The fuel of USO growth

'To what extent do the different antecedents influence the growth of a university spin-off?'

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Abstract

The aim of this research is to identify the success factors of start-up firms, specifically university spin-offs. Success of a USO will be measured by its growth between 2008 and 2010. This research is based on literature on financial capital, the human capital theory, the social capital theory and location theory. In the model, two control variables are added to increase the accuracy of the study. In addition, two interaction effects are added. The first interaction effect is between start-up capital and human capital and the second is between social capital and location. All variables are expected to have a positive influence on growth. The model is tested by multiple regression analysis in SPSS. The results show that, contrary to expectations, only start-up capital has a significant effect on growth. Moreover, this is a quadratic relationship, indicating a 'breaking point' of the positive effect. This breaking point is estimated at a start-up capital of €25.000, indicating that the positive effect on growth turns into a negative effect at this amount. Another notable result is the significant effect of both control variables on the dependent variable. These effects are both in line with the expectations derived from theory.

1. Introduction

This master thesis identifies antecedents of University Spin-offs (USO's), namely start-up capital, human capital, network and location. More precisely, the influence of these antecedents on company growth. USO's are start-up businesses initiated by the university (Fryges and Wright, 2014). Specifically, university spin-offs are defined as new firms established by faculty members or students based on intellectual property generated from their research or studies (Shane 2004). These USO's contribute significantly to the development and innovation of industries (Muendler, Ruach and Tocoian, 2012) and have a unique role in innovation (Lejpras, 2014). Hence, more and more attention is focused on these start-ups. USO's are stimulated and facilitated by, for example, Dutch universities to realize their dreams (www.startupmix.nl, Radboud University). Except for facilitating companies, more and more entrepreneurship programs are implemented worldwide to encourage young entrepreneurs (Fretschner and Weber, 2013). Internationally there are several competitions for university spin-offs to participate in and be able to attract investors for their start-ups, for example www.universityworldcup.com.

Specific to individual spinoffs, once established, these new firms generally have a high propensity for survival (Lowe, 2002; Pressman, 2002; Mustar, 1997), have a high likelihood of attracting early-stage capital such as angel or venture capital (Shane, 2004), and of going public (Goldfarb and Henrekson, 2003). However, there is a lack of empirical research on what antecedents are necessary for future growth. Furthermore, academic entrepreneurship research is often limited to individual universities, typically elite institutions like MIT (Shane, 2004; Roberts, 1991), or has been criticized for failing to utilize or build theory, incorporate insights from multiple disciplines, or employ sophisticated methods and sampling frames (Rothaermel, Agung and Jiang, 2007; Mustar, Renualt, Colombo, Piva, Fontes, Lockett, Wright, Clarysse, and Moray, 2006; O'Shea, Allen, Chevalier, and Roche, 2005). In addition, several researches indicated the need for future research on USO's, as they state the used data is subject to change due to national and even regional differences. Furthermore, research has been done on the antecedents of growth, however, this has been for 'normal' companies. (Zhang, 2009; Fini, Fu, Mathisen, Rasmussen and Wright, 2017; Miranda, Chamorro and Rubio, 2018). Although there is a significant amount of literature about this subject, it lacks in empirical research. Finally, Hayter (2013) stated that most quantitative studies of university spinoffs have relied upon data collected in the annual Association of University Technology Managers (AUTM) and, as a

result, focus on numbers of university spinoffs and their relationship with institutional or environmental factors. This was confirmed by Rothaermel, Agund and Jiang (2007) and Phan and Siegel (2006). While useful, this research typically does not empirically investigate whether or not individual spinoffs actually succeed (Rothaermel et al., 2007; Shane, 2004; 2005). Thus, a gap exists in this specific field on the effects of antecedents on success of the USO's, where success is measured as growth. Although a few researchers have looked at success factors of USO's, this has always been done from a single angle, where only one or two factors were identified. This research offers a comprehensive holistic approach, identifying several factors and analyzing these as well.

In order to effectively tackle the main research question, several sub questions are proposed. These entail four different concepts, namely start-up capital, human capital, social capital and location. Start-up capital is believed to be required for firms to be able to operate (Cassar, 2004). Moreover, human capital theory suggests that human capital increases the productivity rate (Tan, 2014). Furthermore, social network theory dictates that social capital enhances the outcomes of actions of players in a firm (Blumberg and Pfann, 1999). Finally, location of a firm is said to directly tie to the performance of a firm (Audretsch and Dohse, 2007). These different reasonings suggest these concepts are connected to USO growth, and thus might be able to explain this growth. Hence, they will be analyzed for their level of influence on USO growth.

The research question this research aims to answer is as follows:
'To what extent do the different antecedents influence the growth of a university spin-off?'

The following sub questions will be answered in order to answer the main research question:
- *'To what extent does start-up capital influence the growth of a university spin-off?'*
- *'To what extent does human capital influence the growth of a university spin-off?'*
- *'To what extent does social capital influence the growth of a university spin-off?'*
- *'To what extent does location of the USO influence the growth of a university spin-off?'*

Therefore, the objective of this research is to contribute to theory on USO's and to provide insights into the effects of certain antecedents on growth of the business. The overarching research on spin-offs (Vaessen, 2000; 2004; 2008; 2011) was conducted in the years 2000, 2004, 2008 and 2011. This research aims to contribute to this overarching research by filling the theoretical gap about the role of antecedents in the growth of USO's.

The results and conclusions of this research can help to advise students, professors and of graduates that want to start or grow a USO, on the importance of start-up capital, human capital, social capital and location of the business. Thus, whether or not having the right mix of these antecedents will improve the growth of their business and which antecedents are more important than others.

This thesis is structured in the following way. Firstly, an elaboration will be made on the theory about university spin-offs, start-up capital, human capital, social capital and location of the business and measurements of growth. After this, hypotheses will be derived from this chapter. Next, the methodology of the research is explained. After that, the results of the analysis will be discussed. Finally, the last part will consist of conclusions of the results, which will lead to an answer to the research question. This section will also cover limitations of the research and future research directions.

2. Theoretical Framework

2.1 Introduction

In order to comprehend the effects the antecedents have on growth of USO's, this research looks at several theories. Within this chapter, start-up capital, human capital theory, social capital theory and location theory on business growth will be explained. Furthermore, the corresponding hypotheses will be stated and explained in the conceptual model chapter. To be able to study the effects of the antecedents, the concept of growth will be explained first.

2.2 Growth in USO's

Fryges and Wright (2014) stated that USO's are specifically important for the economy and society because of their innovativeness. Furthermore, they said that one of the characteristics of USO's is their goal to commercialize academic knowledge, research results and technologies. After commercialization, growth is needed for survival. Growth has, over the years, been defined in several different ways. Penrose (2006) stated that growth is the product of an internal process in the development of an enterprise and an increase in quality and/or expansion. Dobbs and Hamilton (2007) defined growth as a change in size during a determined time span. Achtenhagen, Naldi and Melin (2010) researched entrepreneurs' ideas on growth and listed the following: increase in sales, increase in the number of employees, increase in profit, increase in assets, increase in the firm's value and internal development. Finally, according to Janssen (2009a), a company's growth is essentially the result of expansion of demands for products or services. A company's sales is the predominant firm growth indicator used in empirical studies under review (Shepherd and Wiklund, 2009). This was confirmed by Miettinen and Littunen (2013) and Unger, Rauch, Frese and Rosenbuch (2011), they stated that sales is often used as an indicator of start-up success and therefore is an established measurement. In addition, entrepreneurs tend to look at sales as an indicator of their start-up success themselves (Witt, Schroeter and Merz, 2008). Thus, sales will be used as an indicator for growth in this research. In addition, a non-financial growth indicator is used, namely employee growth. Employee growth adds a degree of reliability to the concept growth, as sales can be distorted, for example lack of sales at the time of founding. Furthermore, certain USO's place higher value on resources and employee growth than on sales or profit (Scholten, Omta, Kemp and Elfring, 2015).

2.3 Start-up capital

According to the NVCA (National Venture Capital Association) (2004), start-up capital, or seed capital, may be defined as the external equity financing provided before there is a real product or company organized. However, start-up capital not only consists of external equity, it can also consist of self-provided equity. There is research that suggests that different types of capital are driven by heterogeneous motives and lead to different incentives for entrepreneurs. Self-provided equity may lead to a higher stimulus to succeed than venture capital (Lee and Zhang, 2010)

Scholars agree that there are a large number of variables that affect company growth and that start-up capital is one of them (Cooper, Gimeno-Gascon and Woo, 1994; Cassar, 2004; Fairlie, 2012; Fairlie and Robb, 2008; Cressy, 1996; Hayter, 2013). Cassar (2004) states that financial capital is one of the necessary resources required for enterprises to form and subsequently operate. Furthermore, according to Fairlie (2012), one of the most important barriers preventing small businesses from growing is inadequate access to financial capital. The consequence is that these undercapitalized businesses will likely have lower sales, profits and employment and will be more likely to fail than businesses receiving the optimal amount of capital at start-up. However, as Shane (2004) indicated, USO's generally have a high likelihood of attracting early-stage funding, pointing to the fact that this barrier is lower for USO's. Finally, firms with higher levels of start-up capital are less likely to close, have higher profits and sales, and are more likely to hire employees (Fairlie and Robb 2008).

Start-up capital affects company growth in a number of ways. First of all, these financial resources may act as a buffer against the liabilities of newness and smallness (Cooper et al., 1994). Start-ups are engaged in a process of experimentation whereby concepts are tested. This process of experimentation is characterized by iterations of trial and error. Hence, the availability of financial capital at start-up may influence the venture's ability to withstand unfavorable shocks and undertake corrective actions (Cooper et al., 1994). Next to that, start-up capital buys time, giving the entrepreneur time to learn (Cooper and Gimeno-Gascon, 1992). This learning curve must meet a significant level, i.e. become profitable, before the start-up capital is at a zero level. Thirdly, financial capital gives start-ups the opportunity to hire staff and conduct research (Hayter, 2013). Finally, start-up capital leads to more ambitious projects, as well as the possibility to hire employees (Fairly and Robb, 2008). Thus, start-up capital gives entrepreneurs the opportunity to raise the start-up to its full potential and execute this.

On the other hand, Fairly and Robb (2008) argue that potentially successful business ventures are more likely to generate start-up capital and thus explaining the relationship between start-up capital and growth.

It is questionable to which degree start-up capital leads to higher growth, as a linear relationship would indicate more money is always better (Lee and Zhang, 2010). A recent paper by Regasa, Roberts and Fielding (2017) revealed a negative relationship between financial capital and growth. They suggested the negative effect was caused by the use of external finance. This indicates that not all financial capital has a positive effect on growth. In addition, a paper by Law and Singh (2014), proposed a turning point in the positive effect of finance on growth, indicating that after a certain degree the effect becomes negative. The focus of this paper lay on economic growth, however, using deductive reasoning this could also be the case for growth of USO's. The major-premisse of the Law and Singh (2014) research is deduced to a minor-premisse within the university spin-off field. Moreover, Deidda and Fattouh (2002). also found a non-linear relationship between financial capital and growth.

