

Knowledge Spillovers in a Regional Ecosystem: Cognitive Interaction in an Industrial Complex

A CASE STUDY INTO CROSS-OVER ACTIVITY IN THE ARNHEM,
NIJMEGEN, WAGENINGEN REGION

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THE ECONOMIC BOARD | THE RADBOUD UNIVERSITY

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Preface

Hereby I proudly present the culmination of my academic career, my master thesis research. With the finishing of my thesis, I officially am ready to transition over from my days as a student to the beginning of my professional career. The different internships I have done combined with the years I spent at the university have formed me into the person I am today. Over the course of the years, with the passing years, it became ever more apparent what path I would take within the field of human geography. Now after finishing my thesis, I feel confident in saying I am qualified to call myself an economic geographer.

This result could never have come into existence without the persons who agreed for me to interview them. I would also like to thank my internship organization The Economic Board and my thesis supervisor Arnoud Lagendijk for believing in me and helping me in realizing the final product. Lastly I would like to thank my wife Alisa for supporting me in my study endeavors, allowing me to focus on finishing my thesis and graduating. My time at the Economic Board has been extremely invaluable, I was not treated as an intern but as a full-fledged employee. This has helped me develop myself as a young professional. At the same time it increased the expectations that people had of me. I relish the opportunities that have been given to me.

Abstract

This thesis aims to contribute to the body of industrial complex literature as well as the related variety literature. The thesis addresses how related and unrelated industries within a regional ecosystem are able to make use of regional knowledge spillovers through means of cross-over activities. By analyzing the embeddedness of firms, this thesis determines the added value of the regional context in both their core business as well as their cross-over activities. This thesis builds on the works of Hess (2004) and Granovetter (1985) with regard to how the research uses and defines the term embeddedness. For inter-firm interaction to be possible, e.g. to engage in cross-over activity, firms need to have a degree of cognitive proximity in order to be able to understand each other (Cohen & Levinthal, 1990). A firm's absorptive capacity determines to what degree external knowledge can be utilized to expand that firm's technological knowledge base. The thesis uses both inductive research methods (Markusen, 1996), as well as deductive research methods (Gordon & McCann, 2002; Tully & Townsend, 2002). The former is used to analyze the stickiness of the region and the spatial structuring of the clustering, while the latter is used to for a more process orientated view on the spatial structuring.

The area of interest of this research, the case study area, is the Arnhem, Nijmegen & Wageningen region. Governmental policy in this region focuses on the food, health and energy sectors. This research has expanded the focus to also include the bio-based and semi-conductor / high-tech sectors. The main anchor points for the regional ecosystem are the two universities in the region in case of the food and health sectors. The semi-conductor / high-tech sector as well as the energy sector have their primary knowledge base outside of the region, this combined with the fact that capable personnel is hard to find regionally, threatens the regional embedding of these sectors in the long term. Cross-overs do not occur on a systematic basis, instead the hyper-local scale seems to be the optimal scale for stimulating cross-over activity. At the hyper-local scale, the scale of the campus and the industrial park, knowledge spillovers are more likely to occur. The proximity allows firms of different backgrounds to have a greater understanding of where they can potentially be complementary to each other, to achieve synergy. Firms in this study displayed the characteristics that are in line with the social-network model as developed by Gordon and McCann (2002). Moreover they displayed a high degree of network embeddedness, which bolsters their absorptive capacity. For firms to achieve local synergies, they need to be connected through such local networks. However the potential for related diversification effect or related variety as a business model is for the most part still underdeveloped. Despite the fact that the different sectors display areas of overlap, most of the R&D and investments remain for the core business, cross-overs are as of right now, still an afterthought.

Index

Preface	iii
Abstract	iv
Introduction.....	9
1.1 Background	9
1.2 Scientific relevance	10
1.3 Societal relevance.....	10
1.4 Internship.....	12
1.5 Research objectives and research questions	12
2. Theoretical framework	14
2.1 Industrial complex	14
2.1.1 Clusters or sectors.....	14
2.1.2 The Marshallian district and the Italian district.....	15
2.1.2.1 The characteristics of an Marshallian industrial district.....	15
2.1.3 Sticky places in slippery space.....	16
2.1.3.1 The hub-and-spoke district	18
2.1.3.2 The satellite platform	19
2.1.3.3 The state-centered district	20
2.1.3.4 Sticky mixes.....	21
2.1.4 Deductive cluster analysis.....	22
2.1.4.1 The pure agglomeration model.....	22
2.1.4.2 The industrial-complex model.....	22
2.1.4.3 The social-network model.....	23
2.1.4.4 Embeddedness	24
2.2 Technological relatedness and cognitive proximity	25
2.2.1 Technological relatedness	25
2.2.2 Related Variety.....	26
2.2.3 Knowledge transfer within an industrial complex.....	27
2.2.4 Absorptive capacity, cognitive proximity	28
2.2.5 Cross-overs	29
3. Conceptual model and operationalization	30
3.1 Conceptual model	30
3.1.1 Firm level	31

3.1.2 Institutional framework.....	31
3.1.3 Inter-firm relations	32
3.1.4 Industrial complex level	33
3.2 Operationalization.....	33
4. Methodology	36
4.1 Research strategy	36
4.2 Research methods.....	36
5. Regional profile: Arnhem, Nijmegen & Wageningen	38
5.1 Territorial demarcation of the case study area.....	38
5.2 Regional setting	39
5.2.1 demographical development.....	39
5.2.2 Institutional framework.....	43
5.2.2.1 Government.....	43
5.2.2.2 Semi government and non-governmental organizations	44
5.3 Economic performance	46
5.4 Sectoral setting	51
5.4.1 Hotspots.....	52
5.4.2 Champions.....	55
6. A closer look at the regional ecosystem	57
6.1 The regional sphere	58
6.1.1 Embeddedness	58
6.1.1.1 Societal embeddedness	58
6.1.1.2 Territorial embeddedness.....	61
6.1.1.3 Network embeddedness.....	64
6.2 Institutional framework.....	66
6.2.1 Institutional setting	66
6.2.1.1 Triple helix involvement	66
6.2.1.2 Regional economic governance	66
6.3 Inter-firm sphere.....	67
6.3.1 Inter-firm relations	67
6.3.1.1 Cross-sector opportunities	67
6.3.1.2 External linkages.....	69
6.3.1.3 Innovation climate.....	70

6.3.1.4 information sharing.....	71
6.3.2 Cognitive proximity	71
6.4 Firm sphere.....	72
6.4.1 Technological knowledge base	72
6.4.1.1 R&D	72
6.4.1.2 External funding	74
6.4.2 Spillovers of competitors knowledge	75
6.4.2.1 Competitor overview	75
6.4.2.2 Information sharing	75
6.4.3 Future outlook.....	76
6.4.4 Absorptive capacity.....	76
6.5 Regional stickiness	77
6.5.1 Inductive elements	77
6.5.2 Deductive elements	78
6.5.3 Measure of stickiness and embedding	78
7 Conclusion.....	80
7.1 Answering the research question.....	80
7.1.1 Context	80
7.1.2 Sub questions	80
7.1.3 Main research question.....	82
7.2 Recommendations for the Arnhem, Nijmegen & Wageningen region.....	84
7.3 Recommendations for future research	85
7.4 Reflection on the research	86
Literature	87
Statistical Data and figures.....	92
Appendix I Table explanations.....	94
Appendix II Empirical data collection – List of interviewees	95
Appendix III Theoretical framework extended	96
1. The traditional artisan model	96
2. The dependent subcontractor model.....	96
3. The model of the Industrial district Mark I	96
4. The model of the industrial district Mark II	97
5. Hypothesized Features of New Industrial District Types	98

Introduction

1.1 Background

Throughout history we can identify specific technological innovations that significantly changed the way of life. These innovations have changed the time-space convergence, changed the perceived distances between A, and B. These innovations have led to the creation of a vast complex network of economic trade, and global entanglement (Dicken, 2011). Commercial aviation and container shipping provided means to both travel long distances, and a cheap, and efficient way to ship goods all around the world. This allowed for a global world market to emerge, the process of globalization. But it was not until the digital age, the age of ICT, that global integration became so effortless. Information is able to flow fluently, without friction, leading to the assumption that companies can be anywhere in the world, able to share knowledge at zero cost regardless of their location (Bathelt, Malmberg, & Maskell, 2004). This has fueled the assumption that the importance of locality has severely decreased in the globalized world. This hyper globalist view embraces the global market and decreased role of the nation state (Held, McGrew, Goldblatt, & Perraton, 1999). Other scholars however argue that the importance of the *local* has actually increased. Metcalfe and Diliso (1996) argue that despite the shrinking time-space convergence, and technologies such as ICT, the conditions of knowledge accumulation are highly localized. Florida (2005) argues that the world has become spiky, with certain cities or regions being able to attract a critical mass of creative talent, stimulating innovation and economic growth. Time-space shrinking technologies have increased the attractiveness of megacities such as New York, Paris, and London, taking advantage of increased innovation returns, contributing to the 'spikiness' of the world (Florida, 2005). Markusen's work on "Sticky Places in Slippery Space" (1996) explains how in the globalized world it is a paramount to be able to retain and attract economic activity. She argues that only those places that can achieve some form of 'stickiness' can stay competitive. Failing to do so could in the long term be detrimental for a region's outlook and can lead to a decrease in economic activity. One way of combatting this is by examining the degree of embeddedness of firms (Granovetter, 1985; Hess, 2004). For the local to capturing global opportunities and stimulating regional economic growth focusing on the *territorial* embeddedness of firms can provide an effective tool (Amin & Thrift, 1995; Harrison, 2007). In the globalized world, the role of the local then seems to have become more important if anything. Research into successful examples such as Silicon Valley ((Arita & McCann, 2000; Suarez-Villa & Walrod, 1997)) and the Third Italy ((Amin, 1989; Traù, 1997, 1998)) have provided, analytically and empirically, both a new and a renewed focus for the role of space in more general questions of contemporary economic growth (Gordon & McCann, 2000).

Following these examples many regions and countries have chosen to formulate strategic agenda's, cluster policies and / or regional economic policies. The European Union adopted smart specialization strategies (Foray, David, & Hall, 2009; Foray & Goenaga, 2013; Foray & Van Ark, 2007) in their Europe 2020 strategy (Commission, 2010), while other strategies might be more inspired by the work of Porter (Porter, 1990a, 1998) on regional competitiveness and the role of clusters. In 2010, the Netherlands adopted the topsector

policy, outlining several sectors that are deemed key to the competitive position of the Netherlands. In line with Europe 2020 strategy, smart specialization strategies have also been formulated in a great many Dutch regions. The Arnhem, Nijmegen & Wageningen region is home to a number of topsectors with the most important being Agrofood, Health and Energy, as well as three network organizations that correspond with them in Food Valley, Health Valley and kiEMT. These sectors and organizations all operate in triple helix constellations (Leydesdorff & Etzkowitz, 1998) and are therefore embedded to a certain degree in the region. In order to stay competitive or even become more competitive, the region needs to keep innovating. By focusing on realizing the potential that lies in cross-overs between these three industries, the region hopes to create new knowledge and expertise. This can strengthen the territorial embeddedness of firms and can potentially be a great vehicle for regional economic growth.

