependent&lt;br&gt;Strength of ties&lt;br&gt;Partnership-based relation&lt;br&gt;Sponsorship-based relations</td>
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<tr>
<td>Statistical Model 2</td>
<td>52 responses&lt;br&gt;Wageningen University: 21&lt;br&gt;TUDelft: 31</td>
<td>Independent variables&lt;br&gt;Strength of ties&lt;br&gt;Sponsorship-based relations&lt;br&gt;Partnership-based relations&lt;br&gt;Entrepreneurial Orientation&lt;br&gt;Team Efficacy</td>
<td>Hypothesis 4&lt;br&gt;Hypothesis 5&lt;br&gt;Hypothesis 6&lt;br&gt;Hypothesis 7&lt;br&gt;Hypothesis 8&lt;br&gt;Hypothesis 9&lt;br&gt;Hypothesis 10&lt;br&gt;Hypothesis 11&lt;br&gt;Hypothesis 12</td>
<td>Multiple regression analysis</td>
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<td></td>
<td>Dependent variables&lt;br&gt;Realized absorptive capacity</td>
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<tr>
<td></td>
<td></td>
<td>Control variables&lt;br&gt;Academic spin-off age&lt;br&gt;University</td>
<td></td>
<td></td>
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</tbody>
</table>
Appendix C
The depiction of non-normality of the data for variables age of academic spin-off, Strength of ties, Sponsorship-based relations and Partnership-based relations.
### Appendix D
Correlation matrix before employing the multiple regression analysis

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>9</th>
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<tbody>
<tr>
<td>1. Age of academic spin-off</td>
<td>2.58</td>
<td>1.36</td>
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</tr>
<tr>
<td>2. Strength of ties</td>
<td>1.52</td>
<td>8.61</td>
<td>-2.35</td>
<td>-</td>
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<tr>
<td>3. Sponsorship-based relations</td>
<td>3.04</td>
<td>2.41</td>
<td>-0.093</td>
<td>0.547**</td>
<td>-</td>
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<tr>
<td>4. Partnership-based relations</td>
<td>2.04</td>
<td>1.79</td>
<td>-1.42</td>
<td>0.333*</td>
<td>0.255</td>
<td>-</td>
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<tr>
<td>5. Entrepreneurial orientation</td>
<td>4.73</td>
<td>0.76</td>
<td>-0.13</td>
<td>0.201</td>
<td>0.028</td>
<td>0.439**</td>
<td>-</td>
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<tr>
<td>6. Entrepreneurial team efficacy</td>
<td>5.78</td>
<td>0.94</td>
<td>-0.027</td>
<td>-0.049</td>
<td>-0.026</td>
<td>-0.109</td>
<td>0.058</td>
<td>-</td>
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<tr>
<td>7. Realized absorptive capacity (RAC)</td>
<td>3.15</td>
<td>0.5</td>
<td>0.043</td>
<td>0.090</td>
<td>0.052</td>
<td>-0.031</td>
<td>-0.069</td>
<td>0.238</td>
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<tr>
<td>8. University</td>
<td>0.06</td>
<td>0.49</td>
<td>0.365**</td>
<td>-0.299</td>
<td>-0.137</td>
<td>-0.188</td>
<td>0.079</td>
<td>-0.018</td>
<td>0.272</td>
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<td>9. Moderation effect of age to strength of ties and RAC</td>
<td>2.14</td>
<td>25.48</td>
<td>-156</td>
<td>0.935**</td>
<td>0.542**</td>
<td>0.322*</td>
<td>0.190</td>
<td>-0.069</td>
<td>0.047</td>
<td>-0.239</td>
<td>-</td>
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<td>10. Moderation effect of age to Sponsorship-based relations and RAC</td>
<td>7.65</td>
<td>9.24</td>
<td>0.474**</td>
<td>0.295*</td>
<td>0.765**</td>
<td>0.126</td>
<td>-0.017</td>
<td>-0.065</td>
<td>0.082</td>
<td>0.072</td>
<td>0.374**</td>
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<tr>
<td>11. Moderation effect of age to Partnership-based relations and RAC</td>
<td>5.01</td>
<td>5.57</td>
<td>0.246</td>
<td>0.228</td>
<td>0.160</td>
<td>0.875**</td>
<td>0.397**</td>
<td>-0.055</td>
<td>-0.020</td>
<td>-0.052</td>
<td>0.291*</td>
<td>0.274*</td>
</tr>
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</table>

†, p < .10; *, p < .05; **, p < .01; N = 52 (two-tailed)