Thus, even though literature is limited, a quadratic relationship might be at play here, where the relationship between start-up capital and growth is positive to a certain degree, after which it stagnates, or even becomes a negative relationship.

2.4 Human capital theory (Work experience)

The theory of human capital states that education, experience and training increase human capital, and this leads to a higher productivity rate and higher earnings (Tan, 2014; Olaniyan and Okemakinde, 2008; Sweetland, 1996). Furthermore, education increases or improves economic capabilities of people (Schultz, 1971; Sweetland, 1996). Scholars define human capital as productive wealth embodied in labor, skills and knowledge (OECD, 2001; Goode, 1959; Blundell, Dearden, Meghir and Sianesi, 1999) and it refers to any stock of knowledge or the acquired characteristics a person has that contributes to his or her economic productivity (Garibaldi, 2006). According to Lynch (1991), human capital is accumulated in three ways: on-the-job training, off-the-job training and formal schooling. Examples are work experience and training at a company, extra classes next to a job and a certain degree at university. These activities require investments, thus initial costs, to gain return on investments in the future (Becker, 1992).

However, human capital within USO's is not as diversified as usual, as the characteristic of USO's is being founded by faculty members or students of a university. This leads to the fact that the education level of these founders variates little, as all founders have a university level education (Shane 2004). Yet, human capital does not only consist of education. It also looks at experience, that can be accumulated through work length and diversity (Sweetland, 1996; Becker, 1992). Whereas experience contributes to specific human capital, education contributes to general human capital. Specific human capital is an important component of human capital, as it provides knowledge and skills that go beyond education, so-called tacit knowledge. Commercial knowledge is an example of a skill that cannot be gained through education (Jayawarna, Jones and Macpherson, 2014; Delfmann, Koster and Pellenbarg, 2011). Specific to USO's, interactions and experiences outside the university can enhance the skills needed to successfully manage a business, as opposed to, for example, faculty members with long academic careers. The latter often lack the business skills to successfully found and grow a business (Murray, 2004; Nicolau and Birley, 2003). Moreover, experiences, capabilities and knowledge are critical factors for the success of spin-offs as they better equip the founders with the ability to recruit new employees and attract early-stage finance (Clarysse and Moray 2005; Rothaermel et al., 2007).

Scholars agree that human capital affects company growth in a number of ways, as founders themselves need capabilities to be able to manage and deal with the resources to bring their businesses to success (Ucbasaran, Westhead and Wright, 2008; Baptista, Karaoz and Mendonca, 2014; Smith, Matthews and Schenkel, 2009; Unger et al., 2011; Bishop and Brand, 2014; Frese, Krauss, Keith, Escher, Grabarkiewixz, Luneng, Heers, Unger and Friedrich, 2007). First of all, human capital positively influences planning and strategy, which leads to a positive influence on success, through providing capabilities like memorizing complex tasks and being able to make decisions fast (Unger et al., 2011; Frese et al., 2007). Secondly, human capital increases capabilities to identify opportunities for creating new businesses as well as transferring knowledge from university to society (Smith et al., 2009; Unger et al., 2011). Third, human capital leads to greater certainty about one's efficiency and greater abilities to learn fast about market conditions and identifying key success factors in an industry (Baptista et al., 2014). Fourth, human capital contributes to acquiring resources, since capabilities provide knowledge about what where and how to acquire particular resources. Finally, human capital is necessary for further learning and accumulation of knowledge and skills (Unger et al., 2011). However, Fleischhauer (2007) suggested a distinction within human capital, where he

differentiated between specific and general human capital, as mentioned above. This points to the fact that not all human capital is relevant for managing a USO, implicating that not all increases in human capital lead to growth of a USO. Still, there is enough literature to substantiate the hypothesis that human capital does in fact have a positive effect on USO growth.

2.5 Social capital theory

The social capital theory dictates that (capital in) social networks enhance the outcomes of actions (Lin, 1999; Coleman, 1990; Blumberg and Pfann, 1999; Brüderl and Preisendörfer, 1998; Pennings, Lee and Van Witteloostuijn, 1998). Social capital is defined as the resources embedded in relationships among actors (Lin, Cook and Burt, 2001; Leana and Pil, 2006). In addition, Coleman (1990) stated that social capital is created when relations among people change in ways that facilitate action. When starting a business, an entrepreneur's personal network can be of great value. An entrepreneur is not seen as an isolated individual, but as an actor embedded in several contexts, such as social, political and cultural contexts. These contexts can facilitate an entrepreneur in various manners, through the positioning in social networks (Brüderl and Preisendörfer, 1998). "*If we conceive of entrepreneurs as organizers and coordinators of resources, social networking is directly connected with the very idea of an entrepreneur*" (Brüderl and Preisendörfer, 1998, p. 214). Social networking affects two processes for entrepreneurs. First of all, the founding process of a new business, and secondly, the process after founding. The latter is said to be positively affected by social capital, leading to organizational performance (Dubini and Aldrich, 1991). This is called the "network success hypothesis (Brüderl and Preisendörfer, 1998).

Social capital can be divided into informal networks and formal networks (Burns and Stalker, 1961). Informal networks are organic connections between people, which are not embedded in formal structures. Examples are friends, family and working relationships that are the initiative of employees. Formal networks are imposed connections between people, which are embedded in formal structures. Examples are, colleagues, bosses, suppliers, customers and external advisors (Chandler, 1962). Both formal and informal networks can generate resources that can be used to succeed. Specific to USO's, the network of the founders can also impact spinoff success. Informal networks can help faculty members or students by facilitating formal linkages that expedite collaborative research and licensing arrangements with established firms (Martinelli, Meyer and von Tunzelmann, 2008; Landry, Amara and Oumit, 2002). Furthermore,

formal networks can help USO founders to counterbalance the fact that they often have a lack of industry experience. These formal networks then can assist in developing links with potential partners firms and customers, creating business plans, attracting early-stage finance and commercializing technologies (O'Gorman, Byrne and Pandya, 2008; Rappert, Webster and Charles, 1999).

Scholars agree that social capital results in greater performance of a business through a number of ways (Pirolo and Presutti, 2010; Glaeser, Laibson and Sacerdote, 2000; Han, 2006; Burt, 2000; Bachrach, 1989). Firstly, it facilitates the flow of information. In the usual imperfect market situations, social ties located in certain strategic locations and/or hierarchical positions (and thus better informed on market needs and demands) can provide an individual with useful information about opportunities and choices otherwise not available (Han, 2006). Secondly, social capital reinforces identity and recognition. Being recognized as an individual and member of a social group provides emotional support, people 'standing behind' the individual, as well as public acknowledgement of one's claim to certain resources (Lin, 1999). Third, social capital can help increase a USO owner's industry experience through formal networks (Hayter, 2013). Finally, Emerson (1962) suggested that social capital creates more alternatives for obtaining valuable resources and ideas. These resources could, for example, be financial capital, knowledge or skills. This knowledge fuels innovation, productivity and economic growth (Romer, 1986). On the other hand, the knowledge spillover theory of entrepreneurship assumes that it is not necessary that all knowledge is economically useful, as it is subject to institutional, geographic and cost constraints (Hayter, 2013).

2.6 Location theory

Location theory states that the location of a firm in a physical, political or institutional environment has a direct impact on survival and performance (Stearns, Carter, Reynolds and Williams, 1995; Audretsch and Dohse, 2007). That said, this thesis will only focus on the physical location of a firm. A firm's location is then defined as the physical location of its headquarters (John, Knyazeva and Knyazeva, 2011). The impact of geography has always been a topic of interest for scholars of entrepreneurship. More precisely, the decision of choosing a location as a startup. Scholars identified a number of characteristics influencing this decision-making process (Audretsch, Lehman and Warning, 2005). In addition, authors acknowledge the

effect firm location has on success, as locations can differ hugely on several grounds. For example, resources can be scattered across a wide range, or they can be concentrated, making it accessible for a startup. Locations can also differ in skill, as some locations have a broad scope of skills, whilst others have skill uniformity (Stearns et al., 2007). This confirms the crucialness of the locational decision. Several streams of literature suggest certain locations to be prevalent. One of them being location proximity to a university, as universities are said to be sources of knowledge spillovers. In addition, universities produce another kind of spillover, in the form of graduates. The human capital within these graduates can be accessed more easily by firms located close to firms, through hiring these graduates. On the other hand, location proximity to a university also often comes with higher costs of housing. (Audretsch et al., 2005) A second stream of literature focuses on locating a firm within clusters and agglomerations. As firms within clusters or agglomerations have superior access to resources (Audretsch and Dohse, 2007).

Research has shown that location of the firm affects growth of a firm in a number of ways, as locations consist of a mix of capital, labor, information and material that can be critical to the performance of a firm (Stearns et al., 1995). First of all, literature suggests that performance will be higher for firms in spatial clusters, as they can benefit from knowledge spillovers, since access to tacit knowledge is greater (Audretsch et al., 2005). Moreover, Audretsch et al. (2005) stated that knowledge spillovers of universities tend to be high, meaning that locational proximity to a university is important. Secondly, firms located in clusters have superior access to knowledge resources. On the other hand, scholars have stated that location plays no role in accessing knowledge (Spence, 1984; Cohen and Levinthal, 1990). However, the location theory suggests that knowledge does not spread costless across geographic space, meaning that proximity to a knowledge spillover reduces the cost of accessing this knowledge. This was confirmed by Audretsch and Feldman (1996) and Glaeser, Kallal, Scheinkman and Shleifer (1992), as they demonstrated that knowledge spillovers are spatially bound. Thirdly, locations with a higher population density (clusters) have superior access to financial capital (John et al., 2011), as well as other resources (Audretsch and Dohse, 2007).

