Exploring the influence of the business environment on University Spin-offs

A quantitative analysis of the impact of locational clustering on the development of commercial- and knowledge networks

Master Thesis by Bas Smits

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Abstract

This master thesis is a quantitative study analysing the effects of local and sub-local clustering on USO's network development, regarding both the scientific network and the customer network. This study follows the structure of a scientific journal paper, in which the aim is to find the relationship between two types of clustering and the network development of USOs. The USOs that are studied in this study are all connected with Radboud University due to the founders' study/work background. The founders were asked to fill in a survey regarding the amount of contact they had with customers, suppliers, producers, and they were asked about how many connections they have with scientific institutions. These surveys have been done over a period of time, and the data from three surveys have been put together to create the dataset that is used in this study. In order to analyse the data, regression analyses have been used to study the relationship clustering and network development. The results showed that there is only statistical significance regarding the relationship between local clustering and the development of the customer network. There was no statistical evidence found for the relationship between sub-local clustering network development, and this study didn't find a combinatorial effect between local and sub-local clustering. Further research, with preferably a larger dataset and a more precise survey, must be used to further elaborate and study these concepts.

Preface

With this thesis, the end of an era is near, this thesis is the final product of my master program Business Administration, in which I specialised in Innovation and Entrepreneurship. This final chapter of my study career was not easy, and it contributed to many stressful moments. However, I am proud of the achievement and the result. The title of this master thesis is "Exploring the influence of the business environment on University Spin-Offs: A quantitative analysis of the impact of locational clustering on the development of commercial- and knowledge networks." Finalizing this thesis would not have been possible without the following people.

At first, I would like to thank my supervisor dr. P.M.M. Vaessen, who has helped me tremendously with his ideas and his knowledge on the topic. His guidance has helped me to find a path through the overwhelming possibilities that come with writing a master thesis. Furthermore, I would like to thank all people that filled in the surveys in the past years. Without them, this study would not have been possible.

Finally, I would like to thank all of my friends and family who supported me through the many stages of this thesis and challenged me multiple times with debates on the topic. Writing this thesis was not easy for me. However, with the support of everyone involved, I proudly present my final work.

Hopefully, you enjoy reading this thesis,

Bas Smits

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1. Introduction

Knowledge is becoming more and more important for companies to thrive and to gain competitive advantages. The potential for knowledge-intensive firms is high. However, many environmental factors influence the development of these types of firms. University spin-offs (USOs) are an example of knowledge-intensive firms. USOs are companies that originate from a founder that has a study or work-related background at a university (Rappert, Webster, & Charles, 1999). USOs are interesting because of their ability to enhance local economic development, they help the university in their academic mission of teaching and researching and USOs have a considerably high potential in being a high-performance firm (Shane, 2004). However, there is a lack of focus in the existing literature on the development of USOs (Grandi & Grimaldi, 2003; Gübeli & Doloreux, 2005; Walter, Auer, & Ritter, 2006). This thesis focuses on USO network development as an important determinant of their future growth as well as a leverage for spreading university knowledge via USOs and thus fostering regional growth. The research zooms in on the role place and location might play in USO network development.

To fully exploit the beneficial aspects of USOs, it is important for universities and for governments to cluster these firms near the firm's parent university (Su & Sohn, 2015). Clustering the USOs near the parent university enriches the link to the academic world, creating a bigger knowledge network and it ensures that the resources from the university are easily accessible (Corsi, Prencipe, Rodríguez-Gulías, Fernández-López, & Rodeiro-Pazos, 2017). To do so, USOs locate themselves on science parks, which are often within the geographical proximity of a university (Felsenstein, 1994; McAdam & McAdam, 2006). However, a critique on the USOs located on the science parks is that these firms have more difficulties with developing a rich customer network (Dettwiler, Lindelöf, & Löfsten, 2006).

Next to the assumed effects of science parks, the article by Felsenstein (1994) discusses whether science parks are seedbeds for innovation or whether science parks are enclaves of innovation. The results of the farticle show that, based on a survey with more than 160 high-tech firms, that science parks seem to be more of an innovation attracter rather than an innovation enricher. Showing that the information flow between firms on the science parks is not as much as believed by some authors. This is also addressed by Quintas, Wield & Massey (1992) who describe that the UK science park phenomenon does not really influence the innovativeness of the tenants . This also highlights the fact that science parks are not enriching the innovating capabilities of firms but rather attract the more innovative firms to cluster on science parks.

In contrast to developing the scientific network, USOs are also interested in developing the customer network. A location within a business park helps to enhance the customer network and gives access to more resources, information and ideas (Folta, Cooper, & Baik, 2006; Hayter, Lubynsky, & Maroulis, 2017). This is mainly done by clustering USOs on business parks and within multi-company buildings. Clustering USOs on these levels enhances the relationship with other commercial parties and thus influences the customer network. So, the discussion that arises is that USOs want to know how much of an effect the business location has on the development of the knowledge and customer network.

When looking at the overall literature regarding this discussion one finds that there are multiple perspectives. First of all, there is the agglomeration theory in which local benefits can be found by locating in urban areas among many other firms, therefore, reducing costs (Evans, 1986). On the other hand, there is clustering, in which firms decide to locate themselves in business parks, science parks or even on a lower scale in multi-company buildings (Kuah, 2002). Nevertheless, the two perspectives agree on one assumption, proximity to other parties is a key aspect of accessibility of networks and information (Christensen & Drejer, 2005; Ghemawat, 2011).

During this research, the perspectives are combined to look both at clustering (sub-local) and at agglomeration (local) benefits in order to look at the different types of influence these spatial environments might have on USOs in Nijmegen while comparing them with USOs located somewhere else in the Netherlands. The assumption is that the USOs located near or within Nijmegen will have a more prominent customer and knowledge network due to the proximity to other firms and to the Radboud University. Former research mostly focused on single business parks or science parks and looked at the networking developments without contrasting those outcomes with different locations (Avnimelech & Feldman, 2015; Meinders, 2017; Stam, 2006).

For this research a dataset of USOs from the Radboud University will be used to analyze the differences between local and sub-local clustering effects on USOs. In order to do so the following research question will be used: "*To what extent does clustering of USOs at local and sub-local levels affect these firms' business network development regarding both their scientific knowledge network and their customer network?"*

It is relevant to answer this research question because knowledge has become a valuable asset for people and companies. To keep on innovating and further developing technologies, new knowledge needs to be created. This continually growing demand for innovations and new

technologies requires a high rate of high-performance USOs. The commercialisation of knowledge is, therefore, the success factor for all of these companies and the new technologies have a positive effect on society at large. Discovering what spatial context is best for USOs to grow and to gain large customer and knowledge networks will be essential information for universities and governments.

This growing commercial interest is being matched by almost the same growing attention by scholars. This has led to some scholars stating the beginning of an 'academic revolution' in which entrepreneurial universities will become the standard (Ambos, Mäkelä, Birkinshaw, & d'Este, 2008). Next to that, using the keywords university and spin-offs show us clearly shows that interest in the topic has changed and grown rapidly. During the period 1967-2003, around 96 relevant articles were published, while between 2004-2006, almost the same amount of relevant articles were published (Hogan & Zhou, 2010). Therefore, as entrepreneurial universities will become the new standard, it is essential and exciting for academia to find out what type of clustering level positively influences the development of USOs, helping to address the gap in the literature. Besides the attention of scholars, scientific relevance is also addressed because of the use of the theories describing agglomeration and clustering benefits (Kuah, 2002). By looking at the influences these theories combined have, this paper tries to add on the existing literature by testing it with empirical data.

The remaining part of this research is structured as follows. The second chapter contains the literature analysis. During the literature analysis, the definitions regarding the network development of USOs and the environmental influences will be elaborated upon. During chapter three, the methodological choices made during this research will be discussed. The research strategy, data collection, sample analysis and ethics of this research will be elaborated upon. During the fourth chapter, the results of the quantitative analysis will be discussed. Tables and figures will help to clarify the quantitative analysis outcomes. This chapter is followed by chapter five, in which the conclusion of the analysis will be given. Next to that, the discussion, limitations, recommendations and suggestions for future research will be discussed.

2. Theoretical background

Based upon chapter one, it is now clear that the greater demand for the commercialisation of knowledge has led to an environment in which many USOs are being started. To get a better understanding of the spatial factors influencing the network development of USOs, this chapter will elaborate on the existing literature and theories regarding the topic. The chapter will end with a conceptual model of the hypotheses used in the research.

During the next paragraphs, the distinct USO will be discussed and a working definition will be chosen. This is followed by a brief explanation of the scientific and the customer network. Both concepts will also be defined in order to demarcate the concepts. After that, the literature regarding local clustering will be discussed. In which the agglomeration benefits will be elaborated upon. Furthermore, the sub-local clustering effects will be discussed in which clustering locations such as science parks and business parks will be discussed. At last, the combinatorial impact of local and sub-local clustering will be discussed to find all of the hypotheses used in this paper.

2.1 University Spin-offs

This research aims to look at the network development of USOs. Therefore, it is essential to define what is seen as a USO during this study. Research done by Pirnay et al. (2003) shows that there is quite some ambiguity about the definition and the article indicates that multiple terms are used to address the same concept. These terms vary from spin-off, academic spin-off, university spin-off up until research-based spin-offs. During the following paragraphs, some definitions will be discussed to come to a clear overview of what definition of a USO is used during this research.

An early definition by McQueen and Wallmark (1982) shows that a USO should have three distinctive attributes. The requirements based on their article are that the founder(s) have to come from a university, the main activity of the company should be based on technologies and ideas generated in the university environment and the transfer from the university to the founder of the company should be direct. Many of the other definitions are based on this definition, therefore, a lot of resemblance is found between the definitions.

However, the definition by Shane (2004) shows that there is some difference with the description above. Shane (2004) describes that USOs are a subset of start-ups that are created by university students or employees in which academic intellectual property is exploited. Both

definitions exclude the companies that are founded by former students and employees that do not directly found the company.

The definition of USOs in this research is based upon the definition of Rappert et al. (1999). Their article describes USOs as:

> " *firms whose products or services develop out of technology-based ideas or scientific/technical know-how generated in a university setting by a member of faculty, staff or student who founded (or co-founded with others) the firm. The individual or individuals may either leave the university to start a company or start the company while still inside the university. It does not matter whether someone was a student or full-time academic and the time interval between the initial research and commercial exploitation is not an issue so long as their university research experience was essential in enabling the firm to provide particular products or service…"*

This definition gives a clear overview of what attributes the founder and the company should have to be considered as a USO. It shows that, in contrast with the other definitions, the founder of a USO can have some working experience outside the university as long as the scientific knowledge is essential for the exploitation of the firm.

2.2 University spin-offs and the key role of network development

For this research, it is important to understand what networks are and what the determinants of network development are. Network development is a crucial factor for companies to flourish and to gain competitive advantages. During the following paragraphs first the scientific and the customer network are discussed. Secondly, the elements of a social network as described by Hoang and Antoncic (2003), will be discussed and the proxies for network development will be discussed. The proxies for network development will be used to analyse the relationship between clustering levels and network development.

In the case of USOs, it is essential to distinguish two types of networks before going on with the network development. USOs can develop a scientific network and a customer network. The scientific network is the number of links that a USO has with the scientific or academic world. This is based on the idea that the scientific network could be a very important influence on the economic development of a USO (Murray, 2002). The customer network is distinguished in literature as the amount of social linkages the firm has with non-scientific actors (Nicolaou & Birley, 2003). These linkages could be with suppliers, buyers, rivals and other non-scientific firms.

The network of a firm consists of a group of social actors and a set of linkages (Brass, 1992). The development of this network is seen by many authors as an iterative process in which structure, governance and content is needed to further develop and improve the resources one can get out of it (Burt, 2000; Hoang & Antoncic, 2003). To assess the network development of a USO, it is needed to find the underlying factors that influence the development of the network. In the end, the change in the total amount and the strength of the linkages will determine how the network of a USO has developed over time.

The network structure of a company depends on the pattern of direct and indirect social relationships (ties) a company has (Phelps, Heidl, & Wadhwa, 2012). The direct ties are strong relationships in which resources and information can flow directly (Hoang & Antoncic, 2003). The weak ties are more informal and require more actions for resources and information to flow through. Multiple measures for measuring the network structure are used in academic literature. The most important measures are size, network centrality, structural holes and the diversity of ties. During this thesis, the size of the network is the most important proxy for looking at network development. The other proxies also have an influence on the network development of the USO. However, those influences are not fully discussed during this thesis.

The size of a network is measured by the number of linkages that one actor has with other actors. When analysing the size of a network, researchers look for the resources that can be accessed by an entrepreneur or by the firm (Aldrich & Reese, 1993; Katila, 1997). Examining the factual growth of the firms' network size, therefore, gives insights into the quantitative network development. However, this proxy is not a good indicator of the quality of the linkages and patterns.

The next element that influences the network structure is centrality. Network centrality is distinguished as the amount of resources that can be accessed through direct ties or through indirect ties (Brajkovich, 1994; Powell, Koput, & Smith-Doerr, 1996). The difference between centrality and size is that centrality is a combination of direct and indirect ties, while size is only the direct ties. This difference is interesting because indirect ties have many useful applications for starting firms but also for more rigid firm networks.

Another important element when looking at network structure is structural holes. Structural holes are found when there are weak connections between social structures of the market. This means that two groups of firms or people do not have or almost lack direct ties. This creates a disadvantage for the groups because no valuable resources, information, etc are shared. However, these structural holes do create a competitive advantage for those firms that

are able to become the intermediary between the holes. Firms or people could become the broker of information and control the flow between the two sides (Burt, 2000). In the case of USOs, it might be necessary to look at the structural holes one has in the scientific network or in the customer network. Finding these structural holes is essential for building a sophisticated network.

The diversity of the network is another vital aspect for the structure of a network. The diversity of the network implicates the amount of homogenous and heterogeneous linkages that exist in the network. The more homogeneous the linkages are, the less diverse a network is and, consequently, the more heterogenous linkages, the more diverse a network is (Hoang & Young, 2000). A study done by Hansen and Witkowski (1995) even shows that firms that have a lot of weak and diverse ties overseas are more likely to do business abroad, which indicates the potential of network diversity. Network diversity is operationalized by looking at frequency and primariness of the contact.

Networking content is all about the possibility of gaining new resources held by other actors through interpersonal or interorganizational relationships (Hoang & Antoncic, 2003). These resources vary from getting new information or advice from other people up until finding new entrepreneurial opportunities and ideas (Hoang & Young, 2000). This means that entrepreneurs are supported in multiple ways by creating a network and this reliance upon the network is an crucial factor not only during the start-up stage (Johannisson, Alexanderson, Nowicki, & Senneseth, 1994).