1.2 Scientific relevance

The debate surrounding regional economics is very broad and extensive. Concepts such as smart specialization (Foray et al., 2009; Foray & Goenaga, 2013; Foray & Van Ark, 2007), clusters (Porter, 1990a, 1998), regional innovation systems (Cooke, 2001), learning regions (Asheim, 1996), industrial districts (Becattini, 1990; Brusco, 1990) and related variety (Frenken, Van Oort, & Verburg, 2007) all stipulate the crucial role that regions play in achieving economic growth and innovation. Fritsch and Stephan (2005) explain how this body of literature claims that knowledge externalities are geographically discernable yet at the same time being unbounded, because geographical proximity facilitates local and global knowledge sharing and innovation (Asheim, Boschma, & Cooke, 2011). This has, coupled with the reality of globalization, led to a resurgence of the regional dimension in innovation policy (Fritsch & Stephan, 2005). Scholars such as Jacobs (1969a) have argued that a diverse regional structure is more likely to create knowledge spillovers and provide vital resources needed for innovation. While others such as Frenken et al. (2007) question the degree to which Jacob's notion of externalities in fact lead to a knowledge spillover between different sectors. This research seeks to contribute to this debate by shedding more light on how knowledge spillovers can occur between related and unrelated industries. The insights gained from this research, will help broaden the understanding on how key regional industries and regional innovation policies can stimulate cross-over innovation when focusing on knowledge spillovers between related and unrelated industries.

1.3 Societal relevance

From a societal standpoint the issue of cross-over potential is highly relevant. The Arnhem, Nijmegen & Wageningen is a polycentric region that lacks a true metropolitan area, and unlike some other regions, such as the Ruhr area or the Randstad, there is not a single or a collection of large agglomerations present. Instead, all centers in the region range from small to middle size. This means that the region does not have the advantages of scale, that a large metropolitan area has, nor does it have the same capacity to produce a melting pot of influences to the same degree. But nonetheless the region has around a million inhabitants, situated in a strategic location, with the Randstad to the West, and the Ruhr area to the East, the region is home to several universities, world-renowned knowledge and research centers and a

number of large corporations. Since the turn of the decade, the region has invested a lot of time and money in a number of triple helix constellations, tuning regional economic policy as part of the smart specialization strategies set out by GO Oost-Nederland (2013). GO Network organizations such as Food Valley, Health Valley and kiEMT were established to support and facilitate the process of innovation within the region. As of 21-04-2016, the municipalities of Arnhem, Beuningen, Berg en Dal, Doesburg, Druten, Duiven, Heumen, Lingewaard, Montferland, Mook en Middelaar, Nijmegen, Overbetuwe, Renkum, Rheden, Rozendaal, Rijnwaarden, Westervoort, Wijchen, Zevenaar have formed a coalition of the willing (GO) to further proliferate cooperation within the region (Overheid, 2016). This coincided with the founding of the Economic Board (EB), an organization with the board members coming from government, business and knowledge institutions. In cooperation with triple helix Food Valley they aim to stimulate cross-overs between the Food, Health & Energy sectors within the region. From a societal standpoint, it is important to answer the question how knowledge spillovers can be facilitated and stimulated between industries that are seemingly unrelated. How can such cross-overs be promoted and what steps need to be undertaken to create an ecosystem that facilitates the spillover of knowledge between unrelated and related industries within a region. Research into the cross-over network in the region and its economic structure can therefore contribute to the intertwining of these three sectors and help the development of a high quality environment that facilitates innovation and knowledge spillovers.

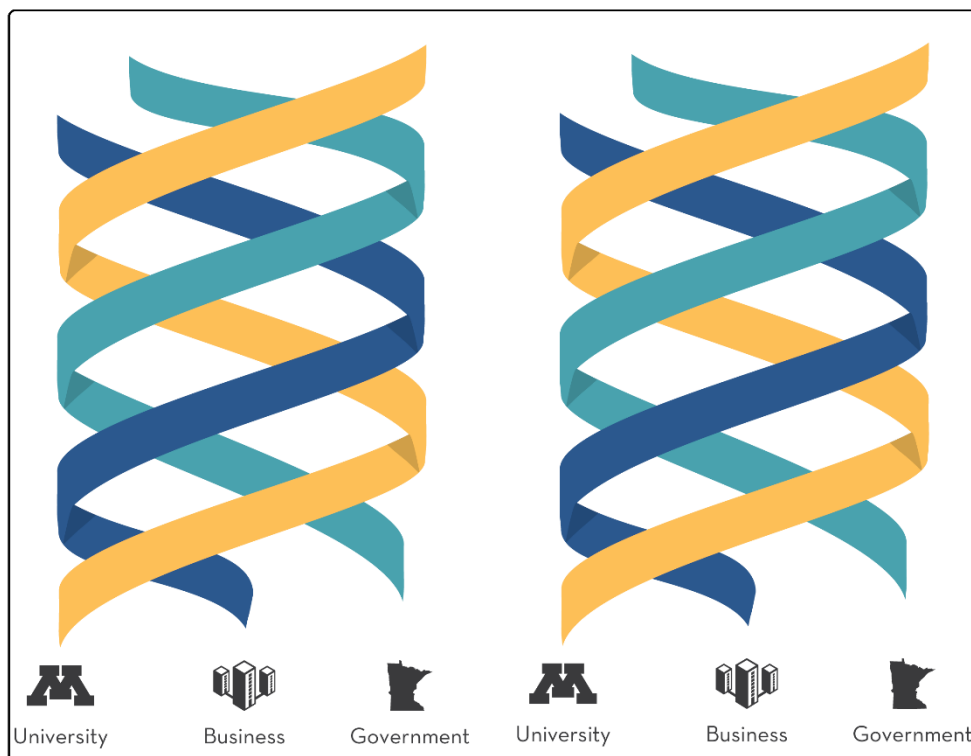


Figure 1 the 'double triple helix' (adapted from OPZuid 2014-2020)

1.4 Internship

As part of my research I will be embedded as a junior researcher at an organization. The organization that I will be embedded in is the Economic Board. Why the Economic Board? The Economic Board was established after businesses, knowledge institutions, the province of Gelderland and several municipalities in the Arnhem, Nijmegen & Wageningen region expressed the desire for more economic cooperation. Facilitating the process behind realizing more entanglement between the three major sectors in the region, Food, Health and Energy, is one of the core tasks of the Economic Board. My research therefore fits very well with the focus of the Economic Board.

During my internship I aim to do the following:

1. Map what firms are leading in their field, which firms are big, which firms are smaller

This allows for a better understanding of the regional economy and the power structure within the region.

2. How is cross-sector development prioritized by the different actors in the network

This involves studying documents and rapports from all actors involved (document analysis), in order to get a better grasp on the strategic focus of the actors involved.

3. Investigate what type of combinations are possible when looking at cross-overs between the Food, Health & Energy, Bio-based and high-tech / semi-conductor sectors

The data for this is generated through means of document analysis supplemented by interviews.

During my internship I will represent the Economic Board at business meetings, when visiting firms and when conducting field work. The ultimate goal is that this research can serve the development of a high quality ecosystem that allows for knowledge spillovers between different industrial sectors within the region.

1.5 Research objectives and research questions

This research does not solely revolve around theory, instead the research also has a strong practice orientated focus. As part of my seven month internship at The Economic Board this research aims to uncover how embedded firms are in the Arnhem, Nijmegen & Wageningen region and if and how cross-overs between different sectors in the region happen. Does a network exist of cross-over activity and if so how is it built up. How is power distributed within the network amongst these actors? Despite the fact that the regional focus from a governmental standpoint is formulated as being food, health and energy, this research will also include the bio-based and high-tech semi-conductor sectors in the scope of the research to be able to construct a more complete overview of the regional economy.

Therefore **the main goal** of this research will henceforth be:

“Improving the embeddedness of firms within the region and stimulating cross-over activity in order to stimulate innovative practices within a regional economy”.

In order to accomplish this **the main research question** will be as follows:

“How is cross-sector value being created, enhanced and captured, through means of a cross-over network, between the (related and unrelated) food, health & energy, bio-based and high-tech / semi-conductor sectors in the Arnhem, Nijmegen and Wageningen region?”

I have formulated a series of sub questions to help answer the main research question:

Sub questions:

1. *“How can related and unrelated industries absorb, and implement external knowledge”?*
2. *“How is the regional ecosystem embedded in the geographical context?”*
3. *“How are food, health and energy, bio-based and high-tech / semi-conductor firms in the Arnhem, Nijmegen & Wageningen region connected through a network and what can be done to improve these linkages?”*
4. *“To what extent are Food, Health and Energy, bio-based and high-tech / semi-conductor firms able to understand, absorb and implement external knowledge from the other sectors?”*
5. *“How well are firms facilitated in their ability to innovate by the government and other institutions?”*
6. *“What steps can be undertaken to improve cross-over activity in the Arnhem, Nijmegen & Wageningen region?”*

To answer the first sub question, the theoretical framework will cover how knowledge spillovers and external knowledge can be absorbed by related and unrelated industries. On the basis of this a choice will be made how to define the terms external knowledge, knowledge spillovers and absorptive capacity. To able to answer the fourth sub question, the region will be analyzed through means of industrial complex analysis. Because a regional profile needs to be established in order make any statement regarding the economic structure of the region, IC literature and relatedness literature will together form the basis for the analysis of the cross-over network and the firm’s abilities to establish said cross-overs. Through means of a qualitative research empirical data will be gathered to help answer sub question two, three, four, five and six. This means that on the basis of semi-structured in-depth interviews and document analysis is determined to what extent firms are able to absorb and implement external knowledge, how embedded firms are in the region and what steps can be taken to improve cross-over activity in the region. Eventually the main research questions will be answered by analyzing what insights can be gained from answering the sub questions, the document analysis and the empirical data analysis.