2.7 Conceptual model

This section discusses the conceptual model of the present study. The model aims to explain USO success by combining several theories and literature streams including, start-up finance literature, human capital theory, social capital theory and location of the firm literature. To summarize the relations between the different variables and in order to answer the research question: *'To what extent do the different antecedents influence the growth of a university spin-off?'*, figure 1 is presented below. After the conceptual model, each hypothesis will be elaborated on to some extent, as all arguments have already been stated in the previous sections. This section will merely recite some of the important arguments.
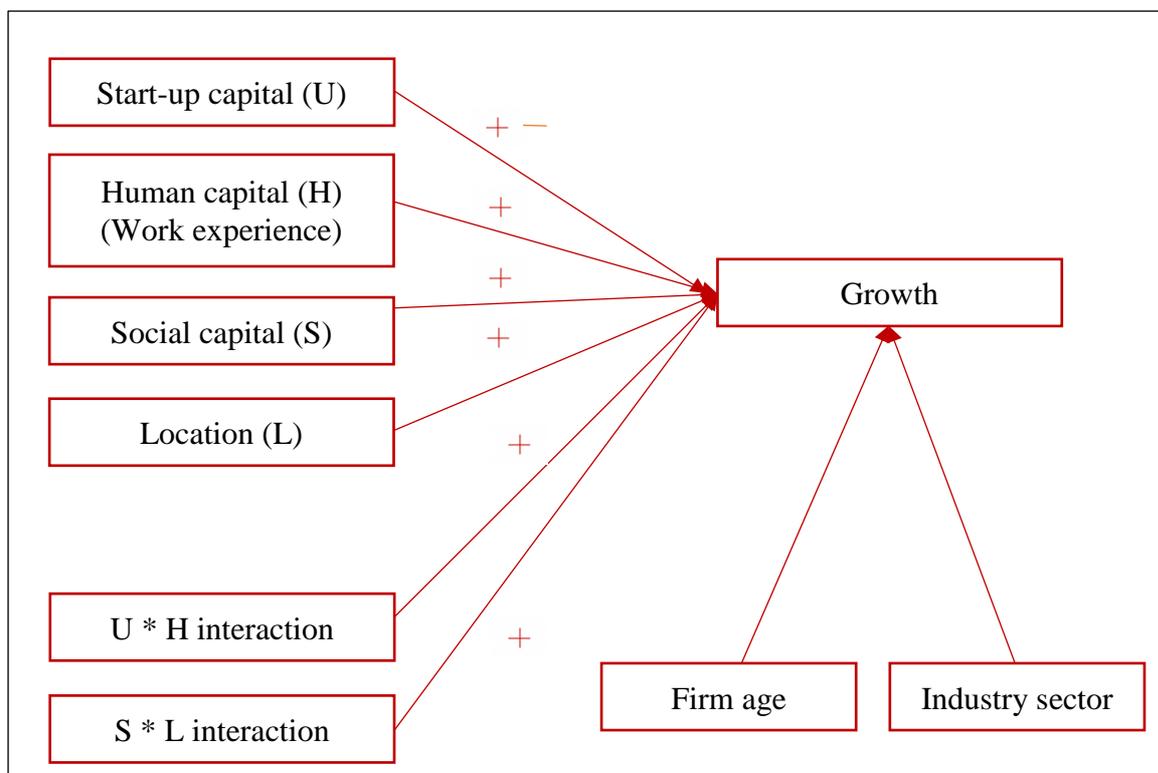
Figure 1. *Conceptual model*

It is expected that the amount of financial capital will positively influence growth of a USO. Start-up capital gives USO founders the ability to lengthen their learning curve, giving themselves more time to succeed. Moreover, start-up capital gives founders the ability to pursue opportunities and execute them as well.

On the other hand, scholars (Law and Singh, 2014; Regasa, Roberts and Fielding, 2017; Deidda and Fattouh, 2002) have suggested both a positive and negative effect of financial capital on growth. This indicates a turning point in the relationship, which implies a quadratic relationship. Hence, hypothesis one is divided into two separate hypotheses.

Hypothesis 1a:

Start-up capital has a positive effect on USO growth.

Hypothesis 1b:

Start-up capital and USO growth have a quadratic relationship (first positive, then negative)

It is also expected that the degree of human capital will positively influence growth of a USO. Human capital contributes to acquiring resources, by equipping founders with the skills to uncover and attract resources. Furthermore, human capital gives founders the knowledge and capabilities to manage firms and the acquired resources successfully.

Hypothesis 2:

Human capital (work experience) has a positive effect on USO growth.

Furthermore, it is expected that the degree of social capital will positively influence growth of a USO. Social capital leads to valuable information on, for example, opportunities, through different networks and contacts. In addition, social capital can generate links with potential partners or help in obtain valuable resources.

Hypothesis 3:

Social capital has a positive effect on USO growth.

Moreover, location of a firm is expected to positively influence growth of a USO. A firm located within a cluster will have better access to resources. Moreover, within a cluster firms can benefit from knowledge spillovers.

Hypothesis 4:

A firm located in a cluster has a positive effect on USO growth.

The interaction effect between financial capital and human capital is also expected to positively influence growth of a USO (*hypothesis 5*). Finally, it is expected that the interaction effect

between human capital and location will also positively influence growth of a USO (*hypothesis 6*). These hypotheses will be explained in the next section.

2.8 Interaction effects

To determine the existence of simultaneous effects of two or more independent variables on growth of USO's, interaction effects need to be examined. This could give a better representation of the relations between the antecedents and growth. Furthermore, it could explain more of the variability in the dependent variable. This next section covers the interaction effects that were found.

2.7.1 Start-up capital – human capital (work experience) interaction

Lee and Zhang (2010) suggested that it is questionable if the findings of a positive correlation between financial capital and growth necessarily indicate a financial deficiency in businesses that fail or do not grow. This would implicate that a startup without financial capital would be unlikely to grow. Although, for the reasons mentioned in paragraph 2.3, there is a truth to this, a second variable in combination with financial capital could provide a superior explanation. Hence, the financial capital – human capital interaction is introduced (Cressy, 1996; Brüderl et al., 1992; Cooper et al., 1994).

On a study of 1,053 new ventures in the US, Cooper et al., (1994) employed a set of human capital variables along with financial capital in explaining firm survival and success, finding a strong positive effect. Cressy (1996) even demonstrated that the positive correlation between financial capital and growth disappears once human capital variables are controlled for. However, Lee and Zhang (2010) stated that though provocative, this claim is likely the result of using a different sample of firms, as other studies do find a positive relation in different settings. Furthermore, Unger et al., (2011) argues that human capital contributes to acquiring resources, such as financial resources, through knowledge on how to bring in particular resources. This was confirmed by Rothaermel et al. (2007), as they stated that experience, capabilities and knowledge equip founders with the skills to attract early-stage finance. Additionally, human capital provides the capabilities to manage these resources (financial capital) wisely (Unger et al., 2011). This leads to two propositions on the reinforcing effect of start-up capital and human capital. First of all, the higher the degree of human capital within a USO start-up, the higher the probability of attracting start-up capital. Secondly, the higher the

degree of human capital within a USO start-up, the higher the probability that acquired financial resources will be used in a constructive manner, enhancing the outcomes for the firm.

Hypothesis 5:

The interaction of financial and human capital will have a positive effect on USO growth.

2.7.2 Social capital – location interaction

When reviewing the literature on this interaction effect, it becomes obvious that the amount of literature is limited. However, research by Vaessen (2005) revealed that within certain locations, a higher degree of social capital is expected, as the availability of potential contacts/networks is higher in clusters. Moreover, through these contacts and networks, firms located in clusters have superior access to resources (Audretsch et al., 2005). This indicates that a startup located in a cluster will profit more from networks than firms that are not, implying that these two amplify each other. This could, in turn, result in higher growth of a USO.

Hypothesis 6:

The interaction of human capital and location will have a positive effect on USO growth.

3. Methodology

3.1 Introduction

This chapter describes the research methodology of this research. More precisely, this part includes the research method, data collection method, control variables, operationalization, analysis method, validity and reliability, research ethics and limitations of the research and ways to tackle these (possible) limitations.

3.2 Research method

This research follows a quantitative method using the statistical program SPSS. A quantitative method is chosen for several reasons. First of all, the objective of this research is to classify features and construct statistical models to explain what is observed. Specifically, in this research the success indicators of USO growth need to be clarified. Secondly, this research aims to find conclusive answers on focused and narrow subjects. Furthermore, it is clear in advance what will be researched. Finally, a quantitative method is more efficient and able to test hypotheses (Hair, Black, Babin and Anderson, 2014).

Within this research a deductive approach is used, to test expected patterns against observations. Hypotheses are developed based on existing theory and a research strategy is designed to test these hypotheses. Using a deductive approach offers the following advantages (Dudovskiy, 2018). First of all, it has the possibility to explain causal relationships between concepts and variables. Secondly, it has the possibility to measure concepts quantitatively. Finally, it has the possibility to generalize research findings to a certain extent. These advantages indicate the clear need of a deductive approach for this research.

As this research is part of an overarching research, of USO's of the Radboud University (RU) Nijmegen, conducted by Vaessen, this same database is used for this research as well. The surveys for this database were held in the years 2000, 2004, 2008 and 2011. The four surveys all focused on different topics, but several questions were left in the surveys to be able to measure variations throughout the years. Respondents were identified by selecting spin-offs with a certain postal code. These spin-offs were found through a database of entrepreneurs owning a firm, that had graduated from or lectured at the RU Nijmegen, as well as through contacts from the university. A total of 301 startups were contacted, however 261 ended up

being suitable to send the survey to. In the end, 134 startups responded and returned the survey. For this survey, only startups that responded in the 2008 and 2011 survey are suitable, as growth of the firm is measured over time. The total amount of respondents for this research is 98.

3.4 Control variables

To increase the accuracy of the study, control variables are added (Hair et al., 2014). *Industry sector* controls for the differences in industry, as these differences will have an effect on the variables. A study by Reynolds (1987) found significant differences of new firm performance per industry. Humphreys and McClung (1981) also stated that different industries have higher or lower success rates. Different industries have different needs for financial capital, human capital, social capital and location. A consultancy bureau will need less financial capital than a manufacturing company. A tech company will need a different set of human capital than an employment agency. A financial services company will need a different set of social capital than a tourism company and a marketing bureau will need a different location than a chemical company (Cooper et al., 1995)

Firm age controls for the differences in the age of the spin-offs, as these differences will have an effect on the variables. Firm age can be defined as the number of years of incorporation of the company (Ilaboya and Ohiokha, 2016). Research has found that the age of a firm is expected to have a relationship with growth of a firm. A younger spin-off tends to grow faster than an older spin-off (Scholten et al., 2015).

3.5 Operationalization

To be able to measure the variables, indicators of the 2008 and 2011 survey of the overarching research of Vaessen were assigned to each of the variables. These variables, their definition, their indicators, the scale of the answers and the corresponding questions (and the year of the survey) are depicted in Table 1. The corresponding questions can be found in Appendix A.

Based on the literature review above, the dependent variable *Growth* is measured by growth of the organization in terms of sales and number of employees. The figures of the years 2008 and 2010 are used to generate a growth index.

Based on the literature review above, the independent variables *Financial capital, Human capital, Social capital* and *Location* are measured as follows: *Financial capital* is measured by the amount starting capital in euros, reflecting the first round of startup financing; *Human capital (work experience)* is measured by work length, in amount of worked years; *Social*

capital is measured by the degree of active networks, through the amount of weekly formal appointments and informal conversations ; *Location* is measured by the physical location of the firm in a certain area (e.g. shared office space, own office, firm cluster).

The variables financial capital, human capital (work experience) and location are measured as a starting condition, as all of these are acquired before or just when the firm starts operating. On the other hand, the variable social capital is measured at a moment in time where the firms have been operating for a while. However, this distinction can help capture the entire picture of growth of USO's as both starting conditions and developing conditions are taken into account. In addition, a so-called time-lag exists between the dependent variable and the independent variables, as growth is measured at two moments in time. This is done to give a more comprehensive view of USO's as performance only focuses on one given moment in time, whereas growth represents the results and performance of a longer period of time.