The third important aspect, when addressing network development is network governance. Many researchers agree that when resources are exchanged via a network, that trust is a critical factor for the exchange to succeed (Hite, 2000; Lorenzoni & Lipparini, 1999). Trust is seen as an implicit open contract between two or more actors in the exchange that is based on power and loss of reputation (Jones, Hesterly, & Borgatti, 1997; Krackhardt, 1990). Moreover, trust becomes the critical factor in these types of exchanges, which decreases the transaction costs that would be made during a market or bureaucratic transaction (Thorelli, 1986).

The three elements, as described above, give this research a theoretical starting point from which the development of networks can be addressed. This thesis will mostly use the network structure' proxies as a tool for analysing the network development of USOs. The following paragraphs will discuss the effects of local clustering, sub-local clustering and the combinatorial effect on network development.

2.3 The effect of local clustering on network development

Local clustering happens when firms, or in this case USOs, cluster within an urban agglomeration (Egeln, Gottschalk, & Rammer, 2004). Examples of local clustering are Silicon Valley, the Randstad but also Eindhoven. However, to fully understand the effect that local clustering has on the network development of USOs, one needs to understand the benefits and drawbacks of these urban agglomerations. Next to that, it is important to understand what is seen as an urban agglomeration. During this thesis, we assume that urban areas with 100.000 or more inhabitants are urban agglomerations. In particular, this means that the city of Nijmegen is seen as an agglomeration area.

The article by Egeln et al. (2004) describes that urban agglomerations have multiple benefits for USOs. First of all, an urban agglomeration has a way broader range of qualified personnel to offer than rural areas, meaning that firms able to reduce the labour costs (Diamond & Simon, 1990). Next to that, informational spill over is an important benefit of urban agglomeration. Informational spill over helps companies located in the urban agglomerations to further develop products, services and other technologies (Arrow, 1971). The third benefit of urban agglomeration is that the transaction costs can be lowered because suppliers, buyers and customers are located closer together, creating the agglomeration economy (Dahl & Sorenson, 2009). However, a disadvantage of the agglomeration economy is the high rents usually paid and the cost of land, then again, this seems to be less of a problem for most USOs since they are knowledge-based firms (Egeln et al., 2004).

Moreover, this shows that the urban agglomeration has multiple complementarities on the network of firms located within the area (Johansson & Quigley, 2004). The reasoning shows that due to the fact that urban agglomerations aggregate a high quantity of local buyers, suppliers and producers, that the network customer network of a company automatically will be influenced in a positive manner. Moreover, the agglomeration theory thus shows that locating a firm near or within an urban agglomeration has a direct positive influence on the customer network development. Therefore, the first hypothesis reads:

H1: The closer spin-offs are located near the city of Nijmegen, the more strongly their customer network develops.

As discussed before, USOs have two major types of networks, the customer network and the scientific network. The relevant literature on the agglomeration theory shows that the customer network of a firm is positively influenced when it is located in an urban agglomeration, whereas, this is less when the firm is located in a rural area. The article by Heblich and Slavtchev (2014), shows that USOs have a tendency towards locating themselves in the proximity of the parent university. The article states that this is done because of cost advantages for the accessibility of knowledge and resources from the university. Since universities are often located in an urban agglomeration, it means that the USOs, consequently, benefits from this. The type of reasoning has many comparisons with the reasoning for locating within an urban agglomeration, however, only to enhance the scientific network (Egeln et al., 2004). It suggests that USOs that are located near a city with a university create a stronger scientific network.

Next to that, the article by Felsenstein (1994) describes that there is another perspective and motivational factor for USO to be located near the parent university. The article describes that science parks and especially the science parks related to a particular university are stimulating interactions between firms and the university. Felsentein (1994) describes that the science parks are not always beneficial because of the economies of scale they might endeavour for but because of the environment that is created. An environment, or as Felsentein (1994) states 'milieu', is created to stimulate the behavioural environment of the science park in which more information is shared and thus also more networks are developed. Therefore, the second hypothesis reads:

H2: The closer spin-offs are located near the city of Nijmegen, the more strongly their scientific knowledge network develops.

2.4 The effects of sub-local clustering on network development

During the following paragraphs, the sub-local clustering effects on network development of USOs will be elaborated upon. The literature surrounding clustering effects will be discussed to enhance the understanding of the academic literature. For this thesis, the effects of sub-local clustering will be discussed only for USOs located within a multi-company building. Examples of these types of sub-local clustering are the media park in Hilversum, Mercator Science Park in Nijmegen and the bio-medical cluster surrounding DSM.

The article by Hewitt-Dundas, Burns and Chapman (2016) shows that the effects of local clustering often arise at the incubator and the way the incubator is able to differentiate the

network structure of newly found firms. It states that incubators are important for the growth of USOs, since incubators are able to facilitate and support USOs with multiple commercial opportunities. Next to that, the article states that incubators might have a role in bridging the gap between the business idea concept and instantiation and thus surviving the 'death valley' (Hackett & Dilts, 2004). This highlights the influences that incubators have on the development of the network and the opportunities that come from this type of clustering.

These incubators are also seen as a place for externalities or spill overs, not regulated by a market mechanism, therefore, not influencing the costs of goods or services (Kuah, 2002). The article by Kuah (2002) describes that the reduction of searching costs for customers and the influence on reputations are also effects that sub-local clustering has on the development of the firm, showing that sub-local clustering, does in fact, have similar effects as local clustering.

However, there is also critique on the effects of incubators. Soetanto and Jack (2013) discuss that incubators are not yet successful in fully fulfilling all the needs of firms located within the multi-company building. This is because there are multiple types of companies that locate within the multi-company building which are looking for different resources and relationships. This makes it difficult for incubators to align the needs of the tenants. On the other hand, the article does show that firms do search for and build networks with other incubator firms and therefore create a mutually supportive environment. Especially when looking for intangible resources, firms perform a variety of network activities to find these resources. This potential within multi-company building is therefore a positive factor for these network activities.

The mutually supportive environment as discussed by Soetanto and Jack (2013) shows that the clustering of USOs in a multi-company building influences the network development of these firms. However, the potential of this locational factor does seem to be underexploited. Therefore, the third hypothesis reads:

H3: Clustering of USOs in a multi-company building (either in a science park-MCB or in a conventional MCB) advances their customer network development compared to not being located in a multi-company building.

Moreover, when looking at multi-company buildings on science parks and business parks, which are central in this thesis, one finds that there is some debate on the effects of sub-local clustering (Phan, Siegel, & Wright, 2005). A paper by Colombo and Delmastro (2002), discusses the differences between network development of technology firms on and off a

science park. The article describes that USOs located on science parks have a stronger tendency towards networking with other firms on the park and within the incubator, than firms that are located not within the incubator. Also, the article of Colombo and Delmastro (2002) and Löfsten and Lindelöf (2001) shows strong evidence that USOs located within an incubator on a science park are more likely to enhance their academic network.

However, there is also critique on literature saying that incubators would bring high rates of network development and growth. The article by Chan and Lau (2005) describes the results of qualitative research among six technology-based firms in an incubator. The results depict that there are some arguable influences from the incubator on the firms located within them. The authors clearly state that there was no evidence among the six companies that there was a networking advantage due to the incubator. This indicates that the incubators' influence with networking events, parties and facilities does not affect the true notion behind creating a new external link. The article states that the underlying aspect for this is that the companies do not have the same operations, culture and so on.

Next to the role of the incubator, the proximity towards the academic institutions could be an influence on the development of the scientific network. The basic argument for this is that proximity to the parent university gives a cost advantage over firms with a longer relative distance (Rodríguez-Gulías, Rodeiro-Pazos, & Fernández-López (2017). The article by Felsenstein (2007) describes this a knowledge spill-over, and states that this has definitely been the case in leading universities in the USA, however, the article also describes that outside of the USA no real causality has yet been found between proximity to universities and academic network development for USOs. To find out how this contradictory perspective plays out on sub-local level, the following hypothesis will be examined:

H4: Proximity to the Radboud University positively influences the scientific network development of USOs located within a multi-company building, compared to USOs within a multi-company building located further away from the Radboud University but within Nijmegen.

2.5 The combinatorial effect of local and sub-local clustering on network development

Something that most of the literature around local and sub-local clustering has neglected to examine is the effect of local and sub-local clustering combined on network development (Chan & Lau, 2005; Heblich & Slavtchev, 2014; Phan et al., 2005). Most research focuses on case

studies, therefore, missing the opportunity to examine the effect of multiple spatial scale environments. This thesis will be looking at the combined effect of local and sub-local clustering. However first, some literature regarding the effects will be elaborated upon.

The assumed effect of combining local and sub-local clustering occurs when USOs are located within in a multi-company building at an urban agglomeration. This assumed result is different for the customer network than for the scientific network (van Oort, Eijsink, & Bijleveld, 2014). Based on the ideas of local clustering and sub-local clustering we assume that the customer network of a firm within Nijmegen in a multi-company building does advance the customer network of a firm outside of the urban agglomeration (Egeln et al., 2004; Phan et al., 2005). Therefore, the fifth hypotheses reads:

H5: Clustering in a multi-company building in the city of Nijmegen advances customer network development both compared to non-MCB housing in Nijmegen and to MCB-housing outside Nijmegen.

The scientific network is influenced by the local clustering effects as discussed at hypothesis 2. Hypothesis 4 showed that the proximity towards the parent universities and academic institutions might also influence the development of the scientific network. The article by Egeln, Gottschalk and Rammer (2004) shows an overview of important reasons for a USO to be located near the parent university. It states that face-to-face interaction is needed to correctly discuss research results and that it is often needed to make use of resources bounded to the university. However, the article also shows that it is more often the high-tech industry firms that are located near the parent university rather than the service-oriented firms. This was also discussed in the article by Felsenstein (1994), in which is he describes that science parks located near a university often attract highly innovative firms. However, the function of these type of science parks is also criticized for not having too much supportive functions (Quintas Wield & Massey, 1992). Therefore, the combination of the science park incubator together with the proximity to the parent university does seem to attract innovative firms. To test whether this also enhances the development of the scientific network, the following hypothesis is examined:

H6: Clustering in a multi-company building on a science park advances the scientific network building compared to multiple other housing situations.

2.6 Conceptual model

The conceptual model, as depicted in figure 1 is based upon the literature and theories as used and discussed in the sections above. It shows that local clustering has a direct positive effect on the development of the customer network and the scientific network development. Next to that, it shows that sub-local clustering also has a positive effect on both the customer network development and the scientific network development. Moreover, one can see that local clustering and sub-local clustering are assumed to have an positive interaction effect both on the scientific network and the customer network development. All the effects, as depicted in the model, assume that there will be an increase in the amount of contacts, possible in the customer network or the scientific network. During the next chapter, this conceptual model will be further operationalised and the methodology to analyse the hypotheses will be discussed.

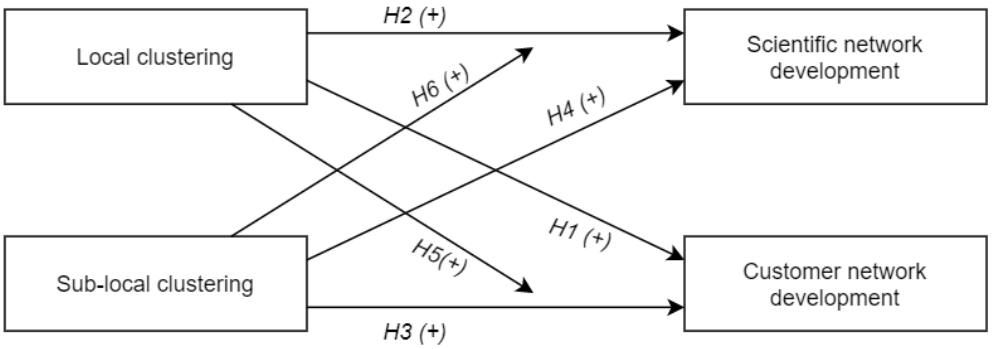

Figure 1: Conceptual model

3. Methodology

The focus of the former parts of this research was mostly on the conceptual and theoretical insights around the network development of USOs. During this chapter, the instruments needed to collect and analyse the data, in order to answer the sub-questions and main question, are discussed.

First of all, the research method is discussed. Second, the sample and type of data collection are clarified, and the research units are discussed. Third, the operationalisation of quantitative research is explained in which the dependent and independent variables are explained. After that, the method of analysis is discussed. Next to that, the procedures done to improve the validity and responsibility are elaborated upon, and at last, the section ends with a discussion on research ethics.

3.1 Research Method

The primary purpose of this research is to find out what and to what extent different spatial scales levels of clustering and a combination of levels of clustering influence the network development of USOs. This means that to find out the development of the network, it is needed to look at a longer time horizon. To find out which underlying aspects influence network development of USOs, quantitative research will be done. Quantitative research helps in finding objective empirical data and it can be compared in a simple manner with results from the past (Vennix, 2010). During this master thesis, the survey used is based on a longitudinal study done by P. Vaessen. Therefore, the methodological choice for this research is a quantitative approach because it enables the researcher to compare and contrast objective data from the present with the past.

3.2 Sample and data collection

The data used in this research is collected from 700 USOs from Radboud University/UMC St. Radboud. The companies that are asked to fill in the questionnaire are all companies that were founded by a student, alumni or (former) employee of Radboud University/UMC St. Radboud. The range of companies consists of text translations firms up until mental health care practices.

The questionnaire is a close-ended structured questionnaire in which the founder(s) of the USOs are asked to give their opinion on the network development of their company over the past years. An invitation with a link to the questionnaire is sent by post to increase the possibility of participation. The USOs will receive a summary of the results afterward, as compensation for filling in the survey.

3.3 Research unit of analysis

Field (2013) describes the unit of analysis as the major entity that is analysed during research. This can be on individual, group, organisational or national level. As stated above, the questionnaire is sent to the founder(s) of the USOs. The founder is asked to speak on behalf of the firm. This means that the units of analysis in this research are USOs from the Radboud University/UMC St. Radboud and the units of observation are the founders of the USOs.

3.4 Operationalisation of variables

During the following paragraphs, the operationalisation of the variables is discussed. The conceptual model, as shown in the former chapter, shows a dependent variable consisting of two dimensions and it shows two different independent variables. The survey is based on former studies done by dr. P.M.M. Vaessen in 2004, 2008 and 2011, the items that were used per survey are included in appendix II.

Dependent variable: network development

The dependent variable during this research is the network development of USOs. This variable consists of two dimensions, as conceptualized in chapter two. These two dimensions are the development of the scientific network and the development of the customer business network. Table 1 shows how these dimensions are operationalised.

Independent variables:

The independent variables during this research are local clustering and sub-local clustering. Table 1 shows how these two independent variables are measured and what the measurement level is. The indicators for the independent variables are also based on the theory, as discussed in chapter 2.

Control variables:

Three control variables will be used to check whether there are any differences between firms working in a different sector, or between firms that do or do not have people assigned to doing R&D work and to check what the baseline is for the use of information and knowledge. Table 1 shows the operationalisation of the control variables.