2. Theoretical framework

As I stated to earlier (§1.2), there are a great many concepts that in one way or another subscribe a certain amount of importance to the regional economy. I will not be using all of these concepts for this research as that would dilute the focus of the research, it would prohibit the research from establishing a clear and contained focus. The main issues for this research are twofold. Firstly, this research focusses on the cross-over network in the region. How do the actors in the network interact and cooperate with each other and does this lead to cross-overs. Secondly, this research focusses on how related and unrelated industries can absorb external knowledge, how local knowledge spillovers happen and how this leads to innovative practices through means of cross-overs. In order to be able to answer these questions, it is paramount to analyze the structure of the regional economy, why are firms located where they are and what value does that place has to these firms. As mentioned earlier, this will be examined by means of industrial complex analysis.

2.1 Industrial complex

Establishing how the regional economy is structured is an important element to uncovering the cross-over network in the Arnhem, Nijmegen & Wageningen region. In the current economic landscape, the focus on the regional economy has been greater than ever. In today's global economy places have become a parts of a much larger and complex system, facing competition not just from the local but also from the global. The notion then becomes that companies have become footloose, able to move their operation to those places that can provide the greatest benefits at the lowest costs. This represents a danger for regional economies. Having firms leave the region for other areas that can provide the same or better services for a lower cost, can therefore be a threat for the regional economy. Many economic geographers have argued however that the value of locality has actually increased rather than deflated. This idea is captured in the notion of industrial complexes or industrial districts. Within the industrial spaces literature, both inductive and deductive research methods are used to explain industrial clustering. The former focuses more on the structure of industrial clustering, puts more emphasis on the process of industrial clustering (Gordon & McCann, 2000). The following paragraphs will provide examples of both.

2.1.1 Clusters or sectors

We define our economy through a series of classifications as described in the Fisher-Clark model (Clark, 1940; Fisher, 1939). This model provides a hierarchy that separates the types of industries into farming and mining (primary), manufacturing (secondary) and services etc. (tertiary). Today these sectors are defined according to the Standard Industrial Classification (SIC), which uses the same principles as the Fisher-Clark model. This definition however has been met with some resistance in the past as being inflexibly and unable to take into account changes within the economy. But most importantly they fail to recognize the ever more blurring line between goods and service production (J. N. Marshall & Wood, 1995). Clusters however do not suffer from the same rigidity as the Standard Industrial Classification.

Instead clusters are comprised of a collection of inter-related firms centered on a specific technology or end market. Often within a cluster the emphasis will mainly be on supply chain linkages (both downwards as upwards), overflowing the conventional boundaries of defining sectors. Within such a cluster you can often find a support structure consisting of R&D, capital and policy support, training and education. The term cluster was coined by Michael Porter (1990b). His contribution to the economic geography brought the concept of the industrial of business cluster into main stream policy. Clusters distinguish themselves from sectors in a few ways; their geographical concentration in region, cities or state & their co-operation or sense of common interest. But despite this distinction the two terms are often interlinked (Tully & Townsend, 2002). Porters work on cluster model has greatly impacted government policy. There are however also critical voices such as Martin and Sunley (2003) who state that Porter's approach is too simplistic, they argue that Porter's diamond model is too poorly defined, being able to include a too wide range of economic activity. Other argue that instead of something new, Porter's diamond model is merely a re-discovery, Tully and Townsend (2002) argue that this is actually a reimagining of the industrial district as described by Alfred Marshal (1890). Research done by Tully and Townsend (2002) in the UK West Midlands found that a 'cluster' is more than just a collection of sectors, recognizing the role of interconnectedness and co-operation. For example seeing a move from an automotive sector to a 'transport technologies' cluster.

2.1.2 The Marshallian district and the Italian district

The earliest mention of industrial districts is in Alfred Marshall's Principles of Economics (1890). Marshall (1890) talks about the fortunes of groups of skilled workers who are gathered within the narrow boundaries of a manufacturing town or a thickly peopled industrial district. He stipulates that an industrial district should not solely focus on a single industry as that would make the region liable to extreme depression. Instead having a variety of employment is a chief cause of their continued growth (Marshall, 1890).

The Marshallian district is often referred to as the Italian district. In the second half of the previous century academics and student communities have closely studied the development of Italy and the role of small firms. Brusco (1990) has distilled those in four models, that describes the development of Italy and the role of small firms (see appendix III).

2.1.2.1 The characteristics of an Marshallian industrial district

Becattini (1990, p. 38) defines industrial districts as a socio-territorial entity which is characterized by the active presence of both a community of people and a population of firms in one naturally and historically bounded area. In the district, unlike in other environments, such as manufacturing towns, community and firms tend to merge. Industrial districts differ from generic "economic regions" in the fact that the dominant activity in industrial districts is as the name implies industrial. Becattini (1990) states that due to an increasing surplus of final products that cannot be sold in the district and increasing problem of putting this surplus on the world-wide market, a permanent network of links between the

district and its suppliers and clients has to be created.

A strong aspect of an industrial district is the local community. Within the local community you have a relatively homogenous system of values and views. Becattini (1990) argues that the development of a system of values constitutes one of the preliminary requirements for the development of a district, and one of the essential conditions of its reproduction. In order to spread those values throughout the district, a system of institutions and rules must be developed (Becattini, 1990). It is important that in order for social interaction to be fruitful, the conflicts of interest between members of the district should be eliminated to the furthest extent. Becattini (1990) notes that this description closely resembles a “closed community”, he argues however that the “peculiarities” of the community will rather be reasons for pride and self-satisfaction. To ensure the vitality of the district, a regular influx of “fresh blood” is required. The success of some of the Italian districts can therefore be attributed to their ability to assimilate and the fact that immigration was for the most part a short-distance phenomenon (Becattini, 1990). Firms in an industrial district become territorially embedded overtime, their concentration is not by accident and cannot be attributed solely to pre-existing localizing factors, and this embeddedness can therefore not be conceptualized independently of its historical development (Becattini, 1990). An example of this are differences in production features from district to district. The firms in a Marshallian district for the most part belong to the same industrial branch. However Becattini (1990) notes that the term industrial branch needs to be explained in a broad sense. Marshall makes a difference between “main industry” and “auxiliary industry”, now they are often captured as vertical integrated branches.

2.1.3 Sticky places in slippery space

The early works on industrial districts is heavily influenced by the work of Alfred Marshall, § Appendix III gives us a broad description of the various forms of Marshallian districts as identified in Italy during the second half of the previous century. As mentioned before most of the research done prior to Markusen’s *Sticky Places in Slippery Space: A Typology of Industrial Districts* (1996) were primarily focused on Marshallian districts, or as Markusen (1996, p.294) describes it “flexibly specialized” or “new industrial district” (NID). (Best, 1990; Goodman & Bamford, 1989; Piore & Sabel, 1984; A J Scott, 1988a, 1988b; Storper, 1989). During the late 20th century interest in the topic of industrial districts picked up momentum with research into the success of Third Italy (Piore & Sabel, 1984; Sable, 1989), the film industry of Los Angeles (Storper & Walker, 1989), Orange County (Allan J Scott & Paul, 1990), and Silicon Valley (Saxenian, 1990, 1991, 1994). Markusen (1996, p. 294) gives the following explanation for the spike in interest: “economists, geographers, and economic development planners have sought for more than a decade for alternative models of development in which existing activities are sustained or transformed in ways that maintain relatively high wage levels, social wages, and quality of life”. Places which are able to achieve this she calls ‘Sticky Places’ (Markusen, 1996). Stickiness connotes both ability to attract as well as to keep, like fly tape, and thus it applies to both new and established

regions (Markusen, 1996, p.294). Markusen (1996, p.295) notes that despite a substantial body of work, empirical testing of the NID model has been surprisingly thin. Markusen (1996, p. 295) argues that:

The limits of the flexibly specialized new industrial district as an emergent paradigmatic form (a claim made by Scott (1988a, 1988b)) are best established by demonstrating that other industrial district profiles are both theoretically plausible and empirically demonstrable.

A common element of NID literature is their normatively favorable if implicit way of writing about the virtues of NID's in terms of providing good jobs, long term stability and dynamism (Markusen, 1996). Likewise Markusen (1996, p. 296) provides five points in which a 'sticky' place is normatively better than other regions:

1. If it ensures average or better-than average growth for a region as a whole over time;
2. Insulates a region from the job loss and firm failures of short-to-intermediate term business or political spending cycles
3. Provides relatively good jobs, ameliorates tendencies toward income duality, and prevents undue concentration of wealth and ownership
4. Fosters worker representation and participation in firm decision making
5. Encourages participation and tolerates contestation in regional politics

Markusen's *Sticky Places in Slippery Space: A Typology of Industrial Districts* (1996) provides us with a framework to measure 'stickiness', as well as a broadened understanding of the type of industrial districts. Markusen sought to identify what regions and under what conditions were able to create these so called 'Sticky Places'. Markusen used an inductive method to identify which places and under what circumstances different regions in the US were able to flourish. The study ultimately identified four different type of district, the Marshallian district and three other forms of industrial districts:

1. The Marshallian district
2. The hub-and-spoke district
3. The satellite platform
4. The state-centered district

Appendix II provides a description of the hypothesized features of these industrial districts (Markusen, 1996, p. 298-299) and Figure 2 gives a schematic representation of the first three models (Markusen, 1996, p.297). In the following sections the three remaining industrial districts will be examined in-depth.