Control variables are included to eliminate external explanations of success factors for USO's as much as possible. *Industry sector* is measured by the sector the firm operates in. *Firm age* is measured by the amount of years since the founding of the firm.

Variable (type)	Definition	Indicator	Corresponding question (year)
Growth (DV)	*"A change in size and sales during a determined time span"*	Sales	13a (2011)
Growth (DV)	*"A change in size and sales during a determined time span"*	Number of employees	15b (2011)
Start-up capital (IV)	*"Equity financing provided before there is a real product or company organized"*	Start-up capital in €	4a (2008)
Human capital (work experience) (IV)	*"Productive wealth embodied in labor, skills and knowledge"*	Years of work experience	18 (2011)
Social capital (IV)	*"The resources embedded in relationships among actors"*	Formal appointments	18a (2008)

Social capital (IV)	*"The resources embedded in relationships among actors"*	Informal conversations	19a (2008)
Location (IV)	*"The physical location of a firm's headquarters"*	Housing of the firm	20 (2008)
Industry sector (CV)	*'The sector in which a firm operates'*	Sector firm operates in	3b (2008)
Firm age (CV)	*'The number of years of incorporation of the company'*	Founding year of firm	1b (2008)

Table 1. *Operationalization of variables*

3.6 Analysis method

To assess the conceptual model, six hypotheses are tested. One method of analysis is required for this, namely *multiple regression analysis* (Hair et al., 2014). The effect of financial capital, human capital (work experience), social capital, location and of the two interaction effects on growth are tested using a regression model. This is done by testing the influence of the independent variables on the growth indicator.

3.7 Validity and Reliability

To ensure valid conclusions, the validity and reliability of this research are assessed (Hair et al., 2014). Measures are performed using the statistical software program SPSS.

Validity is defined as the extent to which the measurements of a study reflect the concept of the study (Babbie, 2010). Measuring validity within this research falls into three different measurements categories, namely convergent validity, construct validity and discriminant validity (Hair et al., 2014). Convergent validity is significant when the loading estimates are statistically significant and have an average variance extracted (AVE) > 0.50. However, this validity looks at the inter-item correlation between the items of a scale. Within this research only the growth construct is based on two items. Construct validity is achieved when the fit indices achieve the required level, meaning whether the survey measures the intended construct. Here again, as all but one variable focus on a single-item scale, this validity measure becomes irrelevant. Discriminant validity is achieved when a value less than 0.85 is reached and indicates that the scales of a construct do not correlate with others, thus measure different constructs (Hair et al., 2014).

Reliability is defined as *'the extent to which results are consistent over time and an accurate representation of the total population under study and if the results of a study can be reproduced under a similar methodology'* (Golafshani, 2003, p. 3). Another definition used is '*the property referring to the consistency of the measurement across several questionnaire items measuring the same latent construct or over time'* (Mazzochi, 2008, p. 10). However, this definition focusses on the multi-item measurement of a construct, whereas in this research, most variables are single-item measurements. The one construct that includes two indicators is the dependent variable growth. For this construct the reliability is measured to assure that these two indicators can be computed into a construct. This is done using Cronbach's alpha. A Cronbach's alpha of more than 0.7 is adequate, but a score above 0.8 or 0.9 is favorable (Hair et al., 2014).

3.8 Research ethics

Throughout this research the quality and integrity of the research is ensured, as well as being independent and impartial. Furthermore, in obtaining the data, the author acted ethically. All participants participated voluntarily in the overarching research by Vaessen, and informed consent was sought. The confidentiality and anonymity of the respondents was respected as no names of founders or business are mentioned in the process.

This research intends to uphold these ethics within this paper. Moreover, the results and data are handled objectively. Finally, everything in the power of the researcher is done to act ethically.

3.9 Limitations

When reading this research, one should acknowledge the fact that this research is based on the overarching research of Vaessen. Within this research data of USO's situated in Nijmegen was gathered, indicating that this sample is not representative of the total population. Results and conclusions that flow from this research will be relevant and useful. However, generalized conclusions are not possible, as, for example, contextual, cultural and economic factors might influence the outcome and be different within the total population. The limitations will be elaborated on in section 5.5.

4. Results

4.1 Introduction

The results chapter will present and review the results from the SPSS analysis. This analysis will test the hypotheses mentioned in chapter 2.7. First of all, the variables that need transformation and the constructs that need to be computed will be discussed. Secondly, the bivariate and univariate analyses are shown. After that, the assumptions for a regression analysis will be tested. The fourth section will present a summary of the regression analysis results. Finally, the validity of the results will be presented.

4.2 Variables and constructs

Preceding the analysis of the data, the data must be checked whether variables are in need of transformations. In addition, the variables need to be constructed.

The first variable that needs to be transformed is 'oprichtingsjaar', as this depicts the year of foundation, for example 1992, and not the age of the firm. The variable is changed into amount of years since foundations, for example 16 years. The new variable is 'firmage'.

The second variable that needs to be transformed is 'huisvestingssituatie', which depicts the housing situation. The answers show a scale of 1 to 4, however these are not ordered from lowest degree of clusters, to highest degree of clusters. These answers, including the scales, are changed. Now, 1 is the housing situation with the lowest degree of being in a cluster, and 4 with the highest degree of being in a cluster.

The first construct to be computed is growth. The growth construct consists of two indicators, namely sales and number of FTE's. The sales and number of FTE's of 2008 and 2010 are computed into two new indicators that depict the growth index of both indicators. The mathematical equation 'new-old/old' is used to generate a growth rate. Before these two indicators are computed into a construct the reliability must be measured by using the Cronbach's alpha value. This value must be at least be above 0.7. The reliability analysis revealed a Cronbach's alpha of 0.844. Thus, the two indicators can be computed into one construct, namely 'totalgrowth'

The second construct to be computed is social capital. Social capital consists of formal networks and informal networks. The variable is measured by amount of appointments and conversations. These are totaled to compute the construct of social capital.

4.3 Univariate analysis

First of all, it is important to look at the missing data for each individual variable. In this case the missing data did not meet the threshold of 10% and therefore the missing data will be ignored. Secondly, to find out whether the variables are normally distributed, the skewness and kurtosis must be analyzed. To determine whether the variables are normally distributed, a range of -3 and +3 is applied, as this is an acceptable range to assume normality given the size of the data set (Hair et al., 2014). All variables, except for growth, fall within this critical range as can be seen in table 4. The high values of skewness and kurtosis show that the variable growth is not normally distributed. The lack of normal distribution can increase probability of rejecting the hypotheses while actually an effect exists.

When analyzing the kurtosis of the data and looking at the bar chart of the growth variable, it becomes obvious why the data is leptokurtic. Many respondents had no increase in sales between 2008 and 2010, filling in the same amounts of sales in both years. When looking at the growth index of these companies, evidently, the growth rate is zero. A possible explanation for this is the financial crisis of 2008. It is evident that economic downturn and unfavorable financial market conditions negatively affect the operation and survival of firms (Cowling, Liu, Ledger and Zhang, 2014) Moreover, a research by Peric and Vitezic (2016) revealed that, during the 2008 crisis, medium- and large-sized companies exhibited higher growth than small firms. This was confirmed by other scholars, that concluded that small firms are more sensitive to cycles and fluctuations (Siemer, 2014; Smallbone, Deakins, Battisti and Kitching, 2012; Bugamelli, Cristadoro and Zevi, 2009). This is noticeable in the data, as it shows that a total of 30 companies had a growth rate of zero. All the other companies all had different growth rates. This resulted in a frequency of 30 for the value of zero, but only a frequency of one for all the other values. Thus, resulting in a high value for kurtosis, indicating leptokurtic data.

The result for skewness clearly exceeds the range, meaning a 'log' transformation is necessary. First of all, the data of growth is positively skewed. However, as the data of growth involves negative numbers, as well as zero's, a standard 'log 10' transformation cannot be used. To be able to address this problem, a value of '2' should be added to the 'log10' transformation. This creates the construct totalgrowth_log. The new skewness is now 1.020, which is within the acceptable range.

Moreover, table 4 depicts the descriptive statistics of the variables. The description of the control variables shows that the USO's have an average age of 12,29 years at the time of their

first participation in the survey (2008). Interesting here, is that the std. deviation is 7.47, indicating a large difference between ages of firms. Furthermore, it shows that the average industry sector is 4,42. Analyzing the frequencies of this data shows that category 5 (business services, training and health and wellbeing) is, by far, the largest category with 71 out of 96 being in this category. All the frequencies of the different industry sectors can be found in table 2. The description of the independent variables shows that the average start-up capital is category 1.15. Analyzing the frequencies of this data shows the following frequencies, depicted in table 3. This table clearly shows the low average of start-up capital for USO's.

Industry Sector	Frequency
'Industrie'	2
'Handel'	9
'speur- en ontwikkelingswerk	7
'ICT'	7
'Zakelijke diensten, training en gezondheid en welzijn'	71

Table 2. *Industry sector frequencies*

Start-up capital	Frequency
€ 0	29
€ < 10.000	41
€ 10.000 – 25.000	18
€ > 25.000	8

Table 3. *Start-up capital frequencies*

The human capital figures show that the average work experience previous to founding the USO is 6,01 years. A side note to be made here, is that the std. deviation is 6,61 years, indicating large difference in experience between founders. The descriptions show that the average social network appointments per week are 4,51. The figures of the housing variable show that the average housing situation is 3.02. Analyzing the frequencies of this data shows that 78 USO's out of 98 are situated on a regular business park (category 3). The description of the dependent variable, growth, shows an average growth of 0,3452 from 2008 till 2010. The standard deviation is 1.5044, suggesting quite a difference in growth rates. However, after the log transformation, the average growth value is 0.3282, with a standard deviation of 0.1717, indicating a much smaller difference in growth rates.