Variable type	Variable name	Indicator	Min.	Max.	Measurement level
Dependent	Δ Customer business network	Growth in linkages with the consumers, buyers, competitors and other businesses	0	999	Ratio
	Δ Knowledge network	Growth in linkages with the academic world, universities and research institutions	0	999	Ratio
Independent	Local clustering	On university terrain, within Nijmegen, within Nijmegen region (< 25 km) and outside of Nijmegen	1	4	Nominal
	Sub-local clustering	Science park, business park, multi-company building, stand alone and home business (within Nijmegen or outside of Nijmegen)	1	2	Nominal
Control variables	Sector	The industry in which a firm operates	1	5	Nominal
	R&D	People assigned to research and development, yes/no	1	2	Nominal
	Baseline	Amount of use of information/knowledge at first participation survey	1	2	Nominal

Table 1: Operationalisation of variables

3.5 Data analysis

In order to conduct research properly and adjusting the research process accordingly to the main research question, requires a research strategy. During this research, the method of analysis is split up into three different parts. The first part of the analysis consists of the univariate analysis. During this analysis, the variables will be compared and contrast by looking at multiple graphs and tables, in order to visualize and summarize the collected data. Next to that, the data will be checked for skewness and kurtosis. The second part of the analysis is the bivariate analysis. During this phase, the correlation between the independent variables will be checked for multicollinearity (Field, 2013). Moreover, a first interpretation of the correlation between the dependent and the independent variables can be done.

The third part of the analysis is a multivariate analysis. To correctly perform the regression analysis, first multiple assumptions will be tested. All of these assumptions will be explained and checked in the following chapter. After this part, a linear regression analysis will be done to check the correlation between the independent variables and the dependent variable. Linear regression analysis is an appropriate analysis for this research because it checks the relationship between independent variables and a dependent variable (Field, 2013). In this case, the independent variables are all on a nominal scale and the dependent variables are measured on a ratio scale. The results can be used to forecast and predict since the model will show how much the dependent variables changes when one or more independent variables change. The program that will be used to analyse the data is SPSS. Using this statistical program helps with computing the results and conducting the correct steps to create valid and reliable results.

3.6 Quality of research

The quality of research is influenced by multiple factors. First of all, it is crucial to find an optimal fit between the goal of the research, the characteristics of the data and the characteristics of the analytical procedures that are applied (Symon & Cassell, 2012). Next to finding the optimal fit, four different measures of quality need to be taken into account. These four measures of quality of research are validity, generalizability, reliability and objectivity (Guba & Lincoln, 1989). During the next paragraphs, the steps taken to improve these quality measures are discussed.

To improve the validity and reliability, multiple measures have been taken into account. First of all, to increase the internal validity, the survey is as specific as possible. This has been done through specifying the multiple variables into various dimensions. By doing this, the researcher ought to measure the concepts in the right manner. Secondly, to increase the external validity, a reminder is sent to the participants about the survey. This reminder was combined with a second copy of the survey in case the participant had lost the first copy. Next to that, the second survey is shortened, this improves the external validity because more respondents will fill in the survey. However, it decreases the internal validity because fewer questions will be asked.

In order to maximize the reliability of this research, the survey only contained questions regarding processes in the firm instead of the founders' opinion. Next to that, it is verified that the owner of the company is also the founder of the firm. Moreover, for the quantitative part, a reliability test is used. The Cronbach's alpha test will be used to check the reliability of the results. This reliability measurement is agreed upon by many scientists as reliable and is used

for checking the scale (Field, 2013). For the generalizability, there is one problem, it is not known what the real population is, since this has never been mapped. The participants during this research are mostly coming from the management' network of the Mercator Science Park. However, there could be many more former students or employees that have started their own business. Therefore, the generalizability will be a point of attention during the next chapter.

3.7 Research ethics

The following paragraphs discuss the research ethics that have been taken into account during this research. Next to the ethical part, a summary of the researcher's view on research is given, as it is always important to understand a writer's view on research while reading a study and its results.

This research had been conducted according to the Ethical Principles Psychologists and Code of Conduct, as stated by the American Psychological Association. This means that five general principles have been followed. First of all, no study should ever harm anyone involved or seek to find benefits over people that play a role or are influenced by the research. Second, a researcher must always act responsibly towards the population he or she is working with. Third, the integrity of the researcher should always be high, meaning that the researcher is honest, accurate and does everything to accurately represent facts. Fourth, researchers ensure that fairness and justice are given to anyone involved or influenced by the research. At last, respect for people's rights and dignity is taken into account and accounted for.

Furthermore, in order to ensure the confidentiality of participants of the survey, some other steps are taken. Based on Vennix (2010), the survey starts with a short explanation of the research. After this, the goal of the research is explained. Then it clearly states that confidentiality is taken into account, meaning that in none of the results one is able to deduce the results of a single USO, and the participants are made aware of the fact that withdrawing from the research is possible at any moment.

Next to the research ethics, it is important to understand the researcher's view on epistemology and ontology. When doing quantitative research, one assumes to find data out there without really interacting with the participants. This means that a researcher believes that it is possible to objectively observe events or phenomena in the outside world (Duberley, Johnson, Cassell, & challenges, 2012). My view on this is in line with the positivist perspective. This philosophy of science has many followers and is widely accepted among quantitative researchers.

4. Results

During the following paragraph, the quantitative analysis of the study is being elaborated upon. First, the characteristics of the data and the missing data is discussed. Secondly, the way that the variables are constructed is discussed, this is followed by the univariate and the bivariate analysis. Then, the multivariate analysis is discussed in which the binomial regression analysis is shown. At last, the results of the analyses are briefly summarized in the light of the hypotheses.

4.1 Response

Due to multiple external problems the gathering of data went different than as explained in chapter three. Instead of gathering new data, a combination of older data will be used. The dataset used in this thesis is a combination of three datasets gathered by dr. P.M.M. Vaessen. The first survey was done in 2004, the second survey was done in 2008 and the third survey was conducted in 2011. The combination of these three surveys forms the basis of the data sample, simply because it was not possible to gather a new data set. The newly constructed dataset consists of 332 respondents (N=332). This amount of respondents is respectively enough, since, at least 100 respondents are needed for this type of research (Hair & Lukas, 2014). These respondents are all founders of USOs that have a background at the Radboud University. Since this data set is constructed of three older surveys, it is not known what the response rate is and to what extent the response rate has differentiated over the years.

To get a feeling of the dataset that is used, some statistics will be elaborated on. Table 2 shows what percentage of the USOs is located on the university terrain, within Nijmegen, within Nijmegen region (< 25 km) and what percentage is located somewhere else in the Netherlands.

Number of USOs	**Count**	**Percentage of total**
# cases on the university terrain	45	13.6%
# cases within Nijmegen	125	37.7%
# cases within Nijmegen region (< 25 km)	60	18.1%
# cases outside of Nijmegen (> 25 km)	101	30.4%
# cases missing	1	0.3%
Total	332	100%

Table 2: Sample USOs located within Nijmegen or elsewhere

The sectors in which the USOs work vary from 1) industrial work, 2) trading, 3) research and development, 4) ICT, 5) business services (training, health and well-being). An overview of the frequencies of USOs operating in a certain industry is shown in Table 3.

Number of USOs	**Count**	**Percentage of total**
# cases industrial work	9	2.7%
# cases trading	29	8.7%
# cases R&D	39	11.7%
# cases ICT	25	7.5%
# cases business services	221	66.6%
# cases missing	9	2.7%
Total	332	100%

Table 3: Frequency USOs per sector

4.2 Variable Construction

During the following paragraphs, the way that the variables are constructed will be elaborated upon. First, the construction of the dependent variables is discussed. Second, the construction of the independent variables is discussed. At last, the construction of the control variables is discussed.

4.2.1 Construction of the dependent variables

The dependent variable during this thesis is the network development of USOs, which is separated in the customer network and the scientific network. While operationalizing the customer network and the scientific network it must be noted that there are multiple operationalisations possible since the network development of a firm can be viewed from multiple perspectives, as discussed in chapter two.

During this study, the development of the customer network is measured by looking at the change in the number of interactions that a USOs has had with their customers, in which information is exchanged. For the scientific network, this is quite the same, however, in this case it is about the change in interactions with scientific institutions. All three surveys had multiple questions asking for the type of interactions USOs had with both their customers and with multiple scientific institutions (see appendix II).

To check whether the reliability of these measures is reliable and consistent, two reliability measures were done. These reliability analyses are done to check the internal consistency of the items, therefore, checking whether the measurement of the multiple items is consistent and reliable. This is done by looking at the Cronbach's alpha of the items. Variables with a Cronbach's alpha lower than .6 are low and variables with a Cronbach's alpha higher than .8 are assumed to be high (Field, 2013).

For the customer network, the Cronbach's alpha is .799, which is high enough, according to Field (2013). The Cronbach's alpha could have been .02 higher after deleting one item. However, this does not lead to a more consistent measurement, therefore, the item is not deleted. The scientific network has a Cronbach's alpha of .877, which is high enough. Again the Cronbach's alpha could have been .03 higher after deleting one item. However, this is again not substantially enough, meaning that the item is not deleted.

4.2.2 Construction of the explanatory variables

During this study, there are two independent variables, namely, local clustering and sub-local clustering. There was evidence in the literature that both independent variables influence the network development of USOs. The following paragraphs will describe the construction of the explanatory variables.

The construction of the first two explanatory variables is quite straight forward. The first independent variable is local clustering. The addresses of the USOs were used to determine the exact location of the firm. By looking at the location of the USOs, we were able to see whether it was located on the university terrain, within Nijmegen (university terrain excluded), within Nijmegen region (< 25 km) and what percentage is located somewhere else in the Netherlands.

The second independent variable is sub-local clustering. This variable is constructed by asking USOs whether they are located on a business park, science park, home business or stand-alone. For all of these questions the respondents were able to fill in whether this was the case and whether or not they are located within a multi-company building and whether or not it is located in Nijmegen. This shows whether the proximity effect of sub-local clustering is active or not for a particular USO.

The combinatorial effect of local and sub-local clustering is measured by looking whether the joint analysis of both variables is greater than the sum of the parts (Field, 2013). Therefore, the combination of local and sub-local clustering is expected to have a stronger

positive effect on the dependent variables. Moreover, the combinatorial effect is expected to be significantly higher than the individual effects of local and sub-local clustering.

4.2.3 Construction of the control variables

The first control variable used in these analyses is the use of inhouse R&D by USOs. Expected is that firms that have an in-house R&D department or that have people partially assigned to doing R&D work, will be having more interaction with the academic world because of the need for new information. This control variable was measured by asking the respondents whether the respondent or someone else in the company was responsible for R&D (yes = 1, no = 2).

The second control variable that is used in the analyses is the sector that firms operate in. This variable was constructed by giving five options of sectors in which a USO might operate (manufacturing and trade, R&D, ICT and business services). This variable is used to control for the type of sector and to check for differences between sectors.

The third control variable is the baseline variable for both the customer network and the scientific network. This baseline variable checks the amount of information and knowledge that was used when the USO first joined the survey. This ensures that we are able to see whether there are changes in the development of the networks over time.

4.3 Univariate analysis

During the following paragraphs, a descriptive analysis is discussed to make a start at analysing the empirical model. This univariate analysis is done to check whether the variables have a normal distribution and to check the skewness and kurtosis is between the critical values (-3, +3) (Field, 2013). The univariate analysis is done for the dependent variables, the independent variables and the control variable.

Table 4 shows the univariate analysis for the dependent variables. The tables show that both the kurtosis and the skewness of both variables are in between the critical values. This means that the variables are sufficient to use for further analysis.

		Development of scientific network	**Development of customer network**
N	Valid	332	332
	Missing	0	0
Mean		2,8614	1,4307
Std. Deviation		1,41595	,70262

Skewness	,799	,800
Std. Error of Skewness	,134	,134
Kurtosis	,076	,082
Std. Error of Kurtosis	,267	,267
Minimum	0,00	0,00
Maximum	6,00	3,00

Table 4: Descriptives dependent variables

Furthermore, table 5 shows the descriptives of the independent variables. The items used for the variable sub-local clustering are all dichotomous, which means that looking at the kurtosis and the skewness is not relevant because these will almost always have high skewness and kurtosis (Field, 2013). Transforming these items would not lead to a more normal distribution, therefore, the items are left this way and are thus not included in the table. The descriptives for local clustering are all sufficiently low enough to be used in the analysis. There is quite a high number of missing values per item, this is because the data is derived from multiple surveys. That means that not all of the respondents were active in all three of the surveys, indicating that this is not a significant problem for the analyses.

Location		**Local clustering**
N	Valid	331
	Missing	1
Mean		2,3444
Std. Deviation		1,05419
Skewness		-,022
Std. Error of Skewness		,134
Kurtosis		-1,298
Std. Error of Kurtosis		,267
Minimum		1,00
Maximum		4,00

Table 5: Descriptives independent variables

Moreover, table 3 already showed the frequencies of the control variable sector, which showed that most firms operate in the sector business services. Table 6 shows the frequencies for the control variable R&D. Table 6 shows that for the valid cases almost half of the firms have employees assigned to R&D work.

Inhouse R&D		
N	Valid	249
	Missing	83
Yes		122
No		127

Table 6: Frequencies control variable R&D

4.4 Bivariate analysis

During the bivariate analysis a test is done to check whether the different variables in the model correlate with each other, the results of the analysis can be found in table 7. In this correlation matrix, the independent variables are also checked for multicollinearity. According to Field (2013), the multicollinearity between items should not have a value higher than .90 (R > .90). Multicollinearity could, in the end, undermine the statistical evidence of the analysis, therefore, it is essential to check for this.

The first thing that the table indicates is that there is one R-value higher than .90. However, this is a correlation between the dependent variables and not between the independent variables. Furthermore, the second-highest R-value that is shown in the table is respectively is .690, this is already quite close to the critical value. This means that there is a strong correlation between being located on university terrain and local clustering. This strong correlation partially supports hypothesis 5 and 6, in which is expected that there is a combinatorial effect between local and sub-local clustering.

The correlation matrix is also an excellent indicator for looking at the relationships between the independent and the dependent variables. As shown in table 6, there is a significant correlation between both the development of the scientific network and the customer network with regards to being located on the university terrain, the R-values are respectively -.296 and -.318. This shows that this bivariate analysis partially supports hypotheses 3 and 4, which assumes that being located in a multi-company building near the university influences both the scientific and the customer network.

Another notable correlation is between being located outside of Nijmegen on a business park and being located within a multi-company building. The correlation between these variables is respectively .500 and it is significant ($p < .05$), see table 7. This shows that it is perhaps quite common for USOs to be located outside of Nijmegen and being located both on a business park while being in a multi-company building, which is a relatively normal situation.