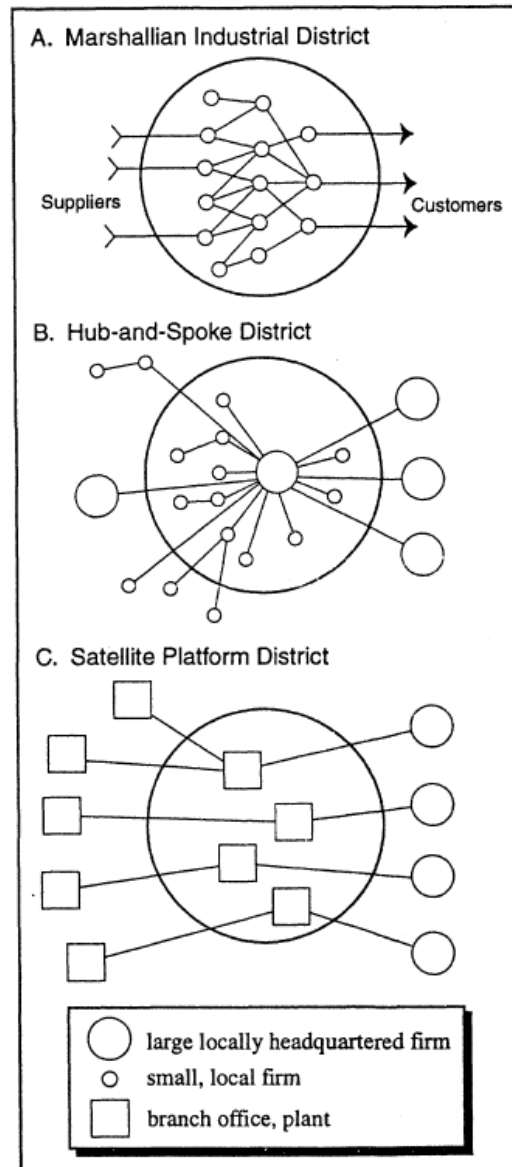


Figure 2 Firm size, connections, and local versus nonlocal embeddedness (Markusen, 1996, p.297)

2.1.3.1 The hub-and-spoke district

Hub-and-spoke districts differ from the Marshallian district in the make-up of the district. A Hub-and-spoke district is a region where a number of key firms and/or facilities act as anchors or hubs to the regional economy, with suppliers and related activities spread out around them like spokes of a wheel (Markusen, 1996, p.302) The dynamic within the district is influenced by the position these anchor firms have on the national and international market. The anchor firm has the highest position within the hierarchy of the industrial district. If the mass of agglomerated skilled labor and business services around the anchor firm

reaches critical proportions, it can lead to new firms having less and less connections to the hub firm. Instead benefiting from the urbanization and agglomeration economies they have created (Markusen, 1996, p.302). The structure of the hub-and-spoke district therefore is characterized by a collection of large vertically integrated firms, operation within one or more sectors, with connecting smaller and less powerful suppliers. The relationships within the hub-and-spoke districts can either be strongly linked, where the smaller firms are reliant upon the anchor firm for either market or supplies. Or the relationships can be looser, where small firms enjoy the agglomerative externalities of the larger organization's presence without necessarily buying or selling to them (Markusen, 1996, p.302). Within the hub-and-spoke district you often have inter-district cooperation, albeit on the terms of the hub firm. The power of the hub firm also influences the labor market, as workers are likely to trade jobs at smaller firms for jobs at the hub firm, when the opportunity arises. This makes it harder for smaller firms to retain talented workers and survive in the market as a result (Markusen, 1996, p.302). Governance structures within hub-and-spoke districts are often underdeveloped and trade associations that do exist are weak. Hub firms are mostly involved with local and national politics regarding topics that influence their core business (Markusen, 1996, p.302). The reliance upon these hub firms can form a danger for the long-term survival of the district. Markusen (1996, p.303) notes that the measure of stickiness is closely related to the ability of mature sectors to release resources into new sectors. The prime example of the danger of a hub-and-spoke district is the way Detroit developed in the 20th century. Due to oligopolistic rigidity and the tight control over Detroit's resources the city failed to branch out into new sectors, which, combined with increasing competition from Japan and South Korea, greatly negatively impacted the stickiness of Detroit. Ultimately the city could not compensate for the decrease in economic activity generated by the automotive industry. Seattle can be seen as an example of how diversification can be beneficial for a hub-and-spoke district. Boeing, the largest company in the world in the aerospace industry, is the clear cut lead firm in the Seattle area, as a company has several unique features, which have helped diversify the regional economy in to other sectors-port-related activities, software, biotechnology-positioning it well to withstand retrenchment and global decentralization in the aircraft industry (Gray, Golob, & Markusen, 1996). Hub-and-spoke networks in general can be characterized as having a strong income distribution. The market position of the anchor firm generally leads to a good returns on capital and investments. The sheer size of the companies in the district may also reflect natural economies of scale. This can lead to high labor productivity and distribution of wages (Markusen, 1996).

2.1.3.2 The satellite platform

The third variant of an industrial district is the satellite platform. A satellite platform can be defined as a congregation of branch facilities of externally based multi-plant firms (Markusen, 1996, p.304). These are often found outside of the major conurbations, either established by national governments or local governments with the goal to stimulate regional development and at the same time lowering the cost of business for competitive

firms are experiencing relatively high urban wage pressure, rents and taxation ((Markusen, 1996). Occupants of satellite platform can range from basic assemblage functions to sophisticated research, the only given is that they should be able to operate on a more or less “standalone” basis, detachable spatially from either up- or downstream operations within the same firm or from agglomerations of competitors and external suppliers or customers (Glasmeier, 1988). The satellite district is characterized by large, externally situated firms, making decisive investment decisions. Within the district minimal intra-district trade happens nor do conversations take place among platform tenants (Markusen, 1996). The satellite district differs from the hub-and-spoke district in the fact that firms inside the satellite district do not share risk, stabilize the market, or engage in innovative partnerships. Firms inside satellite districts can be seen as having non-place embeddedness displaying a strong relation with the parent company. These firms often have high migration rates with talented personal coming in and out of the district. Typically only blue- and pink collar workers are sourced locally (Markusen, 1996). Despite the fact that economic growth in such districts can be achieved through attracting suppliers to the district and stimulating local entrepreneurship, the growth of most satellite districts is still tied to the district’s ability to attract and retain tenants (Howes, 1993). Markusen (1996, p.305) notes that the development of a satellite platform is constrained by a number of features. Firstly, the main sources of finance, technical expertise, and business services are external to the region, furnished through corporate headquarters. The local infrastructure is often not in place to help deal with issues such as management training and marketing issues (Markusen, 1996, p.305). A strong national or local government can only partially compensate for this. Secondly the future growth of a satellite platform is inherently tied to the portability of plants and activity to similar constructed platforms. The measure of stickiness for a satellite platform is tied to the knowledge intensity of the platforms main activity and the extent to which large capital investments have been made in the satellite platform (Markusen, 1996, p.305). The income distribution in a satellite platform differs from good to intermediate though the entry of such a platform into previously depressed regions has, in all studied countries, contributed to higher overall capita incomes (Markusen, 1996, p.305).

2.1.3.3 The state-centered district

The fourth and last type of industrial district is the state-centered district. The state-centered district can be defined as a public or nonprofit entity, be it a military base, a defense plant, a weapons lab, a university, a prison complex, or a concentration of government offices, is a key anchor tenant in the district (Markusen, 1996, p.306). This type of industrial complex is, as Markusen (1996, p. 306) argues, very difficult to theorize. She notes that contingencies particular to the type of activity involved color its operation and characteristics. The schematic representation of a state-centered district resembled that of a hub-and-spoke district in figure 1, though some state-centered districts may display fewer links to the regional economy, making them more closely resemble the satellite platform (Markusen, 1996). The economy is a state-centered district enjoys many of the benefits the economy of

scale brings with it. The anchor organizations in a state-centered district is so large that a sector of suppliers usually grow around the district, relative to the level of public expenditure. The level of cooperation between the anchor organization and the suppliers and its costumers depends on the type of organization. In the case of regional capitals or universities, you may encounter a fairly high degree of cooperation. But in the case of national facilities the threat of exodus is much higher (Markusen, 1996). The labor market is centered on the activity that the district is hosting. It ranges from externally oriented for higher-skilled occupations for universities and national facilities. To blue-collar and unskilled positions in the case of military bases (Markusen, 1996). Local firms play far less of a role in the state-centered district compared to the hub-and-spoke and Marshallian district. Firms do not cooperate to the same degree as firms would in a Marshallian district to stabilize the markets or hedge against risks (Markusen, 1996). Instead long-term growth in a state-centered district depends on two factors: the prospects for the facility at the core of the region, and the extent to which the facility encourages growth within the region by spawning local suppliers, spinning off new businesses, or supplying labor or other factors of production to the local economy (Markusen, 1996, p. 307).

2.1.3.4 Sticky mixes

In the previous paragraphs, I have described a number of different industrial districts. Each district has a distinct make-up, and has distinct ways of operating. In practice, identifying these different districts is less clear cut than the models presented in figure 2 suggest. Markusen (1996, p. 307) notes that in the United States, for instance, most rapidly growing industrial regions do not exhibit the characteristics of the Third Italy. She continues to explain how in Japan, South Korea, and Brazil, finding a rapid growing industrial district is difficult outside of the major metropolitan areas. Often these metropolitan areas owe their stickiness to a combination of hub firms, industries, satellite platforms and / or state anchors (Markusen, 1996). Therefore the models that were previously described are suggestive rather than definite products. Many places, especially larger metropolitan areas, possess traits common to all four models (Markusen, 1996). The prime example of this is Silicon Valley. Silicon Valley on the surface would seem like a traditional Marshallian district revolving around electronics (Saxenian, 1994). But Silicon Valley is also home to multiple import hubs, to platform type branch sites and has it become a large recipient of military spending contracts (Golob, Gray, Markusen, & Park, 1994; Markusen, Hall, Campbell, & Deitrick, 1991; Saxenian, 1985). In reality there are a multitude of forces that determine the stickiness of a place. Industrial structures, state / regional governmental priorities, local and national politics, corporate strategies and profit cycles all influence the stickiness of a place. Markusen (1996, p. 309) acknowledges that studying the success of these sticky places cannot be studied merely at the local level as all actors involved are embedded in exterior relationships, which influences their commitment to the locality and their success there.

2.1.4 Deductive cluster analysis

In the previous paragraphs we have taken a closer look at the industrial clustering approach as used by Markusen (1996). This approach provides good examples of spatial structuring of different forms of so called 'sticky places'. But indicative to many inductive approaches the structures as observed by Markusen (1996) are difficult to apply to wide spectrum of places. In reality many of those 'sticky places' are a combination of different structures as illustrated by the Silicon Valley example. Other scholars favor a deductive research approach over the inductive approach as used by Markusen (1996). Gordon and McCann (2000) suggest three basic forms of industrial clustering: Pure agglomeration model, Industrial-complex model and Social-network model.

2.1.4.1 The pure agglomeration model

The first form as proposed by Gordon and McCann (2002), the pure agglomeration model, resembles the Marshallian district (§2.1.2.2), the model builds forth on the three rationales for the Marshallian industrial district. A common pool of highly skilled and specialized labor, the presence of non-traded infrastructure integral to an industry and a steady flow of information and ideas. There is nothing inherently spatial about this concept outside of the fact that a single large firm can attribute to a large concentration of local employment. This level of employment may cause the inception of new, external economies within a number of local firms that are concentrated in the sector, leading to 'localization' economies. Outside of the sector this can lead to the development of 'urbanization' economies (Gordon & McCann, 2000). This model is based purely on the advantage that proximity provides for firms inside of the district. Therefore co-creation and partnerships are rare if not non-existent in this model. The advantages that the economy of scale provides is paramount in this model. Due to the diverse mix of sectors this type of spatial clustering can prove to be rather resilient to abrupt shock within a certain sector (Mills, 1980).