Variable	N Valid	Missing	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
Firmage (CV)	98	0	12.2857	7.4737	0	37	0.228	-0.168
Industrysector (CV)	96	2	4.4167	1.1018	1	5	-1.713	1.590
Startcapital (IV)	98	0	1.1500	1.1060	0	5	1.276	2.030
Human capital (IV)	98	0	6.0102	6.6107	0	32	1.307	1.819
Socialcapital (IV)	96	2	4.5104	2.0571	1	10	0.567	-0.530
Housing (IV)	98	0	3.0204	0.4536	2	4	0.088	2.056
TotalGrowth (DV)	94	8	0.3452	1.5044	-1.57	10.50	4.996	28.996
TotalGrowth_log (DV)	94	8	0.3282	0.1717	-0.36	1.10	1.020	8.772

Table 4. *Descriptive statistics*   Note: number of observations 98 (n=98)

4.4 Bivariate analysis

To make sure the variables are not highly correlated, the correlation matrix is looked at. A threshold of 0.5 was used (Hair et al., 2014). As can be seen in table 5, it can be assumed that the variables are not highly correlated as there are no values higher than .452. However, the variable firm age has a significant correlation with growth and start-up capital. Moreover, these variables have, by far, the highest Pearson correlation value, as the highest correlation value after these two is .199. A significant correlation between firm age and the dependent variable growth is favorable, as it indicates a linear relationship between the two. On the other hand, a significant correlation between firm age and the independent variable start-up capital is not so beneficial. The negative significant correlation suggests that the younger a firm, the higher the start-up capital, or, the older the firm, the lower the start-up capital. This might suggest that firms nowadays (in 2008) have better access to and make more use of start-up capital than firms in the past.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Growth_log	1						
(2) Startcapital	0.007	1					
(3) Humancapital	0.077	-0.110	1				
(4) Socialcapital	0.091	-0.034	-0.084	1			
(5) Housing	0.021	-0.056	0.093	-0.023	1		
(6) Firm age	-0.452*	-0.268*	-0.054	-0.104	-0.132	1	
(7) Industry sector	-0.177	-0.199	0.161	0.159	0.087	-0.027	1

Table 5. *Pearson correlation matrix*   ** = significant at the .05 level*

4.5 Assumption testing

Before a regression analysis is conducted, several assumptions must be tested. These assumptions determine whether or not a regression analysis is befitting. Moreover, these assess whether the data is adequate for the analysis.

The first assumption to be tested is linearity. To determine this, the residual plot must be analyzed to identify a possible linear relationship in the model. When examining the residual plot, that can be seen in Appendix B, the dots seem to form a clear pattern. However, when looking at the plot more closely, a huge cluster of residuals is found at the -0,5 to 0,5 value for growth. However, this does make sense from a theoretical perspective, as most start-ups/firms do not experience huge amounts of growth in two years and might even experience a small decrease in sales. This does mean that a linear relationship might not be at play for all the independent variables. Thus, other types of relationships must be examined. For example, as mentioned in the theoretical framework, a quadratic relationship might be at play for the start-up capital variable. Finally, there are no curves or triangles in the plot. This means no polynomials have to be included (Hair et al., 2014).

The second assumption to be tested is multicollinearity, the independence of error terms. To assess this, an examination is to be made whether the independent variables correlate highly with the dependent variable and whether the independent variables correlate highly with each other (Hair et al., 2014). The first direct measure of multicollinearity is tolerance. To assure a low degree of multicollinearity, the tolerance values must be high, namely above 0.2 (Hair et al., 2014). As can be seen in Appendix C, the tolerance values are all above 0.88. The second measure of multicollinearity is the Variance Inflation Factor (VIF). To assure a low degree of multicollinearity, the VIF values must be below the threshold of 10. As can be seen in Appendix C, the VIF values are all below 1.2. Both tolerance and the VIF confirm that multicollinearity is low and thus not a problem for this model (Field, p.342, 2005).

The third assumption to be tested is homoscedasticity, the constant variance of error terms. To determine whether the data is homoscedastic, the same plot as used for linearity can be used, namely Appendix B. The residuals show a consistent pattern, as low values have low values for residuals and high values have high values for residuals. This means that the data is homoscedastic.

The last assumption to be tested is the normality of error distribution. To examine whether or not normality can be affirmed, the histogram of the residuals must be looked at (Appendix D), with a visual check for a distribution approximating the normal distribution and the normal probability plot (Appendix E) (Hair et al., 2014). When examining the histogram, a deviation is found. However, to confirm this deviation, the normal probability plot must be examined as well. Appendix E shows that the plotted residuals do not follow the diagonal line exactly, meaning there is no full normality. However, as the residual scores are close enough to the diagonal line, these differences can be accepted.

4.6 Regression analysis

When analyzing the total regression model, one must look at the R square. In case of non-linearity, the adjusted R square must be used. As stated previously, linearity could not be confirmed for all variables. The adjusted R square for the total model depicts a value of 0,193, meaning the independent variables together explain 19,3% of the model/dependent variable. The adjusted R square for the different models and the results of the effects analysis are shown in table 7 and 8 at the end of paragraph 4.4.1.

4.6.1 Effects analysis

The next step is to analyze the effects and reject or accept the formulated hypothesis. Beta coefficients are used to analyze these effects, as these are the standardized beta coefficients. Table 6 gives an overview of the results per hypothesis. After that, each hypothesis will be further elaborated on.

Hypothesis	Effect on growth (DV)	
	Beta	Sig.
1a Start-up capital (linear)	0.373	0.123
1b Start-up capital (quadratic)	-0.492	0.041*
2 Human capital	0.101	0.302
3 Social capital	0.078	0.426
4 Location	0.068	0.566
5 Interaction 1	0.009	0.950
6 Interaction 2	-0.638	0.526

Table 6. *Hypothesis results*   ** = significant at the .05 level*

H1a: Start-up capital has a positive effect on USO growth.
H1b: Start-up capital and USO growth have a quadratic relationship (first positive, then negative)

When testing for a linear relationship, no significant effects are found. However, when looking at a quadratic relationship a significant correlation is found ($p < .05$). Thus, the variable start-up capital-squared needs to be created. The computed variable is called startcapitalSQ. Now, a new linear regression can be done including both the variable startcapitalSQ, as well as the variable startcapital. The outcome shows a significant effect ($p < .05$) for both variables. The beta coefficient for startcapital is 0.373, whereas the beta for its squared value is -0.492. In conclusion, a significant quadratic effect is seen between start-up capital and growth. When examining the scatterplot, illustrated in appendix G, the identified shape of the curve resembles an upside-down U. These relationships are often called a 'too much of a good thing' effect. When start-up capital goes up, the growth rate goes up as well. However, once you get to a certain level of start-up capital, the growth rate goes down again. Too much start-up capital might result in less growth. Examining appendix G unveils that the turning point of the quadratic relations seems to be after the €25.000 marker (answer 2). Practically, this would

mean that firms with a start-up capital of less than €25.000 will have a higher degree of growth compared to firms with a start-up capital larger than €25.000.

After the 2008 financial crisis, research by scholars of the Bank for International Settlement (BIS) and International Monetary Fund (IMF) suggested that the relationship between finance and growth is non-linear. They proposed it to be an inverted U-shape, where there is a turning point in the effect of finance (Law and Singh, 2014). This is in line with the results from this data. Even though the BIS and IMF research was mainly aimed at the financial development leading up to the 2008 crisis, these findings suggest a 'too much of a good thing' effect when it comes to finance. Further research must point out whether this turning point can be confirmed for USO's, as most scholars (as can be seen in paragraph 2.3) have only researched the effect of having financial capital and not the amount of financial capital. It can thus be concluded that hypothesis 1a is rejected, as hypothesis 1 suggested a linear relationship. However, hypothesis 1b suggested a quadratic relationship, meaning it can be accepted.

H2: Human capital has a positive effect on USO growth.

When testing for a linear relationship, no significant effects are found ($p > .05$). Even when testing for other types of relationships, no significant effects are found ($p > .05$). The beta coefficient for human capital is 0.101, indicating a positive relationship. However, it can be concluded that hypothesis 2 is rejected. This is a surprising result, as many scholars agree that human capital does indeed positively influence growth. Specific to USO's researchers expect work experience to enhance business skills of founders. A possible explanation might be that the knowledge gathered through education (university) has a greater impact on USO success than work experience. Within USO's this level of knowledge variates little, justifying the insignificant result.

H3: Social capital has a positive effect on USO growth.

Additionally, social capital did not have a significant effect on growth when testing for a linear relationship ($p > .05$). Also, no significant effects for other relationship types were found ($p > .05$). The beta for social capital is 0.078, indicating a positive relationship. From this data it can be concluded that hypothesis 3 is rejected. This is not in line with the expectations derived from literature, as scholars suggest that social capital results in greater performance for businesses. Networks can help founders gain access to resources, knowledge and information. A potential

reason could be that social capital or networks are difficult to measure in terms of numerical data. This could influence the outcome of the research, making the results insignificant.

H4: A firm located in a cluster has a positive effect on USO growth.
Furthermore, when testing for a relationship between location and growth, no significant effect was found (p > .05). The beta coefficient of location is 0.068, implying a positive relationship. Thus, hypothesis 4 is rejected. The literature study on location indicated that the location of a firm does indeed influence the growth of a firm, however, the results suggest differently. The location of a firm determines the availability of capital, labor, information and other resources, giving an advantage to the firm within that location. A cause for the insignificant results might be the similarity in data retrieved from the survey, as 78 out of 98 respondents declared to be in a comparable location, namely a regular business park. This uniformity could have an effect on the results.

H5: The interaction of financial and human capital (interaction 1) will have a positive effect on USO growth.
Moreover, when testing for different relationships for the interaction of financial and human capital a significant effect (p < .05) for a cubic relation with growth is found, with a beta of 0.009. However, when examining the plot (appendix F) it is obvious that two 'stray' variables create this relationship. Furthermore, a cubic relationship indicates both positive and negative influences on the dependent variable, as the direction of the slope changes twice. Based on these facts, hypothesis 5 is rejected.

H6: The interaction of human capital and location (interaction 2) will have a positive effect on USO growth.
Finally, when analyzing the interaction effect of human capital and location, no significant effects (p > .05) where found for any type of relation. The beta coefficient for this interaction variable is -0.366, indicating a negative relationship. In conclusion, hypothesis 6 is rejected.

Control variables
When analyzing the control variables, the first noticeable aspect is that firm age has a significant effect (p < .05) on growth. The beta coefficient of this variable is -0.423, indicating a negative relationship. As firm age is counted from young to old, these findings reveal that the lower the

age of a firm is, the higher the growth. This finding is in line with the mentioned theory, as Scholten et al. (2015) stated that a younger spin-off tends to grow faster than an older spin-off. When testing for an effect of industry sector, a significant effect is found when testing for the complete model, namely model 4 and 5 ($p < .05$). The beta (-0.212) of industry sector indicates a negative relationship. This negative relationship is mainly due to the high frequency of 'zakelijke diensten' companies (category 5 of scale 105), which are companies focused on services. This category shows a few results with lower growth, which is logical since it is the biggest group, resulting in a negative relationship. In addition, one outlier in category 2 adds on to this negative relationship. Appendix H exhibits this negative relationship, as well as showing the cause of this relationship. The significant effect of the industry sector is in consonance with the expectations of scholars.

Table 7 illustrates the coefficients and the level of significance per model and per variable, used in the effects analysis.