There are no further significant correlations between the dependent and the independent variables. However, it is interesting to note down that while local clustering does not have a significant correlation with both of the dependent variables, it does correlate significantly with almost all the other independent variables. This means that local clustering does have an effect on the various parts of sub-local clustering, as is shown by the R-values in table 6. This could be explained by the fact that there is some overlap between the items that represent local clustering and sub-local clustering.

At last, it is noteworthy that there is no significant correlation between both of the control variables and the dependent variables. This shows that the sector in which a USOs operates and whether a USO has people assigned to doing R&D work has no significant correlations with the development of the scientific network and the customer network in our dataset. However, sector and R&D do have significant effects on the location on campus in MCB and on local clustering. These results show that the control variable sector and R&D account for the effects that the on campus location within MCB and local clustering have on the development of the network.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Development Science netw.	1													
2. Development customer netw.	,980**	1												
3. Local clustering	,023	,019	1											
4. On campus in MCB	-,296**	-,318**	,690**	1										
5. Conventional b.p. in Nijmegen	-,037	-,019	,093	-,106	1									
6. Outside campus in MCB	,121	,122	,234**	-,121	,188*	1								
7. Stand-alone in Nijmegen	,029	,053	,241**	-,125	,352**	-,125	1							
8. Home business in Nijmegen	,115	,116	,305**	-,142	-,088	-,142	-,145	1						
9. Outside Nijmegen on b.p.	,064	,082	-,201**	-,106	-,042	-,076	-,078	-089	1					
10. Outside Nijmegen In MCB	,035	,088	-,274**	-,110	-,069	-,110	-,113	-,129	,500**	1				
11. Outside Nijmegen stand-alone	-,007	-,008	-,263**	-,098	-,061	-,098	-,100	-,114	,147	-,089	1			
12. Outside Nijmegen home business	-,084	-,129	-,627**	-,627**	-,152*	-,244*	-,249**	-,283**	-,153*	-,222**	-,197**	1		
13. Sector	,015	,025	-,161**	-,161**	-,071	,025	-,103	,154*	-,115	-,015	-,024	,138	1	
14. R&D	-,082	-,061	,164**	,164**	-,001	-,042	,093	-,096	,103	,136	,017	-,091	-,130*	1

*p < ,05; **p < ,01

Figure 7: Pearson correlation matrix

4.5 Multivariate analysis

The following paragraphs will be used to discuss the process and the results of the multivariate analysis. First, the assumptions for the regression analysis are discussed, after which the linear regression analyses are elaborated upon. The chapter will end with a summary of the results of the model.

4.5.1 Model Assumptions

Checking the assumptions for a regression model is an important step in the process of analysing the overall effects of the model. The following assumptions are checked based on the criteria described by Field (2013), linearity, homogeneity of variance (homoscedasticity), normality of the residuals, independence of errors and multicollinearity.

First of all, to check for the linearity of the model, it is needed to check the scatterplot. The scatterplot shows the standardized residuals (ZRESID) with the standardized predicted values (ZPRED) of the development of the customer and the scientific network. If the scatterplot shows a linear line, that means that the relationship between the independent variables and the dependent variables is linear, and the assumption is met (Field, 2013). The scatterplot in appendix I, shows a linear line in both the scatterplots, which means that the assumption for linearity is met.

The scatterplots can also be used to check the homogeneity of variance, also, homoscedasticity. This means that there is a constant range between the errors of the independent variables, scattered around 0 (Field, 2013). In appendix I, the scatterplots show that there is no indication that the error terms have a distinct pattern, which means that we may conclude that the assumption for homoscedasticity is met.

The third assumption that needs to be checked is normality, the errors of the model should be normally distributed in the analyses for it to be effective. To check this, the P-P plot, also known as the probability-probability plot, is used (Field, 2013). In appendix I, the P-P plot shows that the range of the errors is equal to zero or almost equal to zero. This shows that the errors are normally distributed and that the assumption is met.

Moreover, the independence of the errors is an important assumption for regression models. This means that the errors that are linked to a certain observation may not be linked with the errors of a different observation (Field, 2013). To test whether the errors are independent, the Durbin-Watson test is used, which assumes that an outcome close to 2 is acceptable. In both cases the Durbin-Watson test was respectively 1.297, which suggests that

there is a positive auto-correlation. However, because the sample size of the data is big enough this is not a significant problem.

Finally, the multicollinearity between the independent variables needs to be checked. In the bivariate analysis, a beginning was made to check the multicollinearity by looking at the correlation matrix. However, the VIF values are also an important indicator for multicollinearity. According to Field (2013), the VIF value of a predictor should lie between 0.2 and 10, values before or beyond these critical values are reasons for concerns. As we can see in appendix I, the variables all lie between 1 and 10, which indicates that there is little multicollinearity. However, the variables *Outside Nijmegen home business* does have a very high VIF value, respectively 9.687. Therefore, this variable must be kept in mind while doing the regression analysis to check whether or not it correlates to much with the other variables. Combined with the correlation matrix, it can be concluded that the assumptions for multicollinearity are met.

4.5.2 Explanatory power of the model

Since all the assumptions for regression analysis are met, the following step is to start doing the regression analyses. To be able to find the main effects in the model and maybe other effects, four regression analyses have been done. Two of these regression analyses had the development of the scientific network as the dependent variable and two had the development of the customer network as the dependent variable. The results of the regression analyses can be found in the following paragraphs.

However, before analysing the regression analyses together with the hypotheses, it is important to look at the explanatory power of the model. This is done by looking at the amount of explained variance of the dependent variables by the model (Field, 2013). To do so, it is needed to check R^2 and adjusted R^2. These SPSS outputs check the explained variance in relation to the amount of variance there was to explain in the first place. The adjusted R^2 also takes into account the complexity of the model. It is adjusted for the number of predictors in the model (Field, 2013).

Furthermore, it is important to check how much of the variability the model can explain relative to the amount it is not able to explain (Field, 2013). This is done by looking at the F-test. The F-test tells us the ratio of how well the model can predict in relation to how bad the model can predict the outcome. This means that a high significant F-test indicates that the model is a good predictor of the dependent variables. During the following paragraphs, the R^2, adjusted

R^2 and the F-test will be discussed per hypotheses together with the other findings of the regression analysis.

4.5.3 The effect of local clustering on network development

Table 8 shows the results of the regression analysis regarding the effect of local clustering on the development of the customer network and the effect of local clustering on the development of the scientific network. Do USOs in the city of Nijmegen, develop more extensive networks, both regarding customer network and knowledge network, compared to USOs located outside the city? Firstly the results regarding the customer network will be discussed, after which the results for the scientific network will be elaborated upon. Development C.N. stands for the development of the customer network and development S.N. stands for the development of the scientific network, this is the same for table 8, 9 and 10. This development is measured by looking at the use of information and knowledge in both the customer network and the scientific network.

When looking at the results of the regression analysis for the development of the customer network, the first thing that needs to be addressed is the explanatory power of the model. In this case, the model has a significant F-value ($p < 0.01$), which means that the model is successfully able to predict the outcomes for the dependent variable. Next to that, table 8 shows that the variance explained by the model is respectively $R^2 = .21$, indicating that the predicting variables explain quite a bit of the variance of the dependent variable.

Furthermore, hypothesis 1 claimed that *The closer spin-offs are located near the city of Nijmegen, the more strongly their customer network develops.* Table 8 column A, shows that the explanatory variable, proximity to Nijmegen, has a significant effect ($p < .05$) on the development of the customer network. This shows that there is evidence that a location within or near the city of Nijmegen has a positive effect on the development of the customer network. This effect is in line with literature from chapter 2 in which was stated that a low proximity to buyers and suppliers helps developing the customer network.

Next to that, the control variables, in which the sector business services is taken as reference category, also show significant results. The sector manufacturing and trade showed a significant effect ($p < .05$) and the sector research companies also shows a, slightly less, significant effect ($p < .1$). This shows that there is not a causal relationship between proximity to Nijmegen and the customer network development, since the control variables also show an effect on the customer network development. At last, the control variable baseline customer

network also shows a significant effect ($p < .01$), showing that the customer network development of USOs has changed over the years.

Therefore, as stated above, the effect of the explanatory variable has statistical significance. The direction of the effect on the development of the customer network is the same as expected. As a result, it can be concluded that hypothesis 1 is supported with a significance of $p < .01$. That suggests that locating a USO closer to the city of Nijmegen, enhances the chance of developing a larger customer network compared to a location further away from the city.

When looking at the results of the regression analysis regarding the development of the scientific network, again, the first thing that needs to be done is to look at the F-test values. This model also has a significant F-test ($p < .01$), showing that the model is able to successfully predict the dependent variable. However, in this model, the R^2 value is lower, respectively $R^2 = .14$. This shows that the model explains less of the variance from the dependent variable, though, this value is still acceptable in social studies (Field, 2013).

The second hypothesis argued that, *the closer spin-offs are located near the city of Nijmegen, the more strongly their scientific knowledge network develops.* Table 8 column B, shows that the explanatory variable proximity to Nijmegen does not have a significant effect on the development of the scientific network. The correlation is also slightly negative and very small. This shows that the effect of the proximity to Nijmegen does not have an effect on the development of the scientific network. Which is slightly unexpected since a lot of academic literature describes the nurturing possibilities of being located near a University as a USO. However, there is also literature that describes science parks more as attractors of innovation rather than developers of innovation. This effect found in this analysis could be an indicator of the attraction function rather than the nurturing function of science parks.

Next to that, there are no significant control variables, except for the baseline scientific network variable. The variable baseline scientific network has a significant effect ($p < .01$) on the scientific network, which suggests that the development of the scientific network has changed over time. In other words, it shows that the frequency of the contact with the academic world changed compared to the starting situation. The control variable inhouse R&D suggests that there is a positive correlation with the scientific network development, however this effect is not significant ($p = .16$). The result suggests that having a inhouse R&D department positively

influences the development of the scientific network, however, since this result is not significant it is only an indication of a possible effect.

Therefore, as stated above, the effect of the explanatory variable has no statistical significance. The direction of the effect on the development of the scientific network is not the same as expected. As a result, it can be concluded that hypothesis 2 is not supported with a significance of $p < .10$. That suggests that locating a USO closer to the city of Nijmegen, does not enhance to development of the scientific network.

		Development C.N.	**Development S.N.**
		b (SE)	b (SE)
Control variables		A	B
	Manufacturing and trade	- .73 (.32)**	-.10 (.23)
	Research companies	64 (.38)*	-.16 (28)
	ICT	-.17 (.46)	.10 (.34)
	Business services	Reference	Reference
	Inhouse R&D	.004 (.26)	.22 (.16)
	Baseline customer network	-.30 (.09)***	-
	Baseline Scientific network	-	-.42 (.11)***
Explanatory variable			
	Proximity to Nijmegen	.29 (.12)**	-.04 (.09)
Model information			
	F-value	4.86***	3.23***
	R^2	.21	.14
	Adjusted R^2	.16	.10
	N	120	122
Explanation	* p < .1; ** p < .05; *** p < .01		

Table 8: Regression analyses regarding the effect of local clustering on network development

4.5.4 The effect of sub-local clustering on network development

Table 9 shows the results of the regression analysis regarding the effect of sub-local clustering on the development of the customer network. Do USOs housed in multi-company buildings develop more extensive networks compared to ‘stand alone’ USOs? Table 10 shows the results

of the regression analysis regarding the effect of proximity to the Radboud university on the development of the scientific network. Do USOs housed near the Radboud university develop more extensive scientific networks compared to USOs housed further away from the university? Firstly the results regarding the customer network will be discussed, after which the results for the scientific network will be elaborated upon.

The F-test, calculating the explanatory power of the model, regarding the development of the customer network was again significant ($p < 0.01$) and it explained for respectively $R^2 = .29$ of the variance. Showing that the model successfully predicts the dependent variable and that it covers almost a third of the variance in the model.

Hypothesis 3 argued that, *Clustering of USOs in a multi-company building (either in a science park-MCB or in a conventional MCB) advances their customer network development compared to not being located in a multi-company building.* Table 9, shows that the explanatory variables both have a positive correlation with the independent variable. This suggests that home businesses and stand alone firms in autonomous buildings have a stronger development of the customer network. However, table 9 column A, shows that both explanatory variables are not significant, showing that the correlation cannot be justified with our data sample, however, it does show an interesting insight in the data since it was expected that companies in a multi-company building would have a higher development of the customer network due to the proximity to other firms.

Furthermore, the control variable baseline customer network has a significant effect ($p < .01$) on the customer network development. This suggests that the development of the customer network has developed compared with the starting situation. It shows that the frequency of the contact with the customer network changed. Next to that, the control variables manufacturing and trade and research companies also show significant effects ($p < .10$). These effects are less significant, however, both effects do correlate quite high with the dependent variable. This suggests that firms that operate in the manufacturing and trade and the research companies sectors are more likely to have an increased customer network development.

Therefore, as stated above, the effect of the explanatory variables have no statistical significance. The direction of the effects on the development of the customer network is the same as expected. As a result, it can be concluded that hypothesis 3 is not supported with a significance of $p < .10$. That suggests that being located in a multi-company building does not

significantly increase the development of the customer network with regards to home businesses and stand alone firms with autonomous buildings.

		Development C.N.
		b (SE)
Control variables		
	Manufacturing and trade	.61 (.33)*
	Research companies	.63 (.37)*
	ICT	.09 (.44)
	Business services	Reference
	Inhouse R&D	.13 (.22)
	Baseline customer network	-.59 (.10)***
Explanatory variables		
	Home business	.08 (.25)
	Stand alone firm in autonomous building	.20 (.30)
	Multi-company buildings	Reference
Model information		
	F-value	5.86***
	R^2	.29
	Adjusted R^2	.24
	N	109
Explanation	* p < .1; ** p < .05; *** p < .01	

Table 9: Regression analysis regarding the effect of sub-local clustering on customer network development

When looking at the results of the regression analysis regarding the development of the scientific network, again, the first thing that needs to be done is to look at the F-test values. This model has a slightly less significant F-test ($p < .05$), however still showing that the model is able to successfully predict the dependent variable. However, in this model the R^2 value is lower, respectively $R^2 = .15$. This shows that the model explains less of the variance from the dependent variable.

The fourth hypothesis argued that, *proximity to the Radboud University positively influences the scientific network development of USOs located within a multi-company building, compared to USOs within a multi-company building located further away from the*

Radboud University but within Nijmegen. In other words, does a USO located in a multi-company building near the Radboud university have an advantage over a USO located in a multi-company buildings outside of the campus when developing the scientific network. Table 10, shows that the explanatory variables do not have a significant effect on the dependent variable. The results show there is no significant difference between being located on campus within a multi-company building and a location outside of the campus within a multi-company building. Showing that in our case proximity to the parent university does not seem to effect the scientific network development significantly.