2.1.4.2 The industrial-complex model

The second form of industrial clustering as proposed by (Gordon & McCann, 2000) is the industrial-complex model. The industrial-complex model closely resembles the pure agglomeration model while at the same time displaying some key differences. Unlike in the pure agglomeration model, industrial-complexes are characterized by sets of identifiable and stable relations among firms which are in part manifested in their spatial behavior (Gordon & McCann, 2000, p. 519). Historically these relationships were usually expressed through trade linkages though it was not long before the link between the location of a firm and production was questioned. It was Weber (1909/1929) who found that a favorable location could have a positive effect on transport costs and local production factors. During that period these transaction costs were believed to include just transport costs. Though recent discussions have advocated for the inclusion of both telecommunication costs (Salomon & Schofer, 1991) as well as logistics-costs (McCann, 1998). With the industrial-complex approach, the rationales for spatial industrial clustering is mainly due to individual firms wanting to reduce spatial transaction costs to the best of their ability. Locating in the vicinity

of other firms with a similar input-output production and consumption achieves this the best (Isard & Vietorisz, 1955; McCann, 1995). This model is essentially static and predictable in nature, and is primarily concerned with cost-saving in relation to production links (Gordon & McCann, 2000, p. 519). The industrial-complex can be regarded as a 'closed club', organized for the sake of increasing the profits of all members (Gordon & McCann, 2000). A good example of this model is Toyota City in Japan.

2.1.4.3 The social-network model

The last model as proposed by (Gordon & McCann, 2000) is different from the previous two models. It differs from the previous two models in the fact that this models does not originate from the school of economics but instead found it inception in the school of sociology. It was Granovetter (1985) who connected economic activity with sociological constructs. In his work he critiques the neo-institutional approach (Williamson, 1975, 1985). According to the neo-institutional school the emergence of hierarchical organizations and institutions was a rational response to opportunism present in a pure market economy and the problems bounded rationality was causing (Pitelis, 1993). In this perspective opportunism fades away as trust becomes institutionalized within the economic system (Gordon & McCann, 2000). Sociologists however argue that this trust gets replaced by the implicit and explicit contracts between agents (Harrison, 1992). The social-network model is the sociologists' response to the neo-institutional approach. The model argues that despite what economic models suggest intrafirm interaction is more chaotic then perceived while on the other hand interfirm interactions are more structured than perceived (Granovetter, 1985). Strong relationships can transcend firm boundaries, putting strong emphasis on the importance of interpersonal trust and the informality between relationships. The strength of these relationships can be described as the degree embeddedness of the social network. Gordon & McCann (2000, p. 520) argue that all economic relations are socially embedded as they depend on institutions, sets of assumptions and norms shared among a group of actors and are not, in themselves, simply the outcome of economic decisions. The level of embeddedness does differ however from model to model, as with industrial clusters, unlike with agglomeration clusters, there is an unusual level of embeddedness and social integration (Gordon & McCann, 2000). The social-network model in itself has no inherent spatial applications. The incentives to invest in a purely local network are limited, instead network development within agglomerations seems more favorable. Establishing a link with local nodes as well as potential other nodes international and national networks (Amin & Thrift, 1992).

Ultimately Gordon & McCann (2000) come to the same conclusion as Markusen (1996), stating that rather than regions being pure examples of one of the previously described models, it is far more likely that a combination of the three can be identified. For example both in the case of the social network, as in the case of the industrial complex, external benefits may become internalized within the group (Gordon & McCann, 2000). The social-network model however fundamentally different from the pure agglomeration model and

the industrial complex model on the basis that network relationships are not expressed through price signals nor organizational structures (Gordon & McCann, 2000).

2.1.4.4 Embeddedness

Building on the distinctions as detailed by Gordon & McCann (2000), and the level of sophistication of inter-firm behavior among firms, it seems useful to work towards a broader, more refined definition of the term embeddedness. Inter-firm behavior is closely related to the level of embeddedness of a firm. This sociological approach as developed by Granovetter (1985) was re-evaluated and re-conceptualized by Hess (2004). Up on till this point the term embeddedness has been used in a multitude of ways and is subscribed to different facets of firm behavior. Redefining what it means to be embedded could thus provide a more accurate ways to describe firm behavior. Hess (2004, p. 176) states that:

“If we agree that embeddedness basically signifies the social relationships between both economic and non-economic actors (individuals as well as aggregate groups of individuals, i.e., organizations), and economic action is grounded in ‘societal’ structures, then out of the confusing variety of meanings we can distill three major dimensions of what comprises embeddedness and who is embedded in what, as follows”.

1. Societal embeddedness
2. Network embeddedness
3. Territorial embeddedness

The societal embeddedness of an actor signifies the background and the culture of said actor. This ‘genetic code’ influences all the actions and decisions made by that actor. This genetic code or local culture is what makes up the identity of the actor, when acting on a global stage the actor carries that local culture with it (Hess, 2004). Actors are subject to bounded rationality, their perception shaped by their history, this creates a certain measure of path dependency for network actors. This cultural formation can act both as a constraint as an enabler for both the actor as the network structure (Emirbayer & Goodwin, 1994, p. 1440)

Network embeddedness is not bound by culture or spatial structure, instead it represents the network persons or actors are part off. One of the most important elements of network embeddedness is trust between actors. High levels of trust can be very beneficial to the success of business relationships. Embedding or disembedding in a network is therefore a process that is developed over time, it important to note that in this process spatiality does not form an obstacle. Proximity can provide advantageous benefits, such as face-to-face contact, but network embedding in itself between heterogeneous actors is possible regardless of location (Hess, 2004).

Territorial embeddedness however expresses to what extent an actor is anchored in a specific territory or place. Territorial embeddedness is the localized manifestation of networks or the nodes in global networks (Hess, 2004). The economic activity and social dynamics as a place are absorbed by an actor as they become embedded. This can provide both constrains as

advantages (Hess, 2004). For example pre-existing cluster networks can be beneficial for firms looking to locate in a certain region. Attracting and anchoring down firms from outside the region might generate new local or regional networks of social and economic relations, including both new and existing firms. In this context embeddedness then becomes an important vehicle to drive regional economic growth and capture global opportunities. (Amin & Nigel, 1994; Harrison, 1992). It must be noted however that regional economic growth can be severely jeopardized if a lead-firm decides to disembed itself from a region (Pike, Lagendijk, & Vale, 2000). Therefore the mode of territorial embeddedness and the level of commitment of an actor is an integral factor for value capture, enhancement and creation (Hess, 2004).

2.2 Technological relatedness and cognitive proximity

Having looked at both the spatial structure of industrial clustering, the process of industrial clustering, as well as the type of firm profiles present in industrial clusters. There is still a very important question that needs to be answered. The importance of knowledge creation, learning and the ability to learn with respect to the competitive position of both firms and regions has been well known. In this context the impact of proximity on learning, knowledge creation and innovation has been extensively covered (Amin & Wilkinson, 1999).

Understanding the role of proximity in innovation and understanding under what conditions interfirm and intrafirm knowledge creation, learning and spillovers can occur is thus paramount. Boschma (2005) stipulates that in order to enable effective knowledge transfer between firms, proximity on various dimensions is required. To accomplish this, firms need to overcome cognitive, social and geographical distances. These three dimensions combined with the measure of technological relatedness between firms represents a firm's ability to absorb, translate and implement external knowledge. In this paragraph we will take an in-depth look at how knowledge is transferred within an industrial complex, and look at in what way cognitive proximity, absorptive capacity impacts this process.

2.2.1 Technological relatedness

As mentioned earlier, effective knowledge transfer between firms requires proximity (Boschma, 2005). To interpret and implement external knowledge firms also need a certain measure of technological relatedness. This is why the growth of a firm can be regarded as a progressive process of related diversification (Penrose, 1959). Firms typically diversify into products that are related to their core business. An answer to why this happens lies in the concept of absorptive capacity. Cohen and Levinthal (1990) argue that a firm's ability to understand, absorb and implement external knowledge is impacted by how close that knowledge is to their own knowledge base. For knowledge to be successfully and effectively transferred between firms absorptive capacity and cognitive proximity is required (Nooteboom, 2000).

Thus, as Boschma, Frenken, Bathelt, Feldman, and Kogler (2012, p. 65) argue, innovation and

knowledge creation comes forth from feedback and interaction between firms and individuals, as long as they are related in terms of shared competences. There are a number of ways how industries can be technologically related (Boschma, 1999). Boschma et al. (2012) provide four different mechanisms of technological feedback. The first technological feedback causing mechanism across sectors is product-user relationships. New key inputs in components or energy sources may open up new technical opportunities, which bring about major innovations in user industries (Boschma et al., 2012, p. 66). The second technological feedback causing mechanism is caused by production-system interdependencies (Landes, 1969). Major innovations can create a situation in which the interdependent production system is imbalanced. To restore production balance, a search process is then started to innovate other, less efficient, parts of the system (Dahmen, 1991). The third mechanism is based on technological complementarity. This concerns major innovations that have to await complementary technological advances in other industries (Boschma et al., 2012, p. 66). An example of this is the technological breakthrough of electric lighting, which required breakthroughs in power transmissions, the measurement of electricity consumption and power stations (Rosenberg, 1982). The fourth mechanism concerns technical interdependencies between industries when they originate from a common technology. Like for instance the invention of synthetic dyestuffs leading to the inception of chemical sectors like pharmaceuticals, synthetic colors, photography, synthetic fibers and explosives (Boschma et al., 2012, p. 66).

At the end of the previous century, this rather descriptive overview of technological relatedness was followed up by an attempt to measure relatedness in a more quantitative measure (Boschma et al., 2012). This was done on several levels, such as the sector level (Fan & Lang, 2000), the national level (Hausmann & Klinger, 2007) and the plant level (Neffke & Henning, 2008).

2.2.2 Related Variety

Now that we have painted a clearer picture what added value technological relatedness has in the context of economic development, we can take a closer look at how it impacts regional development. As established earlier, there is a strong correlation between knowledge spillovers and proximity, as knowledge spillovers are often regionally bounded (Audretsch & Feldman, 1996). Therefore it is relevant to research how technological relatedness impacts knowledge spillovers effects on regional and urban growth. The assumption thus is that technological relatedness has a profound effect on the extent to which knowledge spillovers occur within a region (Boschma et al., 2012). The same train of thought can be found in the work of Jacobs (1969b), who championed economic diversity within cities as a way to foster new ideas and stimulate knowledge spillovers. She was one of the first to argue that a deep division in labor inside a city could provide a vehicle for innovation opportunities and urban growth (Boschma et al., 2012). The question then still remains whether knowledge spillovers really occur within a city just due to the proximity to other firms. Nooteboom (2000) argues that for knowledge spillovers between sectors to occur, the cognitive distance between them

needs to be at appropriate levels. Having too much cognitive distance means firms will not be able to effectively communicate and thus will not be able to have any meaningful knowledge spillovers. When the cognitive distance is too little, it means that firms are too close to each other's core business, potentially leading to a cognitive lock-in (Nooteboom, 2000). This brings us back to the assumption that technological relatedness or related variety is paramount to enable effective knowledge transfer between sectors (Frenken et al., 2007).