Model		Unstandardized coefficients		Standardized coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	0.251	0.126		1.998	0.049
	Startcapital	0.014	0.016	0.095	0.890	0.376
	Humancapital	0.003	0.003	0.111	1.028	0.307
	Socialcapital	0.008	0.009	0.104	0.970	0.335
	Housing	0.004	0.038	0.011	0.102	0.919
2	(Constant)	0.584	0.136		4.292	0.000
	Startcapital	-0.011	0.015	-0.077	-0.744	0.459
	Humancapital	0.003	0.003	0.108	1.093	0.277
	Socialcapital	0.008	0.008	0.103	1.053	0.295
	Housing	-0.012	0.035	-0.033	-0.399	0.735
	Firmage	-0.010	0.002	-0.433	-4.198	0.000*
	Industrysector	-0.031	0.015	-0.199	-1.993	0.051
3	(Constant)	0.478	0.269		1.776	0.079
	Startcapital	-0.014	0.019	-0.094	-0.720	0.474

	Humancapital	0.003	0.003	0.094	0.759	0.450
	Socialcapital	0.031	0.045	0.385	0.697	0.488
	Housing	0.023	0.081	0.066	0.290	0.772
	Firmage	-0.010	0.002	-0.432	-4.143	0.000*
	Industrysector	-0.031	0.016	-0.200	-1.966	0.053
	Interaction 1	0.000	0.001	0.035	0.245	0.807
	Interaction 2	-0.007	0.014	-0.299	-0.512	0.610
4	(Constant)	0.457	0.264		1.730	0.088
	Startcapital	0.055	0.038	0.375	1.442	0.153
	Humancapital	0.003	0.003	0.101	0.830	0.409
	Socialcapital	0.034	0.044	0.419	0.774	0.441
	Housing	0.024	0.079	0.068	0.308	0.759
	Firmage	-0.010	0.002	-0.421	-4.107	0.000*
	Industrysector	-0.032	0.015	-0.211	-2.117	0.037*
	Interaction 1	0.000	0.002	0.009	0.063	0.950
	Interaction 2	-0.009	0.014	-0.366	-0.638	0.526
	StartcapitalSQ	-0.018	0.009	-0.497	-2.067	0.042*
5	(Constant)	0.594	0.134		4.447	0.000
	Startcapital	0.055	0.035	0.373	1.559	0.123
	Humancapital	0.003	0.003	0.101	1.040	0.302
	Socialcapital	0.006	0.008	0.078	0.800	0.426
	Housing	0.024	0.035	0.068	0.308	0.566
	Firmage	-0.010	0.002	-0.423	-4.176	0.000*
	Industrysector	-0.032	0.015	-0.212	-2.145	0.035*
	StartcapitalSQ	-0.018	0.009	-0.492	-2.077	0.041*

Table 7. *Coefficients*   * = significant at the .05 level

4.6.2 Model summary

Table 8 shows the strength of the different models while increasing the number of variables in the model. Model one is the basic model with the dependent variable and the four independent

variables. The R square shows a value of 0.029 and the adjusted R square a value of -0.016. The definition of the adjusted R square allows it to be negative, but it can be seen as zero. This means the independent variables contain too little information about and explain too little of the dependent variable's fluctuations. It can thus be concluded that the basic model fits the data poorly.

When adding the two control variables, model 2, the R square change is 0.203, leading to an R square of 0.232 and an adjusted R square of 0.176. Hence, it is obvious that two control variables have a substantial effect on the explanation of the dependent variable.

After adding the two interactions effects, model 3, the R square only increases with 0.003, leading to a decrease of 0.016 in the adjusted R square. The new adjusted R square is now at 0.160. From this data it can be concluded that the two interaction effects have an insignificant effect on the model. The next step here is to exclude these two variables from the model to observe what effect this has on the adjusted R square. This will be done after all the variables have been included first.

Finally, when adding the quadratic variable start-up capital, the R square change is 0.039, producing an R square of 0.274 and an adjusted R square of 0.193. This reveals that all the variables together explain 19,3% of the model.

However, as stated above, the interaction effects must be excluded to determine whether or not this affects the adjusted R square. This is represented by model 5. The results of this model show that when excluding the two interaction effects, the adjusted R square has a value of 0.208, indicating that the variables explain 20.8% of the model.

Model	R	R square	Adjusted R square	Std. Error of the estimate	R square change	F change	df1	df2	Sig. F change
1	0.171	0.029	-0.016	0.170	0.029	0.639	4	85	0.636
2	0.481	0.232	0.176	0.153	0.203	10.941	2	83	0.000
3	0.485	0.235	0.160	0.155	0.004	0.196	2	81	0.823
4	0.524	0.274	0.193	0.151	0.039	4.272	1	80	0.042
5	0.520	0.270	0.208	0.150	0.004	-	-	-	-

Table 8. *Model summary*

Finally, figure 2, portrays the conceptual model including the strength of the relationships and the significance level. This figure, represents, in sum, the results of the analysis, allowing for a quick overview of the total results section.
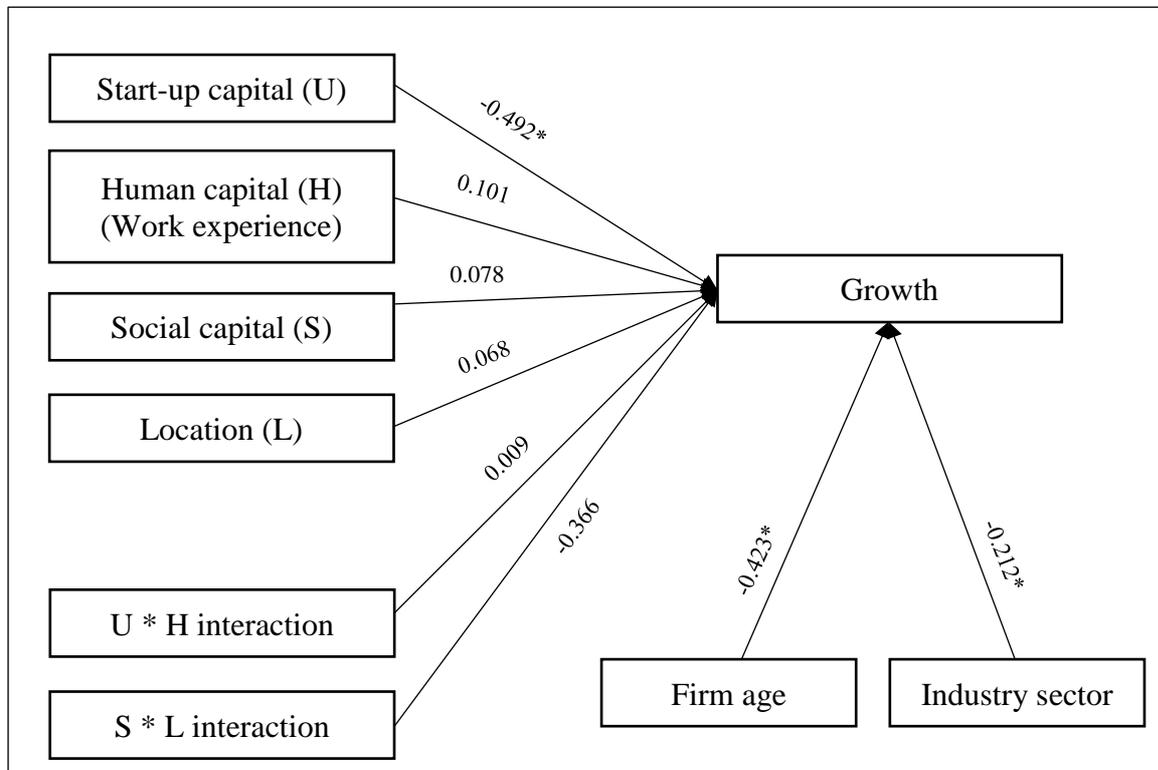

Figure 2. *Conceptual model summary*   ** = significant at the .05 level*

To substantiate the results Structural Equation Modeling (SEM) could be used, as it enables a deeper-level analysis. To be able to perform such an analysis, the use of it must be methodologically justified. A minimum of three indicators per construct is favorable, as SEM is used to identify measurements errors. However, within this research single-item measurements are used, except for growth which consists of two items. When using one indicator per construct, perfect reliability and validity in the measurement model can always be assured (Henseler, Hubona and Ray, 2016). In conclusion, the use of SEM is not methodologically justified, meaning the analysis is not utilized.

4.7 Validity and Reliability

As mentioned in the methodology chapter, the validity and reliability of the research must be measured. However, section 3.7 revealed that the first two types of validity are irrelevant for this research, as convergent and construct validity focus on multi-item measurements. A factor

analysis shows that discriminant validity can be confirmed as the scales of a construct do not correlate with other constructs. Moreover, all values are below the threshold of 0.85. Table 9 shows these correlations. Table 10 depicts the component matrix of the factor analysis. As for the reliability, the reliability analysis revealed a Cronbach's alpha of 0.844 for the two items of growth. Section 4.2 elaborated on this. In conclusion, reliability can be established.

	(1)	(2)	(3)	(4)
(1) Startcapital	1			
(2) Humancapital	-0.098	1		
(3) Socialcapital	-0.034	-0.084	1	
(4) Housing	-0.057	0.103	-0.023	1

Table 9. Factor analysis correlation matrix

	(1)	(2)	(3)	(4)
Startcapital	-0.496			
Humancapital				0.656
Socialcapital		0.820		
Housing			0.781	

Table 10. Component matrix

5. Conclusion

5.1 Introduction

This chapter discusses the results and answers the research question. First of all, a short summary of the research is given. After that, the results will be discussed and reflected on using the used theory. Thirdly, the research question will be answered. Fourthly, the limitations of this research will be stated. Next, the implications that can be derived from this research will be presented. Subsequently, directions for future research are discussed. Finally, a short conclusion on the contributions of the research is presented.

5.2 Summary

The aim of this research was to identify the success factors of start-up firms, specifically university spin-offs. This research is based on literature on financial capital, the human capital theory, the social capital theory and location theory. These theories and literary state the different ways in which certain resources boost a firm's performance and growth. The growth of firms is measured in terms of sales and number of employees. Literature on financial capital dictates that start-up capital enables firms to overcome unfavorable shocks, facilitates acquiring resources and buys time to maximize the learning curve. The human capital theory focuses on personal skills, knowledge and experience gained through education and past work experiences. In turn, this increases capabilities of founders to successfully manage their firm. Specific to USO's is the fact that founders come from a university background, creating a similar education between founders. This leads to more focus on past experiences and training than the education component. The social capital theory focus on the value of a founder's network. The value of these networks is based on the flow of information, the providence of opportunities, the creation of legitimacy for a founder and the creation of alternatives for obtaining valuable resources. A network of high value can in turn boost the performance and growth of a USO. Finally, location theory suggests that the location of a firm influences its performance, as firms located in clusters can benefit from knowledge spillovers and specific knowledge resources.