Next to that, the control variable baseline scientific network has a negative correlation with the independent variable and the effect is significant ($p < .01$). This suggests that over time the development of the scientific network has changed for the USOs in our dataset. It shows that the frequency of contact with the academic world has changed over time. Furthermore, the control variables based on the sector and the inhouse R&D variable do not show any significant effects. That shows that there is no significant difference between different sectors and the development of the scientific network. Next to that, it also shows that an inhouse R&D department does not necessarily mean that a USOs is also seeking for more relationships with scientific institutions. Therefore, based on the evidence found in table 10, one can state that hypothesis 4 is not supported. There is no statistical evidence in our dataset that proximity to the Radboud university advances the scientific network when being located in a multi-company building.

However, post-hoc analyses regarding the intensity of the relationship between firms located on and off campus did show some interesting results. The results showed that the relationship between a firm located on campus and the academic world has more intensity than firms located off campus. These results do show some positive effects of the proximity to the parent university, however, it is not an indication that proximity leads to a better scientific network development.

		Development S.N.
		b (SE)
Control variables		
	Manufacturing and trade	-.18 (.25)
	Research companies	-.25 (.29)
	ICT	.09 (.36)
	Business services	Reference
	Inhouse R&D	.19 (.17)
	Baseline scientific network	-.47 (.12)***
Explanatory variables		
	Outside campus within MCB within Nijmegen	-.19 (.37)
	Nijmegen home business	-.01 (.35)
	Nijmegen stand alone	-.16 (.37)
	All USOs outside Nijmegen	-.03 (.32)
	On campus within MCB	Reference
Model information		
	F-value	2.04**
	R^2	.15
	Adjusted R^2	.08
	N	111
Explanation	* p < .1; ** p < .05; *** p < .01	

Table 10: Regression analysis regarding the effect of proximity to the Radboud university on scientific network development

4.5.5 The combinatorial effect of local and sub-local clustering on network development

Table 10 also shows the results of the regression analysis regarding the combinatorial effect of local and sub-local clustering on the development of the customer network and the effect of local and sub-local clustering on the development of the scientific network. In other words, do clustering advantages on the local and sub-local add up? Firstly the results regarding the customer network will be discussed, after which the results for the scientific network will be elaborated upon. For hypothesis 5 the reference category is USOs located within a multi-company building in Nijmegen and for hypothesis 6 the reference category is USOs that are located within a multi-company building on the university terrain in Nijmegen.

When looking at the results of the regression analysis regarding the development of the customer network, again, the first thing that needs to be done is to look at the F-test values. The model shows a significant F-test ($p < .01$), showing that the model is able to successfully predict the dependent variable. In this model the R^2 value is, respectively $R^2 = .38$. This shows that the model explains quite a bit of the variance from the dependent variable.

Hypothesis 5 argued that, *clustering in a multi-company building in the city of Nijmegen advances customer network development both compared to non-MCB housing in Nijmegen and to MCB-housing outside Nijmegen.* In other words is there an aggregation of local and sub-local effects on the development of the customer network. Table 11 column A, shows that the explanatory variable outside Nijmegen within a multi-company building has a significant effect ($p < .01$) on the dependent variable. The effect is negative, showing that locating a firm in Nijmegen within a multi-company building increases customer network development over a location outside of Nijmegen in a multi-company building.

However, when looking for spatial aggregation of clustering advantages the reference group USOs housed in multi-company buildings within Nijmegen city need to show additional stronger network developments compared to stand alone firms in Nijmegen. This does not appear to be the case. Showing that additional clustering in multi-company buildings in the city of Nijmegen does not provide additional commercial networking advantages compared to stand- alone firms in Nijmegen. Therefore, regarding the commercial network it appears that it is local clustering that counts, while sub-local clustering on top of local clustering fails to generate additional network advantages.

Next to that, the explanatory variable home business outside Nijmegen also has a significant effect ($p < .10$) on the customer network development. This effect also indicates a

negative correlation showing that this type of housing situation decreases the customer network development when comparing it with the reference category. In order to find some more clarity about the effect in this model multiple post hoc analyses are performed. These post hoc analyses showed that a clustering in a multi-company building outside of Nijmegen does not have a significant effect with regards to being a stand alone outside of Nijmegen. The results of these post hoc analyses can be requested at the researcher.

Moreover, the control variable baseline customer network has a significant effect ($p < .01$) on the dependent variable, showing that the customer network has changed over time for firms with multiple housing situations. Next to that, the table shows that the sector manufacturing and trade and the sector research companies both also have a significant effect ($p < .10$) on the development of the customer network. This suggests that, since the correlations are both positive, USOs that are operating in either of these sector have an increased development of the customer network compared to the sector business service.

Therefore, as stated above, the effects of the explanatory variables have some statistical significance. However, the direction of the effects on the development of the customer network is not the same as expected. As a result, it can be concluded that hypothesis 5 is partially supported with a significance of $p < .01$. The analysis suggests that the customer network developed more rapidly in our focus group, i.e. USOs in a multi company building within Nijmegen, compared to firms outside of Nijmegen, however, not compared to stand alone firms within Nijmegen, nor compared to USOs operating form an autonomous business premises nor compared to USOs operating from home.

The regression analysis regarding the effects of local and sub-local clustering on the development of the scientific network shows a significant F-test ($p < .05$), showing that the model is able to successfully predict the dependent variable. In this model the R^2 value is, respectively $R^2 = .16$. This shows that the model explains a bit of the variance from the dependent variable.

Hypothesis 6 argued that, *Clustering in a multi-company building on a science park advances the scientific network building compared to multiple other housing situations.* Table 11 column B, shows that the explanatory variables in this model all have a very small or an negative correlation with the dependent variable. This shows that being located in a multi-company building on the science park would indeed increase the development of the scientific network. However, all the explanatory variables do not have any statistical significance. This

suggests that with our dataset no evidence is found that there is any difference between USOs located in a local and sub-local clustering and with firms that are for example stand alone firms outside of Nijmegen. Next to that, multiple post hoc analysis showed that the relative distance to the university does not influence the development of the network, however it did show that the attraction function of a science park can influence the size of the network.

Therefore, as stated above, the effects of the explanatory variables do not have statistical significance. As a result, it can be concluded that hypothesis 6 is not supported. That suggests that being located in a multi-company building on the science park does not significantly increase the development of the scientific network with regards to home businesses, stand alone firms with autonomous buildings and firms in multi-company buildings outside the university campus.

		Development C.N.	Development S.N.
		b (SE)	b (SE)
Control variables		A	B
	Manufacturing and trade	.64 (.31)*	-.18 (.25)
	Research companies	.48 (.36)*	-.28 (.32)
	ICT	-.24 (.43)	.08 (.37)
	Business services	Reference	Reference
	Inhouse R&D	.21 (.21)	.20 (.18)
	Baseline customer network	-.55 (.10)***	-
	Baseline scientific network	-	-.45 (.12)***
Explanatory variables			
	Nijmegen outside campus in MCB	Reference	-.18 (.38)
	Outside Nijmegen in MCB	-1.15 (.39)***	-.13 (.40)
	Stand alone in Nijmegen	-.25 (.36)	-.15 (.37)
	Stand alone outside Nijmegen	-.14 (.42)	-.04 (.42)
	Home business in Nijmegen	.09 (.33)	.00 (.36)
	Home business outside Nijmegen	-.57 (.30)*	.01 (.34)
	Nijmegen on campus in MCB	-	Reference
Model information			
	F-value	5.90***	1.66**
	R^2	.38	.16
	Adjusted R^2	.31	.06
	N	109	111
Explanation	* p < .1; ** p < .05; *** p < .01		

Table 11: Regression analysis regarding the effect of local and sub-local clustering on network development

4.6 Summary of the results

The multivariate analysis showed that there is support for hypothesis 1, which argued that a location near the city of Nijmegen would increase the development of the customer network of a USO with regards to USOs being located further from Nijmegen. Next to that, the analysis showed that there is partial support for hypothesis 5. Hypothesis 5 argued that on top of local clustering in the city of Nijmegen clustering in a multi-company building advances the customer network of a USO compared to both clustering in multi-company buildings outside Nijmegen and to non-multi-company housing in Nijmegen. The analysis of hypothesis 5 showed that customer network developed more rapidly in our focus group, i.e. USOs in a multi-company building within Nijmegen, compared to firms outside of Nijmegen, however, not compared to stand alone firms within Nijmegen, nor compared to USOs operating form an autonomous business premises nor compared to USOs operating from home. Showing that there is no interaction effect between local and sub-local clustering in this dataset when it comes to customer network development. At last, hypotheses 2, 3, 4 and 6 are not supported. This means that we have not found an effect of local or sub-local clustering on the development of the scientific network and that sub-local clustering does not affect the development of the customer network, based on these analyses. Interesting was that some post-hoc analyses regarding the size of the network instead of the development of the network showed some different results. These post-hoc analyses indicated that the effects of local and sub-local clustering might only be due to the attraction function of clusters rather than a developing function.

5. Conclusion and discussion

This chapter contains a conclusion and a discussion based on the results of the analyses. Paragraph 5.1 will give a summary of the theory, methods and results used in this thesis and it contains concluding paragraphs in which the main question of the thesis is answered. Paragraph 5.2 and 5.3 will elaborate on theoretical and managerial implications based on the results of this thesis. Lastly, the limitations and suggestions for future research are discussed.

5.1 Research summary

Knowledge has become a key aspect for companies to thrive and to gain competitive advantages, meaning that the potential for knowledge-intensive firms is high. USOs are knowledge-intensive firms and universities as well as governments, are starting to see the economic benefits of these types of firms (Corsi et al., 2017; Felsenstein, 1994). This growing interest in USOs began to create a movement in which universities and governments started to create science parks near universities to ensure close proximity to the parent university (McAdam & McAdam, 2006). However, academic literature showed that this would mainly influence the development of the scientific network of the USO. Moreover, proximity to other businesses and to the customer is needed to enrich and advance the development of the customer network (Folta et al., 2006; Hayter et al., 2017). The literature surrounding these ideas of local clustering and sub-local clustering mostly focused on either of them. To achieve a more in-depth analysis of the effect of both local and sub-local clustering the following research question needed to be answered: "*To what extent does clustering of USOs at local and sub-local levels affect these firms' business network development regarding both their scientific knowledge network and their customer network?"*

To answer this question, six hypotheses were used to create an overview of the effects of certain types of clustering. The hypotheses will be discussed hereafter.

Academic literature regarding the development of the network of USOs stated that agglomerations have multiple benefits for these firms (Egeln et al., 2004). Agglomerations have multiple complementarities for the networks of USOs and it creates proximity to buyers, suppliers, competitors and producers (Johansson & Quigley, 2004). This leads to the first hypothesis, *H1: The closer spin-offs are located near the city of Nijmegen the more strongly their customer network develops.*

Furthermore, an article by Heblich and Slavtchev (2014), stated that USOs have a tendency of locating themselves near their parent university to enhance their scientific network.

The proximity towards the university could lead to more interactions with scientific institutions. The second hypothesis therefore reads, *H2: The closer spin-offs are located near the city of Nijmegen the, more strongly their scientific knowledge network develops.*

Next to that, academic literature also describes that on a smaller spatial scale, sub-local, clustering of firms is also a positive network enhancer. This sub-local clustering in multi-company buildings boosts productivity and capabilities of firms, in which spill-overs of information and knowledge could happen (Hewitt-Dundas, Burns & Chapman 2016). The third hypothesis therefore reads, *H3: Clustering of USOs in a multi-company building (either in a science park-MCB or in a conventional MCB) advances their customer network development compared to not being located in a multi-company building.*

Also, an article by Chan and Lau (2005), described the contradictory perspective on the effects of incubators. The article showed that the development of networks was not highly advanced for firms located in an incubator. To see how this is for the USOs located within a multi-company building near the Radboud university, the following hypothesis needed to be answered, *H4: proximity to the Radboud University positively influences the scientific network development of USOs located within a multi-company building, compared to USOs within a multi-company building located further away from the Radboud University but within Nijmegen*

Additionally, there was a lack of academic literature regarding the combinatorial effect of local and sub-local clustering on the development of the customer and the scientific network (Chan & Lau, 2005; Heblich & Slavtchev, 2014; Phan et al., 2005). To find out how this combinatorial effect influenced the network development of the USOs, two more hypotheses were created, *H5: Clustering in a multi-company building in the city of Nijmegen advances customer network development both compared to non-MCB housing in Nijmegen and to MCB-housing outside Nijmegen.* And *H6: Clustering in a multi-company building on a science park advances the scientific network building compared to multiple other housing situations*

To analyse the hypotheses, a quantitative study was performed with a combined data-set of three surveys. The combined data-set consisted of 332 respondents. These respondents were all founders of USOs and they had a background at the Radboud University. The analysis consisted of a univariate, bivariate and multivariate analysis. During the univariate analyses the descriptive analysis was done to check whether the variables were skewed or had problems with kurtosis. The univariate analysis of the variables did not show any remarkable observations. The values of skewness and kurtosis were sufficiently low for all of the variables.

The bivariate analysis checked for the correlations between the variables and it checked whether there was a problem with multicollinearity. The correlation matrix showed some support for hypotheses 3 and 4, which assumed that being located in a multi-company building near the university effects both the scientific and the customer network. Unexpectedly, there were no other significant correlations between the independent and the dependent variables. Next to that, the bivariate analysis did not show any significant values of multicollinearity, which was also checked during the multivariate analyses.

Furthermore, the multivariate analyses were done to check, by using regression analyses, whether the models had any explanatory power and to see what the relationships were between the independent and the dependent variables. All six models had a significant F-test, which showed that the models were able to predict the dependent variables. The regression analyses, as discussed in chapter 4, showed that there was support for hypothesis 1 and partial support for hypothesis 5 and that hypotheses 2, 3, 4 and 6 did not have any statistical support.

5.1.2 Answering the main research question

The main research question during this thesis was, "*To what extent does clustering of USOs at local and sub-local levels affect these firms' business network development regarding both their scientific knowledge network and their customer network?".* To answer this question in a structured manner first, the influences of local and sub-local clustering on the customer network development are discussed, after which the influences of local and sub-local clustering on the development of the scientific network are discussed.

As was shown by hypothesis 1, local clustering does influence the development of the customer network of USOs. It showed that being located near the city of Nijmegen has a positive relationship with the development of the customer network. However, the analysis of this dataset did not show any evidence that clustering of USOs on sub-local level influences the development of the customer network. This was unexpected and contradicting with the literature that was found in chapter two. An explanation for this could be that the respondents do not feel the true notion of a new external link when they share a building or when located on the same business park. This was also addressed by an article from Chan and Lau (2005), in which is discussed that incubators do not create a significant advantage towards the development of external relationships. These researchers believed that a reason for this was that the tenants have nothing in common and that there are no opportunities for partnerships, synergies and knowledge sharing. Next to that, the analysis in this thesis did find some evidence

for a combinatorial effect of local and sub-local clustering. However, post hoc analyses showed that this effect was merely based on the effect of local clustering and that sub-local clustering failed to aggregate extra contributions. Therefore, the analyses together with the post hoc analyses showed that being located within a multi-company building in Nijmegen advances the development of the customer network compared to other housing situations outside of Nijmegen, however, not compared to stand alone firms within Nijmegen, nor compared to USOs operating form an autonomous business premises nor compared to USOs operating from home.