2.2.3 Knowledge transfer within an industrial complex

Having established the value of technological relatedness and the added value related variety for enabling effective knowledge spillovers, we can now look at what mechanisms of knowledge transfer exist within an industrial complex. Research done by Camuffo and Grandinetti (2011) looked how Italian industrial districts can be seen as a cognitive system. They built on the fundamentals of previous research into Italian industrial districts (see table 1 (Camuffo & Grandinetti, 2011, pp. 818-819)) From this they extrapolated four mechanisms of how interfirm knowledge transfer seems most frequent within Italian industrial districts:

1. inter-organizational and interpersonal relations;
2. the observation, aimed at imitation, of other district firms' artefacts and actions;
3. the mobility of human resources from one existing firm to another existing firm; and
4. the creation of new ventures through spin-off, i.e. the mobility of human resources from one existing firm to a newly born firm.

(Camuffo & Grandinetti, 2011, p. 820)

The first mechanism of inter-firm knowledge transfer often happens as buyer-supplier relations exchange technical and business information (Snehota & Hakansson, 1995) or informal know-how trading among competitors (Lissoni, 2001; Von Hippel, 1987). This type of knowledge circulation is not limited to the supply-chain or business relations. Camuffo and Grandinetti (2011) argue that this process can also be mediated by a third party, such as a laboratory providing services to two competing companies. Each node in the local network can then work as a cognitive relay (Camuffo & Grandinetti, 2011). Interpersonal relationships also bolster knowledge transfer when the overlap between social life and product activities begins to fade (Lazerson & Lorenzoni, 1999).

The second mechanism of inter-firm knowledge transfer, observation, aimed at imitation, of other district firms' artefacts and actions, is often aimed at imitating the product innovations of others (Cainelli, 2008). New products, from a cognitive point of view, embody both explicit and tacit knowledge, contingent on their architecture, they may be characterized by different degrees of knowledge encapsulation (Langlois, 2002).

If within a district there is a high degree of skilled worker turnover rate then cross-firm knowledge transfer allows for tacit knowledge to be spread within the district with a certain measure of ease. The lion share of inter-district tacit knowledge transfer is mostly simple, like technical know-how to improve machinery performance. Though at times even very complex knowledge is transferred such as secret recipes or formulas (Camuffo &

Grandinetti, 2011).

Extracting human resources from an existing firm or organization and transferring them to a newly established firm, or spin-off represents the fourth mechanism of inter-firm knowledge transfer. From a cognitive perspective, spin-offs are a form of knowledge transfer. They are the most common way in which knowledge gets transferred from firms that act as incubators for entrepreneurship to newly established firms (Agarwal, Echambadi, Franco, & Sarkar, 2004; Klepper & Sleeper, 2005). Spin-offs combine elements from all three other mechanisms of knowledge transfer (Camuffo & Grandinetti, 2011). Industrial districts are often characterized by a high degree of relationships that lead to knowledge transfer as described above in mechanism one through three. Employees who seek to quit and start their own business are able to benefit from that fact (Lipparini, 1995).

2.2.4 Absorptive capacity, cognitive proximity

Having the right measure of cognitive proximity between firms is, as explained above, crucial for effective knowledge spillovers or knowledge transfer. It is useful to discern how the process of knowledge transfer goes and determining what sub-processes can be identified. Camuffo and Grandinetti (2011, p. 823) identify three different sub-processes to knowledge transfer:

1. the transmission, whether intentional or not, of knowledge to the potential receiver
2. The receiving of knowledge by the receiver
3. The assimilation of knowledge

The ease of transfer between actors is dependent on the complexity of the knowledge that is being transferred. Some scholars (Reed & DeFillippi, 1990; Teece, 1986; von Krogh & Roos, 1996) argue a correlation between the level of tacitness of an innovative process and the measure of difficulty it is to imitate this process. Camuffo and Grandinetti (2011) argue however that it is knowledge complexity which hinders imitation, not knowledge tacitness. Through a series of mechanisms as explained in § 2.2.3, tacit knowledge can become explicit, such as through observation. Moreover tacit knowledge can be absorbed by firms through the transfer of human capital, even without being made explicit (Camuffo & Grandinetti, 2011). Tacit knowledge can be defined as not explicit yet (Spender, 1993). Tacit knowledge will not remain sticky forever. Instead, very complex tacit knowledge might not be possible to become articulated and explicit, due to a number of circumstances, in the short term (Cowan, David, & Foray, 2000). Absorptive capacity of the receiving organization can mitigate the hindrance that knowledge complexity can cause to the transfer process (Camuffo & Grandinetti, 2011). Or in other words the cognitive proximity between firms. The absorptive capacity of firms increases when the knowledge that is being transferred is related. Therefore technological relatedness between firms is vital for cognitive interaction. Nooteboom, Van Haverbeke, Duysters, Gilsing, and Van den Oord (2007) do however note that there is a positive effect on cognitive distance when firms engage in more radical,

explorative alliances. They found that there is value in the differences between firms in complicated alliances. The trade-off that firms have to make in this case is the opportunity of novelty versus the risk of being misunderstood. The optimal cognitive distance in such risky alliances is not fixed, rather it is dependent on one's past investment in building technological knowledge as a basis of absorptive capacity (Nooteboom et al., 2007). To summarize, cognitive proximity and cognitive interaction, represent, through their impact on absorptive capacity, the conditions under which the above-described mechanisms of knowledge transfer between existing firms may work effectively (Camuffo & Grandinetti, 2011, p. 825).

2.2.5 Cross-overs

Having discussed the implications of both technological relatedness, related variety, absorptive capacity and cognitive distance, it is now possible to theorize how cross-overs play a role in this. When looking at two different industries it is possible to create a matrix of what possible combinations are possible between those industries. For example when combining high-tech and food, it is possible to think of cross-overs ranging from the most disruptive innovations such as robots to replace human elements to smart solutions which complement rather than replace the regular worker. Cross-overs do not necessarily come forth from deliberate action, as they might occur as an unintended consequence from a knowledge spillover. Regional spillovers can provide the basis for cross-over activities if firms are able to translate the knowledge into a format that can be understood by said firm. Cross-overs can also occur when different industries share a common link in their supply chain or have related activities. In this sense the measure of technological relatedness between firms and the absorptive capacity of those firms provide the basis for the potential for cross-overs. Moreover having a high degree of related variety would in turn increase the likelihood of cross-overs occurring on an organic basis. Cross-overs can be seen as the intertwining of economic activity within a region or between sectors driven by a firm's desire to innovate in order to stay competitive.

3. Conceptual model and operationalization

The previous chapter has provided an extensive framework of theory and previously conducted research. This chapter will outline how this research will build upon the elements provided in the theoretical framework through means of a conceptual model. After that I will operationalize the model.

3.1 Conceptual model

This research intends to uncover how firms are able to make use of the of expertise and knowledge that resides in the Arnhem, Nijmegen & Wageningen region. In order to uncover

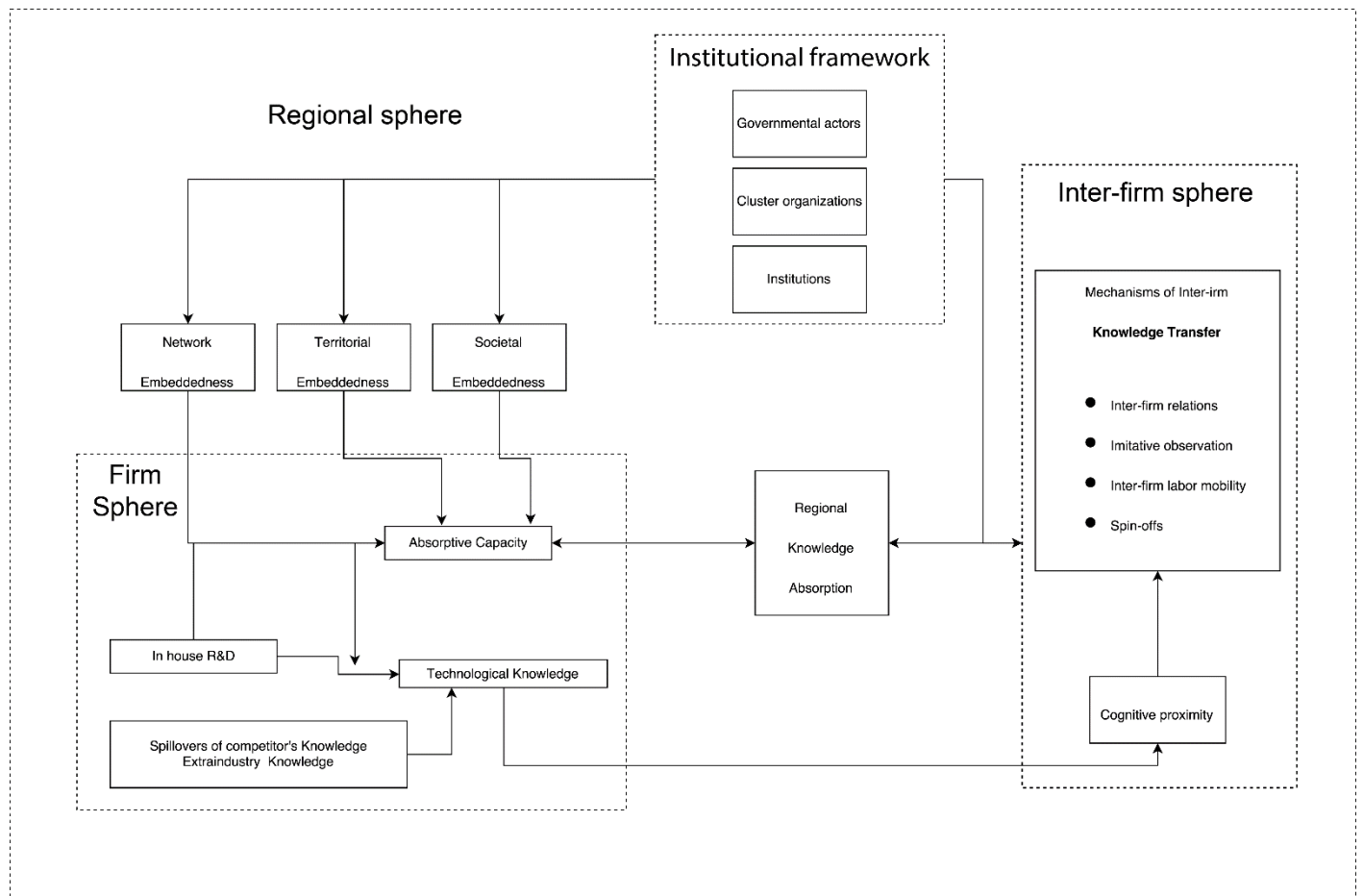


Figure 3 Conceptual model

this, it is imperative to map the network of these firms and measure their embeddedness. For knowledge spillovers to be successful between firms, firms need to be able to understand each other to be able to translate knowledge into a workable concept or product. Figure 3 shows the conceptual model as used for this research, the conceptual model combines different elements discussed in chapter 2. The conceptual model consists of three spheres. The outer sphere represents the region while the inner sphere is broken down into firm, inter-firm spheres and the institutional framework. The scope of the region is not fixed, the interpretation of the region can significantly differ from firm to firm, and some firms might operate on an international scale and thus experience the dimension of distance differently

than a small start-up firm that operates only in their direct vicinity. I will now shortly describe all the elements of the conceptual model.