These four variables are presented in a model, depicting their relationship with the dependent variable growth. All variables were expected to have a positive influence on growth. In the model, two control variables were added to increase the accuracy of the study. In addition, two interaction effects were added. The first interaction effect was between start-up capital and

human capital and the second was between social capital and location. These interaction effects were also expected to have a positive effect on growth. The model was tested by multiple regression analysis in SPSS. The results showed that, contrary to expectations, only start-up capital had a significant effect on growth. Moreover, this was a quadratic relationship, indicating a 'breaking point' of the positive effect. This breaking point was estimated at a start-up capital of €25.000, indicating that the positive effect on growth turns into a negative effect at this amount. Another notable result was the significant effect of both control variables on the dependent variable. These effects were both in line with the expectations derived from theory.

5.3 Discussion

When examining the results, it is obvious that these are not in line with the expectations derived from the presented theory. The expectation was that the variables financial capital, human capital, social capital and location would all influence the growth of a USO. A possible literary explanation for the insignificant effect of human capital is that the amount of work experience is not decisive for human capital, as is advocated by scholars in section 2.4 (Murray, 2004; Nicolau and Birley, 2003; Clarysse and Moray 2005). What might be decisive though, are more detailed tasks and roles fulfilled within the years of work experience (Iversen, Malchow-Moller and Sorenson, 2016). Examples might be leadership roles and organizational tasks. Thus, the key for human capital would then be the quality of the work experience and not the quantity.

An explanation for the insignificant effect of social capital on growth might be the indirect effect it has on growth. Bosma, van Praag, Thurik and de Wit (2002) suggest that social capital influences the generated employment, the acquirement of resources and the survival time. This would indicate that social capital does not have a direct effect on growth, but merely influences variables that, in turn, influence growth. When these variables have insignificant effects, the effect of social capital also becomes insignificant.

The insignificant effect of location might be due to the fact, already mentioned in the results, of uniformity of the data. A larger sample is required to diversify the responses and to find significant effects. In addition, a possible explanation could be that the cost of spreading knowledge across geographic space might be negligible, as opposed to the findings of certain scholars (Audretsch and Feldman, 1996; Glaeser, Kallal, Scheinkman and Shleifer, 1992). This then reinforces the findings of Spence (1984) and Cohen and Levinthal (1990) that location plays no role in accessing knowledge.

The significant quadratic effect of financial capital on growth is partially in line with theory, as scholars (Cooper, Gimeno-Gascon and Woo, 1994; Cassar, 2004; Fairlie, 2012; Fairlie and Robb, 2008; Cressy, 1996; Hayter, 2013) suggested financial capital to have a positive influence on growth of USO's. This is partly true, as until €25.000 in start-up capital, the effect is positive. After this value, the effect turns negative, meaning every extra value of start-up capital, leads to lower growth. This was in line with the second set of expectations, as a few scholars (Law and Singh, 2014; Regasa, Roberts and Fielding, 2017; Deidda and Fattouh, 2002) indicated a non-linear relationship, after which a quadratic effect was deduced. Revealing a quadratic relationship has implications for the university spin-off field, as, until now, this relationship had not been found. Research must confirm this finding by examining this quadratic relationship in other USO contexts. Moreover, future research on USO's should take into account this quadratic effect instead of assuming a linear relationship.

The two control variables both had a significant effect on USO growth, as was expected according to literature. A notable aspect is that firm age had a negative effect on growth. However, this meant younger spin-offs tend to grow faster than older spin-offs, which was in line with research conducted by Scholten et al. (2015).

A final noteworthy consideration are the limited growth-indexes in the data. As explained previously, this could be caused by the financial crisis in the years of the survey. This definitely had an effect on the results, as 30,61% of the respondents noted a growth of zero between 2008 and 2010. This might have been a partial cause for the insignificant results.

5.4 Research question

The question this research tried to answer is '*To what extent do the different antecedents influence the growth of a university spin-off?'.* To answer this question analysis were done on these USO's. The data that was used for these analyses, was from a research conducted by Peter Vaessen, where he focused on university spin-offs in the city of Nijmegen. Specifically, those connected to the Radboud University. The results of the analyses revealed that only financial capital had a significant effect on growth. This relationship was of a quadratic nature, indicating that it was not merely a positive effect. At the financial capital value of €25.000, the positive effect turned into a negative effect. The variables human capital, social capital and location, in contrast with expectations, did not have significant effects on the growth of USO's. In conclusion, the answer to the main research question is that the variables human capital, social

capital and location do not influence growth of a USO to any extent, whereas financial capital does indeed influence the growth of USO's, however both positively and negatively.

5.5 Limitations

As mentioned in section 3.9, this research does include certain limitations, which the reader should be aware of. The first limitation is the diversity of the data, which aims at three different limitations. First of all, as stated previously, solely USO's connected to the Radboud University Nijmegen were used for the data gathering, meaning the sample might not be representative of the total population, as certain contextual factors could influence the outcomes in other locations. Secondly, in light of the 2008 financial crisis, it is imminent that the growth of university spin-offs, as well as firms in general, was influenced. As stated in section 4.3, scholars stated that especially small firms were victims of this crisis. This resulted in no growth or even negative growth for some of the surveyed USO, which is visible in the data, making it more difficult to find significant effects. Thirdly, due to the similar USO's that were used for the research, variables such as location, start-up capital and industry sector contained multiple identical responses. For example, 79,59% of the respondents were located in a similar location and 73,96% were operating in the same industry.

A second general limitation is the operationalization of certain variables. First of all, as mentioned in section 5.3, the operationalization of human capital might be too general, as specific tasks and roles within the work experience were not measured. Secondly, the variable financial capital could have been measured on a scale-basis instead of categories, allowing for more deviation in the responses. The altering of the operationalization of variables could have led to different outcomes.

A final limitation is the single-item measurement focus of this research. All the independent variables are measured by one indicator, leaving space for skepticism. Research (Sauro, 2018) suggests that concerns arise when using single-item measurements. These concerns are low content validity, as this validity cannot be measured with one measurement item, sensitivity to fewer points of discrimination and a lower reliability, as the cronbach's alpha cannot be measured for single-item measurements. On the other hand, several researchers (Scarpello and Campbell, 1983; Cunny and Perry, 1991; Hyland and Sodergren, 1996; Ittner and Larcker 1998; Bergkvist and Rossiter, 2007; Van Doorn, Lemon, Mittal, Nass, Pick, Pirner and Verhoef,

2010) have proved single-item measurements to be an adequate substitute for multi-item measurements. This illustrates that there are always exceptions to certain rules.

5.6 Implications

The results of this research have some relevant implications for university spin-off founders and future founders. As stated in chapter one, USO's contribute significantly to the development and innovation of industries (Muendler, Ruach and Tocoian, 2012) and have a unique role in innovation in general, having an important effect on the economy (Lejpras, 2014). This indicates the significant role of USO's, hence research on this matter is of great practical value.

The finding that start-up capital has a quadratic effect on growth is relevant for university spin-offs. It indicates that having a certain amount of start-up capital can indeed positively influence the growth of one's start-up, however, that too much start-up capital will result in lower growth. This can be used by founders too carefully measure out the needed start-up capital, without exceeding certain limits. This, of course, does not rule out the option of high-investment start-ups, as certain industries, for example production companies, require a high amount of start-up capital. However, one must analyze the necessity of the capital needed, as well as map the risks involved when working with high-investment start-ups. Furthermore, this research suggests that human capital, social capital and location are not reliable predictors for the growth of USO. Thus, when a founder has an abundance of experience, a great social network and an exceptional location, this is no guarantee of immense growth of a USO. One must realize that a wider variety of factors play a role in the predictions of growth.

5.7 Future research

As this research focuses on a select number of variables in a specific environment, future research directions are imminent. A first future research direction is conducting a similar research in a different context, in order to confirm generalizability of the results. This research could also introduce opposing results, which would ask for additional research on the arisen differences.

A second direction for future research is the inverted U-shape relationship of start-up capital on growth. As mentioned previously, the BIS and IMF research (Law and Singh, 2014) revealed there to be a turning point in the effect of finance. This turning point should be researched more

in-depth to be able to confirm this quadratic relationship between start-up capital and USO growth. This could then lead to a new finding in the area of university spin-offs.

Next, a future research direction would be to examine the variable human capital, to identify more precise measures for this variable. As stated previously, work experience might not be an accurate measure for human capital, as it measures a too broad phenomenon. Future research could provide insights on specific roles, tasks and experience that create a more accurate reflection of the degree of human capital of a certain person.

A final direction of future research would be the identification of other success factors when it comes to USO growth. This would provide a more complete picture on the different influencers of USO growth, leading to a better understanding in literature.

5.8 Conclusion

This research contributes to literature on university spin-offs by finding a quadratic relationship between start-up capital and growth. This relationship has, to the best of the author's knowledge, not been identified in other research in the field of USO's. Moreover, this research could lead to more investigations on the success factors of USO's, which would in turn better equip founders by broadening their knowledge on the direct effect of certain variables and aspects on the growth of their university spin-off.

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Appendices

Appendix A

Survey questions (Vaessen, 2008 & 2011)

Dependent variable

Growth

13. Omzet

		Jaar 2008	Jaar 2009	Jaar 2010
a.	Geef aan hoeveel de totale omzet van uw bedrijf bedroeg over de jaren 2008, 2009 en 2010 (exclusief btw)	€	€	€ ....
b.	n.v.t. we hadden nog geen omzet	1	2	3

15. Medewerkers *(u zelf inbegrepen)*

Geef het gemiddelde aantal medewerkers in uw bedrijf in achtereenvolgens de jaren 2008, 2009 en 2010 *(uzelf incluis)*

		Jaar 2008	Jaar 2009	Jaar 2010
a.	Totaal aantal medewerkers			
b.	Aantal medewerkers op basis van fulltime eenheden			
c.	n.v.t. het bedrijf was nog niet opgericht	1	2	3

Independent variables

Start-up capital

4. Financiering

		< 10.000	10.000 - 25.000	25.000 - 50.000	50.000 - 100.000	100.000
4a.	Hoeveel euro bedroeg het startkapitaal van dit bedrijf?	1	2	3	4	5

Human capital

18. Werkgevers

Vermeld per bedrijf of organisatie waar u na beëindiging van uw opleiding aan RU/UMC werkzaam bent geweest.

Naam organisatie/werkgever	Plaats	Jaartal in dienst	Jaartal uit dienst *(mits van toepassing)*	type organisatie	
				profit	non-profit
				1	2
				1	2
				1	2
				1	2
				1	2
				1	2
				1	2

Social capital

18. Formele afspraken met ondernemers en medewerkers van ándere organisaties
(Het gaat om formele afspraken, zoals meestal genoteerd in uw agenda).

18a. Hoeveel formele afspraken met ondernemers of medewerkers van andere organisaties heeft u in de werktijd voor uw eigen bedrijf?
Vul het antwoord in dat het meest van toepassing is.

- [1] gemiddeld minder dan één *per week*
- [2] gemiddeld 1 – 2 *per week*
- [3] gemiddeld 3 – 4 *per week*
- [4] gemiddeld één per dag   V18aand V16aand __ __
- [5] gemiddeld meer dan één per dag, namelijk: .... aantal afspraken

19. Informele persoonlijke gesprekken met ondernemers en medewerkers van ándere organisaties
(Het gaat om informele face-to-face gesprekken niet alleen over bedrijfszaken, maar ook over privé-aangelegenheden, hobby, sport e.d.)