For the second part of the main question, there was little statistical evidence. The regression analyses did not show significant outcomes for the development of the scientific network. The relationship between local and sub-local clustering and the development of the scientific network was very small and the analyses showed that the relative distance to a university does not influence the development of this network. This was not really surprising, since there is still much discussion within academic literature on the relationship between the effects of clustering and the development of the scientific network. Therefore, it seems not yet possible to falsify a competing theory. Moreover, in line with Felsenstein (1994) the results indicate that science parks have more of an attraction function rather than a developing function with regards to network development and innovativeness. Next to that, it must be stated that the results are based on three surveys that were configurated together to create the dataset as used. This configuration might have led to a dataset which did not fully conform to the analysis that was done eventually. However, it could also be that since the definition of a scientific network is more vague, respondents have more problems in relating the concept to developments in their real life situation.

To conclude, the results of this study show that the location of a USO plays a key role into the development of the customer network. Investing in a location near Nijmegen positively influences the customer network of USOs. However, this analysis has not given us any evidence to suggest that it is the same for the scientific network. The data has shown that a location in Nijmegen does not significantly enhance the scientific network relative to a location outside of the city. Next to that, the analyses did not find the combinatorial effect between local clustering and sub-local, showing that clustering in a multi-company building in Nijmegen does not necessarily give an advantage over clustering outside of Nijmegen for the scientific network, however, with the development of the customer network this is the case, although it seemed that this effect was solely based on local clustering.

5.2 Theoretical implications

Studies and academic literature describing and discussing the network development of USOs are widely found. However, the academic literature on the combinatorial effect that different spatial levels could have is still underdeveloped. This study tried to contribute to that gap in academic literature by seeking for evidence for this relationship. The results showed that this analysis did not find any evidence for a combinatorial effect. Therefore, this study contributes to theory that, for now, a combinatorial effect between local and sub-local clustering on the development of USO's scientific network cannot be supported by this analysis.

Furthermore, the general literature regarding the effects of local clustering on the scientific and customer network has been partially confirmed by the analyses. The study showed that there was a significant relationship between local clustering and the development of the customer network. Showing, that the results in this study have some confirmatory insights regarding the theory on local clustering for the customer network, however, not for the scientific network development.

In addition, the aim of this study was also to find evidence for the relationship between sub-local clustering and the network development of USOs. Academic literature widely discusses science parks and incubators and the doubtful effects of this sub-local clustering for the network development. This study showed that there is not yet evidence for a positive or a negative relationship, neither for the customer network nor the scientific network.

To conclude, this study shows that there is still a lot of contradicting views on the way that the network development of an USO is influenced and that there is still knowledge missing on the combinatorial effect of local and sub-local clustering. This shows that there is still a gap in the existing literature and that further research is needed to further develop our understanding of this topic.

5.3 Managerial implications

This study likewise tried to contribute to the practical relevance of this topic. The results of this study show that for USOs that are interested in developing a greater customer network that a location near or within a city is beneficial and that a location within a multi-company building enhances this. However, this study also showed that for USOs, it is not necessarily needed to stay close to their parent university in order to develop the scientific network.

Moreover, the results implicate that the decision for the USO's managers on where to locate the firm is more important when thinking about the customer network development rather than the scientific network development. The results of this research show that the relative distance to the university has less of an impact on that type of network than the relative distance to customer has on the network development. For a manager it might therefore be helpful to realise and to think of what type of network building is needed to become a thriving business and use that information when choosing a new location for the firm.

5.4 Limitations and suggestions for future research

Doing research is a very deliquiate process in which a lot of requirements and rules need to be taken into account. Next to that, a researcher is always bound to a certain amount of time, money and other resources. All these conditions are limitations for a study, likewise, there are also some methodological limitations in this research. Next to the limitations, the following paragraphs will also describe some suggestions for future research. These suggestions might be based on the limitations of this study or might be interesting topics related to this study.

First of all, a limitation of this study was the research population. The problem with this is that we do not know the full population of USOs. Since the database for alumni is not all-encompassing, it is very likely that there are firms missing in this study. This means that a particular firm would be applicable for this study, however, these companies are not included in the survey list since they are not registered. This lack of knowledge regarding the entire research population brings some limitations to the research due to problems with the accuracy of the data and that it might show a different picture than what is really happening. However, it is difficult to tackle this problem because of the number of alumni the Radboud University has each year.

A second limitation of this research is that the data used in the analyses was based on three older surveys, dating back from 2004, 2008 and 2011. Therefore, the old data set is not sufficiently able show what the developments have been in the past five years. Moreover, it would be very interesting to use an updated list and send out a new survey, more focused on the aspects regarding the network development of USOs, to see whether major changes have occurred in the last period. A fourth survey would also increase the quality of the longitudinal approach surrounding this topic.

Next to that, this study focused on the quantitative part of network development for USOs. This means that a lot of potential data is not used. For future research, it might be

interesting to use a qualitative or a mix-method approach to find more in-depth arguments for why clustering might help to improve a network. Moreover, networking is a social interaction between actors. Doing interviews might help in our understanding of what factors are positive and negative influences on the customer and scientific network.

Lastly, as this research focusses on USOs solely with a background at the Radboud University, it would be interesting to see whether the same results are applicable for other universities. Future research could investigate whether a different university city has the same impact on the network development of USOs. In addition to this, future research could look at what type of governance different universities have regarding USOs. Different types of governance could also lead to different developments of at least the scientific network.

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Appendix I – SPSS Output

Reliability statistics – Customer network

Item-Total Statistics

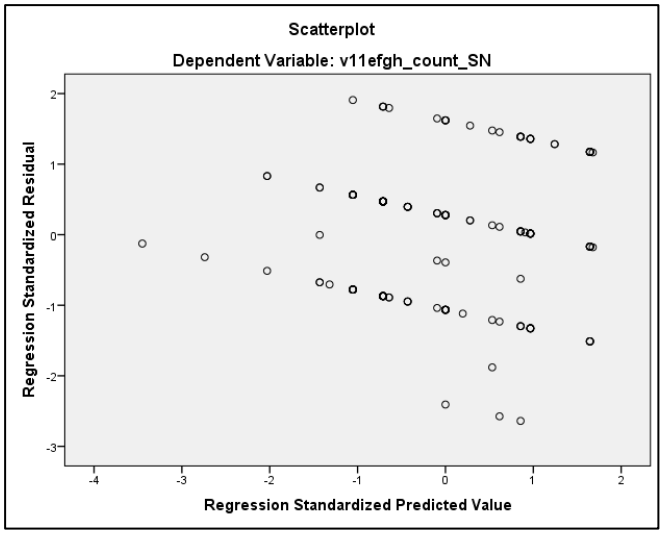
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
informatiebron wijzelf	34,7500	49,767	,452	,784
informatiebron afnemer	35,7955	49,391	,320	,797
informatiebron leverancier	36,7955	51,915	,370	,791
informatiebron concurrent	36,3864	50,612	,351	,792
v13b afnemers	35,8409	48,663	,384	,790
v8b Afnemers	35,6591	49,091	,514	,780
v8c Leveranciers van apparatuur, materialen, componenten of software	36,2955	50,661	,437	,786
v8d Concurrent of andere bedrijven in uw bedrijfstak	35,9318	50,494	,369	,790
informatiebron vakliteratuur	35,6591	47,583	,481	,781
v13c leveranciers van apparatuur, materialen, componenten of software	36,3409	49,345	,432	,785
v13d concurrent of andere bedrijven in uw bedrijfstak	36,2045	52,582	,205	,802
v17a hoe goed bent u op de hoogte van de problemen waarmee uw klanten te maken hebben?	34,5682	51,097	,391	,789
v17b in welke mate heeft u inzicht in de omvang van de koopkrachtige vraag uit de markt?	35,2045	48,709	,468	,783
v17c hoe goed kent u de specificaties van de producten van uw concurrenten?	34,9773	48,863	,419	,787
gebruik informatie van afnemers	35,7273	48,874	,637	,774

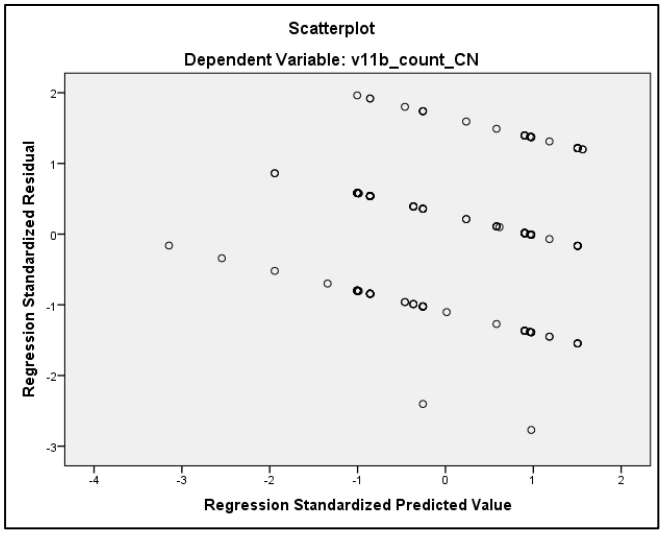
Reliablility statistics – Scientific network

Item-Total Statistics

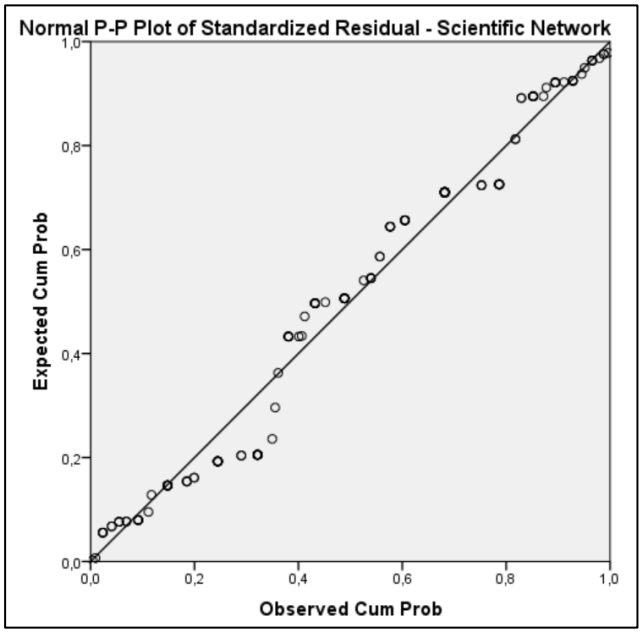
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
informatiebron RU Nijmegen	32,7037	96,285	,395	,875
informatiebron overige kennisinstellingen	33,0741	99,011	,466	,873
informariebron consultant	33,0370	100,990	,194	,880
informatiebron vakliteratuur	31,8148	91,738	,597	,867
v16a de Radboud Universiteit Nijmegen/UMC St. Radboud?	33,1481	92,174	,560	,868
v16b andere universiteiten?	33,5926	94,447	,682	,866
v16c andere onderzoeksinstellingen?	33,9630	101,682	,197	,879
v7a Hoe vaak zijn er in de laatste drie jaar op enigerlei wijze contacten geweest tussen uw bedrijf en a de Radboud Univ	32,8519	97,764	,381	,875
v7b andere universiteiten?	33,5926	93,704	,735	,865
v7c andere onderzoeksinstellingen?	33,4444	96,094	,555	,870
v13e Radboud Universiteit Nijmegen/UMC ST Radboud	32,4815	92,264	,585	,867
v13f andere universiteiten of openbare onderzoeksinstellingen	32,3704	90,028	,720	,862
v13h consultants, commerciële laboratoria of particuliere R&D-instituten	32,8519	96,481	,410	,874
v13j wetenschappelijke tijdschriften en vak-/technische publicaties	31,8148	96,751	,419	,873
v8e Radboud Universiteit Nijmegen/UMC St Radboud	32,1481	93,315	,503	,871
andere universiteiten of openbare onderzoeksinstellingen	32,1111	95,530	,316	,880
v8i Consultants, commerci‰le R&D-instituten of laboratoria	32,8148	99,802	,305	,877
v8k Wetenschappelijke tijdschriften en vak-/technische publicaties	31,7037	96,670	,358	,876
Gebruik van kennis en informatie van wetenschappelijke kennisinstellingen voor innovatie	32,4815	93,755	,862	,863
gebruik informatie RU	32,4444	93,530	,680	,865

Linearity and Homoscedasticity

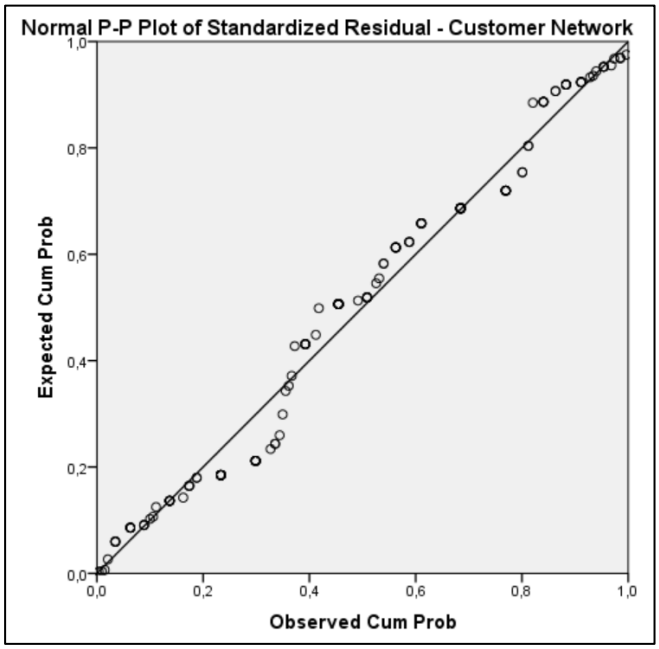




Normally distributed errors – Scientific network



Normally distributed errors – Customer network



Durban watson – Scientific network

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,270[a]	,073	,017	1,48931	1,297

Durban watson – Customer network

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,293[a]	,086	,030	,72408	1,297