3.1.1 Firm level

Every firm has some measure of expertise on any number of areas of industry. The assumption is made that each firm will always try and enhance their knowledge base in order to stay competitive in which ever field they are operating in. Building a knowledge base is often done through investing in R&D. Firms can also build their knowledge base by utilizing spillovers from knowledge that originates from competitors. The third place where knowledge can come from are other sources such as private research facilities or universities. Cohen and Levinthal (1990, p. 141) explain that

“A central feature of the model is that the firm’s absorptive capacity determines the extent to which this extramural knowledge is utilized, and this absorptive capacity itself depends on the firm’s own R&D”.

The model assumes that competitors knowledge can be exploited through the interaction of the firm's absorptive capacity with competitors' spillovers (Cohen & Levinthal, 1990, p. 141). Only through investing in a firm’s own knowledge base, e.g. investing in R&D, are firm’s able to utilize these spillovers. Firms are encouraged to invest in their absorptive capacity to take full advantage of the technological opportunities around them. In the past spillovers were seen as a deterrent to R&D (Arrow, 1962; Nelson, 1959; Spence, 1986). Cohen and Levinthal (1990, p. 142) however argue that:

“The more of its competitors’ spillovers there are out there, the more incentive the firm has to invest in its own R&D, which permits it to exploit those spillovers”.

Therefore regional knowledge spillovers can both occur because of the output of a firm (through in-house R&D or serve as the input for firms. Examples of this can be a firms’ decision to innovate their input stream to turn another firm’s waste product into high grade material that they can use as their input. A firm’s ability to learn is impacted by the measure of embeddedness that firm has. Boschma (2005, p. 66) argues that there is a positive link between socially embedded relationships and increased (innovative) performance. Relations between actors are socially embedded when they involve trust based on friendship, kinship and experience (Boschma, 2005, p. 66). For firms and organizations to learn social proximity is essential. The reason for this is that transferring tacit-knowledge often involves trust-based social relationships as doing this through markets is highly difficult (Lundvall, 1992; Maskell & Malmberg, 1999). This model therefore argues that a firm’s absorptive capacity is influenced by its embeddedness. The model uses the distinctions as provided by Hess (2004) as the origin of the embeddedness can differ depending on the individual relationships.

3.1.2 Institutional framework

For firms to effectively operate within a region, there needs to be an institutional framework that allows them to do so. Edquist and Johnson (1997, p. 46) use the following definition for

institutions: sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals and groups. The institutional setting acts as the glue for collective action because they reduce uncertainty and lower transaction costs (Boschma, 2005, p. 68). For firms to be able to learn and absorb knowledge, a stable environment is required institutional proximity can therefore act as an enabler to facilitate this process (Boschma, 2005). A strong institutional framework can however also hamper a region's ability to learn and innovate. Grabher (1993) for instance notes that with powerful institutional players might react to change in a very conservative and routinized way. These institutional actors can both affect the embeddedness of firms as the inter-firm relations. In other words an effective institutional framework needs to provide openness (providing opportunities for newcomers), institutional stability (reducing uncertainty and opportunities) and flexibility (experimenting with new institutions). This should be done in order to create a system of checks and balances (Boschma, 2005, p. 68).

3.1.3 Inter-firm relations

The second sphere is the inter-firm sphere. For it to be possible for firms to learn from each other, to benefit from regional knowledge spillovers a certain degree of cognitive distance is needed. Nooteboom et al. (2007, p. 2) give the following explanation for how cognitive distance works:

In first instance, as cognitive distance increases, it has a positive effect on learning by interaction because it yields opportunities for novel combinations of complementary resources. However, at a certain point cognitive distance becomes so large as to preclude sufficient mutual understanding needed to utilize those opportunities.

This links the firm sphere to the inter-firm sphere. For knowledge spillovers or effective and efficient cooperation between firms to take place the technological knowledge bases between both firms need to be compatible. This cooperation is also subjected to the measure of embeddedness of both firms as knowledge transfer occurs easier when there is a certain degree of cultural proximity and a common language (Maskell & Malmberg, 1999). Inter-firm relations can also be facilitated by triple helix organizations or other likeminded actors that operate within the institutional framework. This can be either in a formal setting or an informal setting. Within an industrial district socio-cultural the distance between actors is short, this allows actors in the district to communicate easily. This distance is what Camuffo and Grandinetti (2011, p. 827) as 'community proximity'. The transfer of knowledge spillovers within the district manifests itself in four different ways (Camuffo & Grandinetti, 2011):

1. Inter-firm relations
2. Imitative observation
3. Inter-firm labour mobility
4. Spin-offs

Knowledge is often spread across the different parties involved in inter-firm cooperation (Antonelli, 2000). To be able to effectively transfer and exploit this knowledge, a certain degree of absorptive capacity needs to exist within all parties involved. Perez and Soete (1988)

however note that there is a negative correlation between the cost of firms must make to acquire new technology and their current technological knowledge base. This means that when the cognitive proximity between firms is too great the cost of bridging that gap is not viable. But knowledge might also be transferred within a region or district without having been made explicit, as often tacit knowledge resides in people. For people to understand, communicate and process information successfully, that new information should be close to their cognitive base (Boschma & Lambooy, 1999). Thus the relationship between cognitive proximity and effective communication and knowledge transfer.

3.1.4 Industrial complex level

The third sphere is the industrial complex level or the regional level. How a firm operates in a region can be traced back to how embedded a firm is in a region. The more embedded a firm is in a region, the more value a location has to a firm. As mentioned earlier, I differentiate between three different forms of embeddedness, network, territorial and societal embeddedness. Network embeddedness represents a firm's network such as their suppliers, partners and any other actor a firm interacts with. Network embeddedness does not have a spatial dimension nor is it bound by culture. Territorial embeddedness on the other hand represents a firm's ties to a specific territory or region. This can be through owning physical assets such as real estate or social assets, key relations that make being in that specific place more value for a firm, like close relations with a local university. Societal embeddedness can be seen as the 'genetic code' of a firm. It represents the culture that exists within a specific place, a set of shared norms and values that enables local firms to more effectively understand each other or allow them to have a unified outward image. But also the origin and background of a firm.

These three forms of embeddedness all impact the way knowledge gets transferred within a region as relationships are always embedded through a network, through culture, through territory or through a combination of them. Or in other words a firm's embeddedness has a positive effect on their ability to generate and make use of knowledge spillovers within the region.

Regional knowledge spillovers and absorption are thus reliant upon the absorptive capacity of firms (and the cognitive proximity to other firms in the region) and their embeddedness. Improving either of those aspects will improve the regional absorption rate of knowledge spillovers.

3.2 Operationalization

Figure 3 provides the overview for the research. In order for the model to be translated into workable concepts, the model needs to be operationalized. The aim of the operationalization is four-fold. The first aim is to map the profiles of the firms associated with this research. The second aim is to assess how embedded firms are in the region, and how through that embeddedness knowledge gets transferred within the region. The third aim is to assess if and what provides a measure of stickiness for the region (see § 2.1.3). The fourth and last aim

is to assess how technological related firms are and how that relatedness impacts the potential for cross-over activity within the region (see § 2.2). But even before we can operationalize the conceptual model we need to clarify how some ambiguous concepts are used throughout this research. The first is the notion of 'the region'. The regional scale is an important notion in geography, but also a highly contested one. The terms that are used to describe the regional scale are often vague (Herod, 2011, p. 127), commonly placed between the national and the urban scale (Whitehead, 2007, p. 139). A region can be defined through a number of lenses. From an administrative standpoint the region is defined in the narrowest way. Or in other words only those areas that fall within the administrative jurisdiction. While when looking at the region as an ecosystem one can argue that the boundaries of said region has rather semi-permeable borders. What do I mean with semi-permeable borders? It represents how in an ecosystem some activities span over a larger area than other activities, meaning that the 'regional border' is a relative term, not a hard one. In practice this means that this research will work with a dual definition of 'the region'. On the one hand, an administrative definition is used as used by the government (for more in-depth information see §5.2). On the other hand, the region is loosely defined as the Arnhem, Nijmegen & Wageningen region without a clear demarcation of which municipalities do or do not belong to the region. The second term that needs more clarification before the final operationalization of the research can be done is the term 'cross-over'. When does something become a cross-over, how do we classify what is counted as a cross-over or not. Is something a cross-over when new markets are created or can we regard focusing on lowering the sugar levels in food also as a cross-over? In this research the term cross-over is defined as the interaction between two entities who operate in different sectors or industries, this interaction can be the result of deliberate actions or an unintended consequence.

The conceptual model will be operationalized according to the three spheres and the institutional framework. For the operationalization of the conceptual model, this research will use a set of eight different concepts, which will be worked out into definitions and indicators. Filling out the operationalization scheme, for each interviewed company, provides a profile of that companies activities, ties to the region and their measure of embeddedness. There are two important elements of the theoretical framework that are not explicitly explained in the operationalization and those elements are the absorptive capacity and the cognitive distance between firms. These two elements can only be answered after the interviews are done and analyzed. This research will not measure the absorptive capacity and the cognitive distance of every firm, instead an analysis will be made covering all firms that are interviewed. This analysis will be the basis of the aggregated measure of absorptive capacity and cognitive distance of these firms.