19a. Schat het aantal gesprekken dat er op deze informele manier plaatsvindt met personen van andere organisaties tijdens werktijd voor uw eigen bedrijf.
Vul het antwoord in dat het meest van toepassing is.

- [1] gemiddeld minder dan één *per week*
- [2] gemiddeld 1 – 2 *per week*
- [3] gemiddeld 3 – 4 *per week*
- [4] gemiddeld één per dag   V19aand V17aand __ __
- [5] gemiddeld meer dan één per dag, namelijk: .... aantal gesprekken

Location

20. Huisvesting

20a. Hoe is uw bedrijf gevestigd?

- __ __ a. op een bedrijvenpark (industrieterrein, science park of kantorenpark)   [1]
- __ __ b. in een bedrijfsverzamelgebouw of business incubator met gemeenschappelijke voorzieningen   [2]
- __ __ c. in een (kantoor)gebouw zonder gemeenschappelijke voorzieningen   [3]
- __ __ d. In een autonoom bedrijfspand uitsluitend voor uw bedrijf bestemd   [4]
- __ __ e. In/aan uw woonhuis zonder gescheiden adres   [5]
- __ __ f. anders, namelijk: V20af

Control variables

Industry sector

3b. Wilt u de kernactiviteit(en) van uw bedrijf hieronder zo concreet mogelijk omschrijven?

v3b   —— v1_2   v3b

Firm age

1b. In welk jaar is het bedrijf opgericht? .... oprichtingsjaar

Appendix B

Residual plot

Scatterplot

Dependent Variable: Growth_log
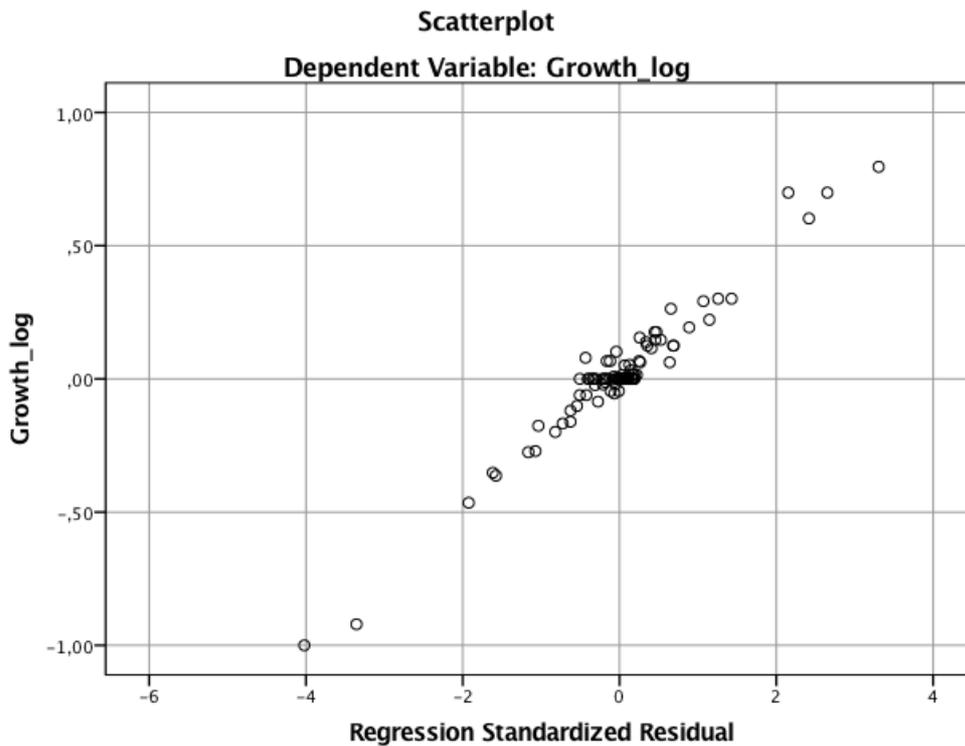
Appendix C

Multicollinearity

Collinearity Statistics

Model		Tolerance	VIF
1	(Constant)		
	Startcapital	0.994	1.006
	Humancapital	0.976	1.024
	Socialcapital	0.992	1.008
	Housing	0.989	1.011
	Firmage	0.887	1.128
	Industrysector	0.909	1.100

Appendix D
<u>Histogram of residuals</u>

Histogram
Dependent Variable: Growth_log

Mean = –1,07E–16
Std. Dev. = 0,977
N = 88
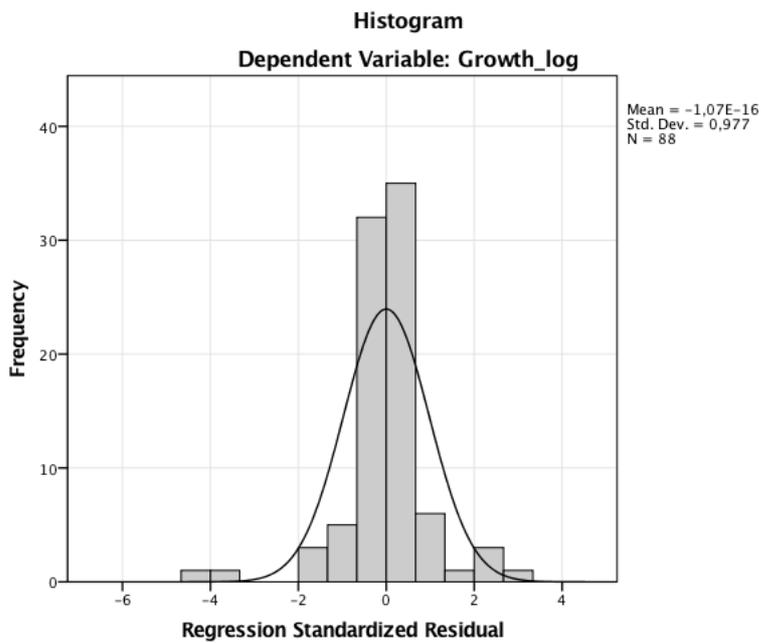
Appendix E

<u>Normal probability plot</u>

Normal P–P Plot of Regression Standardized Residual
Dependent Variable: Growth_log
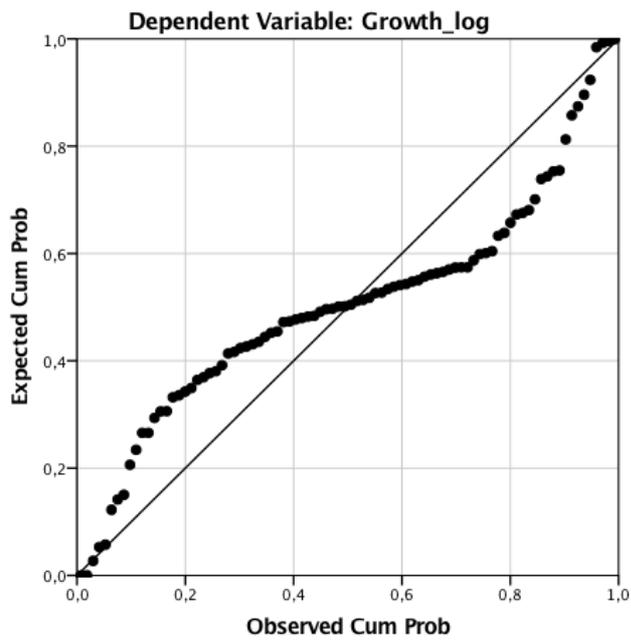
Appendix F

Plot cubic relationship

Growth_log
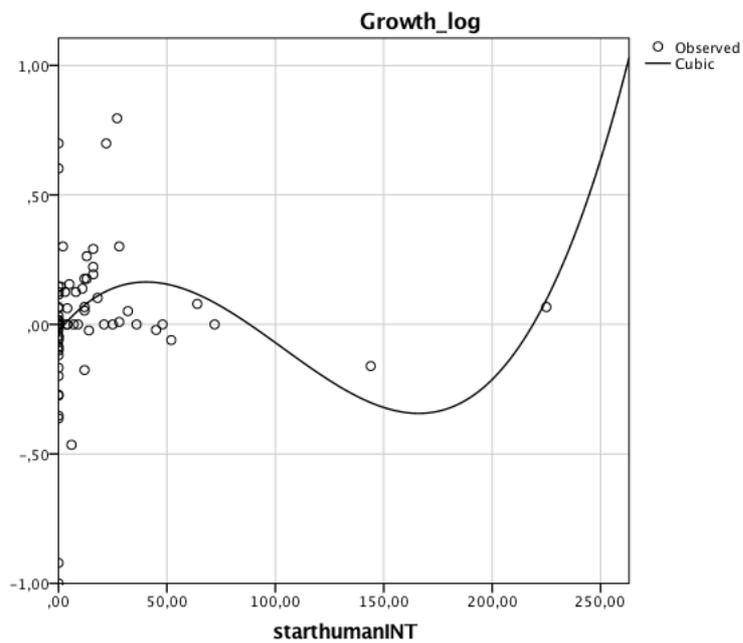
Appendix G

Quadratic relationship start-up capital

totalgrowth_log
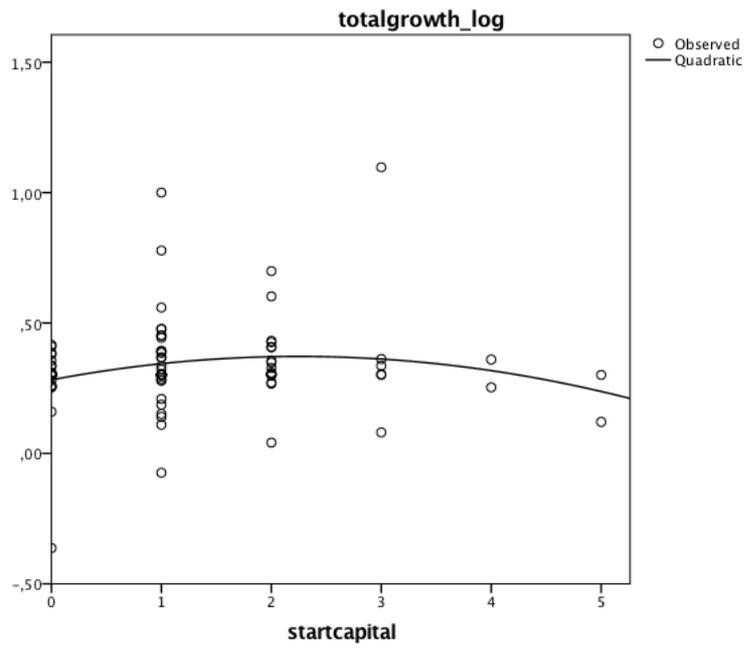
Appendix H

Relationship industry sector and growth

totalgrowth_log