VIF values

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	1,899	,979		1,940	,054		
	situering ten opzichte van/clustering rond de Radboud Universiteit	,288	,288	,203	1,001	,319	,137	7,324
	located on university grounds in a multicompany building?	,107	,796	,022	,135	,893	,207	4,841
	Conventional business park in Nijmegen?	-,927	,594	-,129	-1,559	,121	,822	1,217
	Nijmegen outside university campus multi company building?	1,489	,710	,309	2,096	,038	,259	3,854
	Nijmegen stand alone company?	1,169	,715	,248	1,634	,104	,244	4,091
	Nijmegen home business?	1,214	,687	,283	1,767	,079	,219	4,570
	Netherlands outside Nijmegen on business park?	,254	,638	,035	,398	,691	,713	1,403
	netherlands outside Nijmegen in multi company building?	1,360	,840	,261	1,619	,107	,216	4,628
	Netherlands outside Nijmegen stand alone company?	1,224	,839	,214	1,459	,146	,262	3,820
	Netherlands outside Nijmegen home business?	1,110	,743	,349	1,494	,137	,103	9,687

a. Dependent Variable: v11efgh_count_SN

Pearson Correlation matrix

Correlations

		v11efgh_count	v11b_count	situering ten opzichte van/clustering rond de Radboud Universiteit	located on university grounds in a multicompany building?	Conventional business park in Nijmegen?	Nijmegen outside university campus multi company building?	Nijmegen stand alone company?	Nijmegen home business?	Netherlands outside Nijmegen on business park?	netherlands outside Nijmegen in multi company building?	Netherlands outside Nijmegen stand alone company?	Netherlands outside Nijmegen home business?	v3b_sector	average
v11efgh_count	Pearson Correlation	1	,980**	,023	-,296**	-,037	,121	,029	,115	,064	,035	-,007	-,084	,015	-,082
	Sig. (2-tailed)		,000	,672	,000	,599	,110	,697	,128	,370	,647	,925	,268	,782	,141
	N	332	332	331	199	200	176	177	177	199	176	177	177	323	323
v11b_count	Pearson Correlation	,980**	1	,019	-,318**	-,019	,122	,053	,116	,082	,088	-,008	-,129	,025	-,061
	Sig. (2-tailed)	,000		,725	,000	,789	,107	,483	,126	,248	,244	,912	,087	,653	,274
	N	332	332	331	199	200	176	177	177	199	176	177	177	323	323
situering ten opzichte van/clustering rond de Radboud Universiteit	Pearson Correlation	,023	,019	1	,690**	,093	,234**	,241**	,305**	-,201**	-,274**	-,263**	-,627**	-,161**	,164**
	Sig. (2-tailed)	,672	,725		,000	,194	,002	,001	,000	,004	,000	,000	,000	,004	,003
	N	331	331	331	199	199	176	176	176	199	176	176	176	322	322
located on university grounds in a multicompany building?	Pearson Correlation	-,296**	-,318**	,690**	1	-,106	-,121	-,125	-,142	-,106	-,110	-,098	-,244**	-,209**	,268**
	Sig. (2-tailed)	,000	,000	,000		,137	,110	,100	,061	,137	,146	,195	,001	,003	,000
	N	199	199	199	199	199	176	176	176	199	176	176	176	196	198
Conventional business park in Nijmegen?	Pearson Correlation	-,037	-,019	,093	-,106	1	,188*	,352**	-,088	-,042	-,069	-,061	-,152*	-,071	-,001
	Sig. (2-tailed)	,599	,789	,194	,137		,013	,000	,243	,557	,363	,418	,044	,319	,992
	N	200	200	199	199	200	176	177	177	199	176	177	177	197	199
Nijmegen outside university campus multi company building?	Pearson Correlation	,121	,122	,234**	-,121	,188*	1	-,125	-,142	-,076	-,110	-,098	-,244**	,025	-,042
	Sig. (2-tailed)	,110	,107	,002	,110	,013		,100	,061	,317	,146	,195	,001	,742	,583
	N	176	176	176	176	176	176	176	176	176	176	176	176	173	175
Nijmegen stand alone company?	Pearson Correlation	,029	,053	,241**	-,125	,352**	-,125	1	-,145	-,078	-,113	-,100	-,249**	-,103	,093
	Sig. (2-tailed)	,697	,483	,001	,100	,000	,100		,055	,303	,135	,183	,001	,178	,217
	N	177	177	176	176	177	176	177	177	176	176	177	177	174	176
Nijmegen home business?	Pearson Correlation	,115	,116	,305**	-,142	-,088	-,142	-,145	1	-,089	-,129	-,114	-,283**	,154*	-,096
	Sig. (2-tailed)	,128	,126	,000	,061	,243	,061	,055		,241	,089	,130	,000	,043	,207
	N	177	177	176	176	177	176	177	177	176	176	177	177	174	176
Netherlands outside Nijmegen on business park?	Pearson Correlation	,064	,082	-,201**	-,106	-,042	-,076	-,078	-,089	1	,500**	,147	-,153*	-,115	,103
	Sig. (2-tailed)	,370	,248	,004	,137	,557	,317	,303	,241		,000	,052	,043	,107	,147
	N	199	199	199	199	199	176	176	176	199	176	176	176	196	198
netherlands outside Nijmegen in multi company building?	Pearson Correlation	,035	,088	-,274**	-,110	-,069	-,110	-,113	-,129	,500**	1	-,089	-,222**	-,015	,136
	Sig. (2-tailed)	,647	,244	,000	,146	,363	,146	,135	,089	,000		,239	,003	,842	,072
	N	176	176	176	176	176	176	176	176	176	176	176	176	173	175
Netherlands outside Nijmegen stand alone company?	Pearson Correlation	-,007	-,008	-,263**	-,098	-,061	-,098	-,100	-,114	,147	-,089	1	-,197**	-,024	,017
	Sig. (2-tailed)	,925	,912	,000	,195	,418	,195	,183	,130	,052	,239		,009	,754	,825
	N	177	177	176	176	177	176	177	177	176	176	177	177	174	176
Netherlands outside Nijmegen home business?	Pearson Correlation	-,084	-,129	-,627**	-,244**	-,152*	-,244**	-,249**	-,283**	-,153*	-,222**	-,197**	1	,138	-,091
	Sig. (2-tailed)	,268	,087	,000	,001	,044	,001	,001	,000	,043	,003	,009		,070	,232
	N	177	177	176	176	177	176	177	177	176	176	177	177	174	176
v3b_sector	Pearson Correlation	,015	,025	-,161**	-,209**	-,071	,025	-,103	,154*	-,115	-,015	-,024	,138	1	-,130*
	Sig. (2-tailed)	,782	,653	,004	,003	,319	,742	,178	,043	,107	,842	,754	,070		,021
	N	323	323	322	196	197	173	174	174	196	173	174	174	323	314
average	Pearson Correlation	-,082	-,061	,164**	,268**	-,001	-,042	,093	-,096	,103	,136	,017	-,091	-,130*	1
	Sig. (2-tailed)	,141	,274	,003	,000	,992	,583	,217	,207	,147	,072	,825	,232	,021	
	N	323	323	322	198	199	175	176	176	198	175	176	176	314	323

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Regression analysis 1 – Development customer network

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.453[a]	.205	.163	1.12200

a. Predictors: (Constant), Information communication technology company, Research company, Gebruik van informatie afnemers bij eerste deelname aan het onderzoek, Manufacturing or trade company, Proximity to Nijmegen city, inhouse R&D?

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36.738	6	6.123	4.864	.000[b]
	Residual	142.254	113	1.259		
	Total	178.992	119			

a. Dependent Variable: development through time use of information from customers

b. Predictors: (Constant), Information communication technology company, Research company, Gebruik van informatie afnemers bij eerste deelname aan het onderzoek, Manufacturing or trade company, Proximity to Nijmegen city, inhouse R&D?

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.014	.445		-.032	.975
	Proximity to Nijmegen city	.292	.121	.213	2.423	.017
	Gebruik van informatie afnemers bij eerste deelname aan het onderzoek	-.299	.085	-.306	-3.522	.001
	inhouse R&D?	.004	.216	.002	.018	.985
	Manufacturing or trade company	.731	.319	.198	2.290	.024
	Research company	.644	.376	.152	1.711	.090
	Information communication technology company	-.172	.462	-.033	-.371	.711

a. Dependent Variable: development through time use of information from customers

Regression analysis 2 – Scientific network development

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.380[a]	.144	.100	.82563

a. Predictors: (Constant), Information communication technology company, Research company, Manufacturing or trade company, Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek, Proximity to Nijmegen city, inhouse R&D?

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.210	6	2.202	3.230	.006[b]
	Residual	78.391	115	.682		
	Total	91.600	121			

a. Dependent Variable: development through time use of information from scientific institutions

b. Predictors: (Constant), Information communication technology company, Research company, Manufacturing or trade company, Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek, Proximity to Nijmegen city, inhouse R&D?

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.829	.321		2.584	.011
	Proximity to Nijmegen city	-.040	.089	-.040	-.446	.656
	Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek	-.472	.112	-.391	-4.210	.000
	inhouse R&D?	.223	.161	.128	1.384	.169
	Manufacturing or trade company	-.097	.226	-.038	-.431	.667
	Research company	-.162	.279	-.054	-.582	.562
	Information communication technology company	.099	.343	.027	.290	.772

a. Dependent Variable: development through time use of information from scientific institutions

Regression analysis 3 – Customer network development

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.538[a]	.289	.240	1.06459

a. Predictors: (Constant), Information communication technology company, Stand alone firm in an autonomous business building?, Research company, Gebruik van informatie afnemers bij eerste deelname aan het onderzoek, Manufacturing or trade company, inhouse R&D?, Home business?

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	46.521	7	6.646	5.864	.000[b]
	Residual	114.469	101	1.133		
	Total	160.991	108			

a. Dependent Variable: development through time use of information from customers

b. Predictors: (Constant), Information communication technology company, Stand alone firm in an autonomous business building?, Research company, Gebruik van informatie afnemers bij eerste deelname aan het onderzoek, Manufacturing or trade company, inhouse R&D?, Home business?

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.260	.448		2.813	.006
	Stand alone firm in an autonomous business building?	.202	.296	.068	.682	.497
	Home business?	.076	.250	.031	.303	.762
	Gebruik van informatie afnemers bij eerste deelname aan het onderzoek	-.589	.102	-.504	-5.805	.000
	inhouse R&D?	.134	.218	.055	.618	.538
	Manufacturing or trade company	.610	.332	.163	1.834	.070
	Research company	.628	.374	.149	1.678	.096
	Information communication technology company	.092	.435	.018	.211	.834

a. Dependent Variable: development through time use of information from customers

Regression analysis 4 – Scientific network

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.392[a]	.154	.079	.84079

a. Predictors: (Constant), Information communication technology company, Nijmegen home business?, Research company, Manufacturing or trade company, Nijmegen outside university campus multi company building?, Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek, Nijmegen stand alone company?, inhouse R&D?, All USOs outside Nijmegen city

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.997	9	1.444	2.043	.042[b]
	Residual	71.400	101	.707		
	Total	84.396	110			

a. Dependent Variable: development through time use of information from scientific institutions

b. Predictors: (Constant), Information communication technology company, Nijmegen home business?, Research company, Manufacturing or trade company, Nijmegen outside university campus multi company building?, Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek, Nijmegen stand alone company?, inhouse R&D?, All USOs outside Nijmegen city

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.881	.414		2.130	.036
	Nijmegen outside university campus multi company building?	-.189	.371	-.070	-.508	.612
	Nijmegen stand alone company?	-.155	.368	-.059	-.420	.675
	Nijmegen home business?	-.006	.353	-.003	-.016	.987
	All USOs outside Nijmegen city	-.034	.320	-.019	-.106	.916
	Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek	-.469	.117	-.392	-3.998	.000
	inhouse R&D?	.185	.172	.106	1.076	.285
	Manufacturing or trade company	-.190	.250	-.072	-.760	.449
	Research company	-.279	.312	-.092	-.894	.373
	Information communication technology company	.086	.361	.024	.237	.813

a. Dependent Variable: development through time use of information from scientific institutions

Regression analysis 5 – Customer network

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.613[a]	.376	.312	1.01270

a. Predictors: (Constant), Information communication technology company, Nijmegen home business?, Research company, Gebruik van informatie afnemers bij eerste deelname aan het onderzoek, Netherlands outside Nijmegen stand alone company?, Manufacturing or trade company, netherlands outside Nijmegen in multi company building?, inhouse R&D?, Nijmegen stand alone company?, Netherlands outside Nijmegen home business?

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	60.485	10	6.049	5.898	.000[b]
	Residual	100.506	98	1.026		
	Total	160.991	108			

a. Dependent Variable: development through time use of information from customers

b. Predictors: (Constant), Information communication technology company, Nijmegen home business?, Research company, Gebruik van informatie afnemers bij eerste deelname aan het onderzoek, Netherlands outside Nijmegen stand alone company?, Manufacturing or trade company, netherlands outside Nijmegen in multi company building?, inhouse R&D?, Nijmegen stand alone company?, Netherlands outside Nijmegen home business?

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.455	.434		3.351	.001
	Nijmegen stand alone company?	-.248	.356	-.068	-.696	.488
	Nijmegen home business?	.088	.330	.028	.267	.790
	netherlands outside Nijmegen in multi company building?	-1.146	.391	-.284	-2.929	.004
	Netherlands outside Nijmegen stand alone company?	-.135	.416	-.031	-.325	.746
	Netherlands outside Nijmegen home business?	-.570	.297	-.215	-1.920	.058
	Gebruik van informatie afnemers bij eerste deelname aan het onderzoek	-.549	.098	-.469	-5.601	.000
	inhouse R&D?	.213	.209	.087	1.018	.311
	Manufacturing or trade company	.643	.317	.171	2.028	.045
	Research company	.478	.361	.114	1.325	.188
	Information communication technology company	-.244	.430	-.049	-.568	.572

a. Dependent Variable: development through time use of information from customers

Regression analysis 6 – Scientific network

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.394[a]	.156	.062	.84846

a. Predictors: (Constant), Information communication technology company, Nijmegen home business?, Research company, netherlands outside Nijmegen in multi company building?, Manufacturing or trade company, Netherlands outside Nijmegen stand alone company?, Nijmegen outside university campus multi company building?, inhouse R&D?, Nijmegen stand alone company?, Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek, Netherlands outside Nijmegen home business?

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.128	11	1.193	1.658	.094[b]
	Residual	71.268	99	.720		
	Total	84.396	110			

a. Dependent Variable: development through time use of information from scientific institutions

b. Predictors: (Constant), Information communication technology company, Nijmegen home business?, Research company, netherlands outside Nijmegen in multi company building?, Manufacturing or trade company, Netherlands outside Nijmegen stand alone company?, Nijmegen outside university campus multi company building?, inhouse R&D?, Nijmegen stand alone company?, Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek, Netherlands outside Nijmegen home business?

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.835	.432		1.932	.056
	Nijmegen outside university campus multi company building?	-.182	.375	-.067	-.485	.629
	Nijmegen stand alone company?	-.150	.372	-.057	-.405	.687
	Nijmegen home business?	.000	.357	.000	.001	.999
	netherlands outside Nijmegen in multi company building?	-.128	.398	-.044	-.321	.749
	Netherlands outside Nijmegen stand alone company?	-.044	.419	-.014	-.106	.916
	Netherlands outside Nijmegen home business?	.006	.338	.003	.019	.985
	Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek	-.453	.124	-.379	-3.654	.000
	inhouse R&D?	.196	.176	.112	1.115	.267
	Manufacturing or trade company	-.177	.255	-.067	-.693	.490
	Research company	-.283	.315	-.093	-.898	.372
	Information communication technology company	.076	.365	.021	.209	.835

a. Dependent Variable: development through time use of information from scientific institutions

Appendix II – Survey items

Variable Information

Variable	Position	Label	Measurement Level	Role	Column Width	Alignment	Print Format	Write Format	Missing Values
Vid_04	1	respondentnummer	Scale	Input	8	Right	F3	F3	-9
Vid_08	2	<none>	Scale	Input	8	Right	F8.2	F8.2	
Vid_11	3	Respnr	Scale	Input	8	Right	F6	F6	999998, 999999
v1a	4	een of meerdere oprichters	Nominal	Input	14	Right	F8.2	F8.2	,00
v1b	5	oprichtingsjaar alle samples	Scale	Input	10	Right	F8.2	F8.2	
xnaam	6	vnaam	Nominal	Input	24	Left	A105	A105	
bedrijfsnaam	7	<none>	Nominal	Input	26	Left	A150	A150	
vstraat_all	8	<none>	Nominal	Input	26	Left	A150	A150	
vpostcij_all	9	<none>	Scale	Input	14	Right	F8.2	F8.2	
v2a	10	fulltime of parttime ondernemer	Nominal	Input	10	Right	F8.2	F8.2	
v3b_sector	11	<none>	Nominal	Input	13	Right	F8.2	F8.2	-99,00
v6_ambitie	12	<none>	Nominal	Input	15	Right	F8.2	F8.2	
v7c_04	13	r&d	Scale	Input	8	Right	F1	F1	8
v7c_08	14	v14a Zijn in uw bedrijf bepaalde medewerkers (uzelf incluis) specifiek belast met het ontwikkelen van nieuwe of het verb	Scale	Input	4	Right	F1	F1	8, 9
V7c_11	15	v4c Zijn in uw bedrijf bepaalde medewerkers (u zelf incluis) specifiek belast met het ontwikkelen van nieuwe of het verb	Nominal	Input	5	Right	F1	F1	8, 9
v11a_04	16	informatiebron wijzelf	Scale	Input	8	Right	F1	F1	8
v11b_04	17	informatiebron afnemer	Scale	Input	8	Right	F1	F1	8
v11c_04	18	informatiebron leverancier	Scale	Input	8	Right	F1	F1	8
v11d_04	19	informatiebron concurrent	Scale	Input	8	Right	F1	F1	8
v11e_04	20	informatiebron RU Nijmegen	Scale	Input	8	Right	F1	F1	8
v11fgh_04	21	informatiebron overige kennisinstellingen	Scale	Input	8	Right	F1	F1	8
v11i_04	22	informariebron consultant	Scale	Input	8	Right	F1	F1	8
v11k_04	23	informatiebron vakliteratuur	Scale	Input	8	Right	F1	F1	8
v10a_08	24	v16a de Radboud Universiteit Nijmegen/UMC St. Radboud?	Scale	Input	4	Right	F1	F1	8, 9
v10b_08	25	v16b andere universiteiten ?	Scale	Input	4	Right	F1	F1	8, 9
v10c_08	26	v16c andere onderzoeksinstellingen?	Scale	Input	4	Right	F1	F1	8, 9

v10a_11	27	v7a Hoe vaak zijn er in de laatste drie jaar op enigerlei wijze contacten geweest tussen uw bedrijf en a de Radboud Univ	Nominal	Input	5	Right	F1	F1	8, 9
v10b_11	28	v7b andere universiteiten ?	Nominal	Input	5	Right	F1	F1	8, 9
v10c_11	29	v7c andere onderzoeksinstellingen?	Nominal	Input	5	Right	F1	F1	8, 9
v11a_08	30	v13a Hoe belangrijk waren de volgende informatie-/kennis-bronnen in de periode 2005-2007 voor de innovatieactiviteiten v	Scale	Input	4	Right	F1	F1	8, 9
v11b_08	31	v13b afnemers	Scale	Input	4	Right	F1	F1	8, 9
v11c_08	32	v13c leveranciers van apparatuur, materialen, componenten of software	Scale	Input	4	Right	F1	F1	8, 9
v11d_08	33	v13d concurrent of andere bedrijven in uw bedrijfstak	Scale	Input	4	Right	F1	F1	8, 9
v11e_08	34	v13e Radboud Universiteit Nijmegen/UMC ST Radboud	Scale	Input	4	Right	F1	F1	8, 9
v11fgh_08	35	v13f andere universiteiten of openbare onderzoeksinstellingen	Scale	Input	4	Right	F1	F1	8, 9
v11i_08	36	v13h consultants, commerciële laboratoria of particuliere R&D-instituten	Scale	Input	4	Right	F1	F1	8, 9
v11k_08	37	v13j wetenschappelijke tijdschriften en vak-/technische publicaties	Scale	Input	4	Right	F1	F1	8, 9
v11a_11	38	v8a @NInformatiebronnen@N Hoe belangrijk waren de laatste drie jaar de volgende informatiebron voor de innovatie-activit	Nominal	Input	5	Right	F1	F1	8, 9
v11b_11	39	v8b Afnemers	Nominal	Input	5	Right	F1	F1	8, 9

v11c_11	40	v8c Leveranciers van apparatuur, materialen, componenten of software	Nominal	Input	5	Right	F1	F1	8, 9
v11d_11	41	v8d Concurrent of andere bedrijven in uw bedrijfstak	Nominal	Input	5	Right	F1	F1	8, 9
v11e_11	42	v8e Radboud Universiteit Nijmegen/UMC St Radboud	Nominal	Input	5	Right	F1	F1	8, 9
v11fgh_11	43	andere universiteiten of openbare onderzoeksinstellingen	Nominal	Input	16	Right	F8.2	F8.2	
v11i_11	44	v8i Consultants, commerci‰le R&D-instituten of laboratoria	Nominal	Input	5	Right	F1	F1	8, 9
v11k_11	45	v8k Wetenschappelijke tijdschriften en vak-/technische publicaties	Nominal	Input	5	Right	F1	F1	8, 9
v17a_08	46	v17a hoe goed bent u op de hoogte van de problemen waarmee uw klanten te maken hebben?	Scale	Input	4	Right	F1	F1	8, 9
v17b_08	47	v17b in welke mate heeft u inzicht in de omvang van de koopkrachtige vraag uit de markt?	Scale	Input	4	Right	F1	F1	8, 9
v17c_08	48	v17c hoe goed kent u de specificaties van de producten van uw concurrenten ?	Scale	Input	4	Right	F1	F1	8, 9
v13_05	49	v24a Omzet 2005	Scale	Input	9	Right	F9	F9	999999999
v13_06	50	v24b Omzet 2006	Scale	Input	9	Right	F9	F9	999999999
v13_07	51	v24c Omzet 2007	Scale	Input	9	Right	F9	F9	999999999
v13_08	52	v10a Omzet Jaar 2008	Scale	Input	10	Right	F8	F8	99999998, 99999999
v13_09	53	v10b Omzet Jaar 2009	Scale	Input	10	Right	F8	F8	99999998, 99999999
v13_10	54	v10c Omzet Jaar 2010	Scale	Input	10	Right	F8	F8	99999998, 99999999
v15a_05	55	totaal aantal mdwers 2005	Scale	Input	5	Right	F3	F3	8888, 999, 9999
v15a_06	56	totaal aantal mdwers 2006	Scale	Input	5	Right	F3	F3	9999
v15a_07	57	totaal aantal mdwers 2007	Scale	Input	5	Right	F3	F3	8888, 999, 9999
v15a_08	58	totaal aantal mdwers 2008	Scale	Input	7	Right	F4	F4	8888, 999, 9999
v15a_09	59	totaal aantal mdwers 2009	Scale	Input	7	Right	F4	F4	8888, 999, 9999
v15a_10	60	totaal aantal mdwers 2010	Scale	Input	7	Right	F4	F4	8888, 999, 9999

v14_05	61	v25a Bedrijfsresultaat 2005	Scale	Input	4	Right	F1	F1	8, 9
v14_06	62	v25b Bedrijfsresultaat 2006	Scale	Input	4	Right	F1	F1	8, 9
v14_07	63	v25c Bedrijfsresultaat 2007	Scale	Input	4	Right	F1	F1	8, 9
v14_08	64	v11a Netto bedrijfsresultaat Jaar 2008	Nominal	Input	6	Right	F1	F1	8, 9
v14_09	65	v11b Jaar 2009	Nominal	Input	6	Right	F1	F1	8, 9
v14_10	66	v11c Jaar 2010	Nominal	Input	6	Right	F1	F1	8, 9
v20aa	67	v20aa Hoe is uw bedrijf gevestigd? a op een bedrijvenpark (industrieterrein, science park of kantorenpark)	Scale	Input	5	Right	F1	F1	-99
v20ab	68	v20ab in een bedrijfsverzamelgebouw of business incubator met gemeenschappelijke voorzieningen	Scale	Input	5	Right	F1	F1	-99
v20ac	69	v20ac in een (kantoor) gebouw zonder gemeenschappelijke voorzieningen	Scale	Input	5	Right	F1	F1	-99
v20ad	70	v20ad In een autonoom bedrijfspand uitsluitend voor uw bedrijf bestemd	Scale	Input	5	Right	F1	F1	-99
v20ae	71	v20ae In/aan uw woonhuis zonder gescheiden adres	Scale	Input	5	Right	F1	F1	-99
v20af	72	v20af anders, namelijk:	Scale	Input	5	Right	F1	F1	-99
ut	73	gevestigd op universiteitsterrein?	Nominal	Input	10	Right	F8.2	F8.2	-98,00, -99,00
oN	74	Overig Nijmegen, exclusief het Mercator Science Park/universiteitsterrein?	Nominal	Input	10	Right	F8.2	F8.2	
oNg	75	Overig Nijmeegs stadsgewest (< 25 km), exclusief Nijmegen en universiteitsterrein?	Nominal	Input	10	Right	F8.2	F8.2	
eNb	76	Elders in Nederland, buiten het Nijmeegs stadsgewest ?	Nominal	Input	10	Right	F8.2	F8.2	
cluster	77	situering ten opzichte van/clustering rond de Radboud Universiteit	Nominal	Input	10	Right	F8.2	F8.2	-99,00

UT_MCB	78	located on university grounds in a multicompany building?	Nominal	Input	10	Right	F8.2	F8.2	-98,00, -99,00
Nijm_CBP	79	Conventional business park in Nijmegen?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
Nijm_MCB	80	Nijmegen outside university campus multi company building?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
Nijm_SO	81	Nijmegen stand alone company?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
Nijm_HM	82	Nijmegen home business?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
Ned_CBP	83	Netherlands outside Nijmegen on business park?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
Ned_MCB	84	netherlands outside Nijmegen in multi company building?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
Ned_SO	85	Netherlands outside Nijmegen stand alone company?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
Ned_HM	86	Netherlands outside Nijmegen home business?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
v11efgh_count	87	<none>	Nominal	Input	15	Right	F8.2	F8.2	
v11efgh	88	Gebruik van kennis en informatie van wetenschappelijke kennisinstellingen voor innovatie	Scale	Input	10	Right	F8.2	F8.2	
v11e_count	89	<none>	Nominal	Input	12	Right	F8.2	F8.2	
v11e	90	gebruik informatie RU	Scale	Input	10	Right	F8.2	F8.2	
v11e0408	91	<none>	Scale	Input	10	Right	F8.2	F8.2	
v11e0411	92	<none>	Scale	Input	10	Right	F8.2	F8.2	
v11e0811	93	<none>	Scale	Input	10	Right	F8.2	F8.2	
v11e_growth	94	development through time use of information from Nijmegen University	Scale	Input	13	Right	F8.2	F8.2	
v11e_begin	95	Gebruik van informatie RU bij eerste deelname aan het onderzoek	Nominal	Input	12	Right	F8.2	F8.2	
v11efgh04_count	96	<none>	Nominal	Input	17	Right	F8.2	F8.2	
v11efgh04	97	<none>	Scale	Input	11	Right	F8.2	F8.2	
v11efgh08_count	98	<none>	Nominal	Input	17	Right	F8.2	F8.2	
v11efgh08	99	<none>	Scale	Input	11	Right	F8.2	F8.2	
v11efgh11_count	100	<none>	Nominal	Input	17	Right	F8.2	F8.2	
v11efgh11	101	<none>	Scale	Input	11	Right	F8.2	F8.2	
v11efgh0408	102	<none>	Scale	Input	13	Right	F8.2	F8.2	
v11efgh0411	103	<none>	Scale	Input	13	Right	F8.2	F8.2	
v11efgh0811	104	<none>	Scale	Input	13	Right	F8.2	F8.2	

v11efgh_growth	105	development through time use of information from scientific institutions	Scale	Input	16	Right	F8.2	F8.2	
v11efgh_begin	106	Gebruik van informatie van wetenschappelijke kennisinstellingen bij eerste deelname aan het onderzoek	Scale	Input	15	Right	F8.2	F8.2	
v11efhg_begin	107	<none>	Scale	Input	15	Right	F8.2	F8.2	
v7c_all	108	<none>	Nominal	Input	10	Right	F8.2	F8.2	
Overig1	109	Overige spin-offs (niet op science park, niet op bedrijvenparkelders in Nijmegen en niet op bedrijvenparkelders in Ned)?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
Overig2	110	Overige spin-offs niet in MCB niet in bedrijfsverzamelgebouwelders in Nljmege en nietin bedrijfsverzamelgebouw buiten Nijmegen?	Nominal	Input	10	Right	F8.2	F8.2	-99,00
v11b0408	111	<none>	Scale	Input	10	Right	F8.2	F8.2	
v11b0411	112	<none>	Scale	Input	10	Right	F8.2	F8.2	
v11b0811	113	<none>	Scale	Input	10	Right	F8.2	F8.2	
v11b_count	114	<none>	Nominal	Input	12	Right	F8.2	F8.2	
v11b	115	gebruik informatie van afnemers	Scale	Input	10	Right	F8.2	F8.2	
v11b_growth	116	development through time use of information from customers	Scale	Input	13	Right	F8.2	F8.2	
v11b_begin	117	Gebruik van informatie afnemers bij eerste deelname aan het onderzoek	Nominal	Input	12	Right	F8.2	F8.2	

Variables in the working file