Sphere	Concept	Definition	Indicator	interview question
Regional sphere	Embeddedness	Location history		Why are you located in this region?
		Location advantages	Advantage of the location with regard to the supply chain	Does this location provide your firm with regard to your supply chain?
			Trade-linkages	How does your supply chain look like, how are your trade linkages?
			Infrastructure	Does this location provide your firm with regard to infrastructure?
			Points of improvement for the region	In what areas can this region improve according to you?
		What needs to be done to accomplish this?		
		Important partners	Location of the most important partners	Where are your most important partners located and how is that network built up?
		Local ecosystem		What type of business are important to have in the direct vicinity for your company?
				What (type of) business would you like to see coming to this region?
		Human Capital	The availability of qualified personal	How would you classify the quality of available talent in the region
Institutional framework	Institution setting	Triple helix involvement		Are you involved in triple helix
				Are you in frequent contact with the (local) government and if so how does or doesn't this support your business and local investments?
		Regional economic governance	The role of local government in the regional economy	How would you describe the role of the (local) government when it pertains to the regional economy?
Inter-firm sphere	Cognitive proximity			Determined on the basis of the interview
	Inter-firm relations	Cross sector opportunities	Diversification	How important is diversification for your business model?
			Involvement in cross-over activity	Are you involved in any cross-over activity, and if so what (local) expertise can provide an added benefit to your company?
				Do you see technological opportunities for your company through means of cross-sector appropriation?
				On what basis are you involved with (local) partners in these cross-overs, how does the governance structure look like?
		External linkages	Outsourcing	Do you outsource parts of your business, if so why?
		Innovation climate	Local practices of information sharing	How do you see local practices of sharing information between different parties?
		Information sharing	The role of trust	Does trust play a role in the decision whether to share information with an outside party, if so how can that trust be created / enhanced?
	Imitation		To what extent does information get transferred between competitors and how much if this is wanted / unwanted?	
Firm sphere	Spillover of competitors knowledge	External funding	Outside funding	Does your firm use of outside funding?
	Technological knowledge base		The usage of grants	Are you involved in consortia to acquire EFRO funding or other governmental grants?
			The ease of which to acquire funding	How would you describe the means to acquire funding locally?
	Are there (local) obstacles to acquire funding and how does that affect your firm's ability to compete with other (national / international) firms?			
		Spillover of competitors knowledge	Competitor overview	origin of competition
	Where does most of your competition come from? National or international companies?			
	Technological knowledge base	R&D	In-house R&D	Do you invest in R&D?
			Extra industry knowledge	Are you connected to any knowledge / research institutes, if so to what extent?
	Absorptive capacity			Determined on the basis of the interview
	Future outlook			What is the outlook for your company in the immediate future?

Table 1 Operationalization scheme

4. Methodology

In this chapter I will discuss what research strategies are used for this research. Following this the research methods are outlined and the reasons behind the choices are detailed.

4.1 Research strategy

As I eluded to earlier (§1.4) this research is conducted as part of my internship at The Economic Board. This internship period spans seven months and is broken up into two different parts. During the first part of my internship I will participate in the day-to-day operation of the EB. This helps me to gain more intimate knowledge of how the regional economy is structured, what the important actors are and above all allows me to embed myself in the network of the regional ecosystem. The EB provides this research with invaluable connections that really enhances the reach that this research can have. Bear in mind that the format of this research is a master thesis and therefore the scope of the research has to be very focused in order to get any meaningful results. Moreover the time frame for this research does not allow for a more extensive research. As such the choice has been made to interview a select number of firms as part of the case study about the regional ecosystem of the Arnhem, Nijmegen & Wageningen region. This case study will be done in two

Stake (1995, p. xi) describes a case study as ‘the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances’. Swanborn (2013, p. 22) provides six elements of a case study:

A case study is about the study of a social phenomenon,

- One or multiple owners of the phenomenon: people, groups, interacting people and groups

In its natural habitat

- In a fixed period, in which on several moments measurements are being done, or afterwards

when information about the developments in that period is being collected

- In which multiple data sources are being used, like documents, interviews and observations

In which the researcher is focused on a detailed description of stability and the change in

- numerous variables in order to discover the clarification of processes

In which these descriptions and clarifications are being tested

4.2 Research methods

Following the elements as provided above, this case study will be conducted in three different manners.

1. Through observation and embedding in the Economic Board, my internship location.
2. Through semi-structured interviews with a number of carefully selected actors.

3. Through statistical data collection regarding the economic performance of the case study area.

As the three different ways of doing research as noted above show, this research uses both quantitative and qualitative research methods. The triangulation of methods is important to be able to collect the necessary data for the case study. By using triangulation you ensure the validity of the research. Before the empirical data gathering started, an extensive literature study has been conducted to get more insight into the inner workings of regional ecosystems and industrial complexes. For this study academic literature has been used, both papers and books alike. The theoretical framework signifies the conclusion of this part of the research.

For the case study also nonacademic literature has provided important insight into the regional ecosystem such as regional policy documents, reports, newspaper articles and press-releases. During my internship I also came in contact with lots of different actors that operate in the regional ecosystem, those conversations serve as an observational basis for this research. These moments allowed me to build up a network of contacts that I can later utilize for the empirical data gathering. The direction where to gather my empirical data from has been heavily influenced by those experiences.

The empirical data collection is done through semi-structured interviews with experts. The interviewees are selected to give a good representation of the different sectors that are represented in the case study area. Meuser and Nagel (2002) explain how with semi-structured interviews it is not so much the person itself that is the main interest point of the interview, but rather they act as expert for a certain field of activity. Therefore they should not be regarded as single cases, instead they represent a group. To define the term expert I use the definition as formulated by Beeke (1995, in: Flick, 2009, p. 165): *“those persons as experts who are particularly competent as authorities on a certain matter of facts”*. The pre-made list of topics of discussion serve as an initiator for the dialogue during a semi-structured interviews. Different than a structured interview, is the interviewer able to delve deeper into specific lines of questioning depending on where the interview is going. In being able to do so, the interviewer is able to let the dialogue have a natural flow while at the same time allowing the interviewees to provide additional information and allow them to elaborate further on certain topics (Flick, 2009).

5. Regional profile: Arnhem, Nijmegen & Wageningen

This chapter will provide an in-depth profile of the case study area. The choices for the territorial demarcation are explained and presented. Following this the regional setting will be detailed, this setting is split up into demographical development and the institutional framework. As third I will look at the economic performance of both the region and the province compared to other regions in the country to provide a benchmark for the research to build upon. Lastly the sectoral setting is outlined. This outline is divided into the regional hotspots and sectoral champions.

5.1 Territorial demarcation of the case study area

In §1.3 the double triple helix is introduced, representing how the governance structure within the regional ecosystem is organized. A set number of municipalities are a part of this governance structure. This however does not mean that the regional ecosystem solely revolves around these municipalities. This would imply that the ecosystem would have hard, fixed borders rather than a rhizome with its roots stretching out to far corners. The ecosystem is likely to be much more fluent than the administrative demarcation that the double helix provides. But for the research to be territorially grounded a base demarcation has to be made. In doing so provides a few advantages. Firstly this allows for comparisons between this region and other regions to benchmark economic performance and secondly this provides a blueprint to compare to the regional ecosystem as derived from the empirical data. This chapter will provide an in-depth analysis of the case study area.

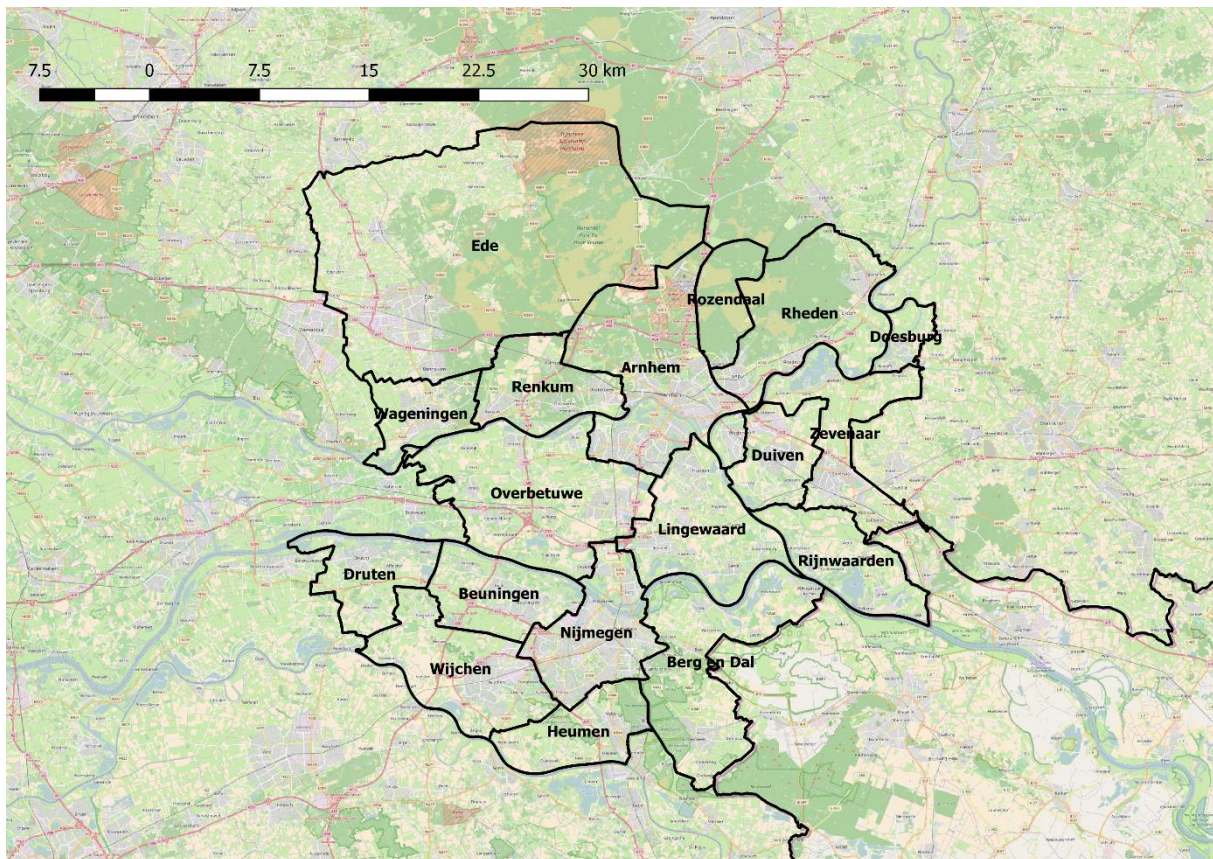


Figure 4 Case study area

Above figure 4 is displayed, the area is as mentioned earlier divided into two parts, the Food Valley on the left side and Arnhem & Nijmegen on the right side. The area is naturally divided by three different natural borders. The first of these borders is the Rhine, this river flows from Germany into the Netherlands. When the Rhine enters the Netherlands it gets split up into two different rivers, the Rhine going north through Arnhem and the Waal going south through Nijmegen. The third border is a large forest, the Veluwe, dividing Arnhem and the Food Valley.

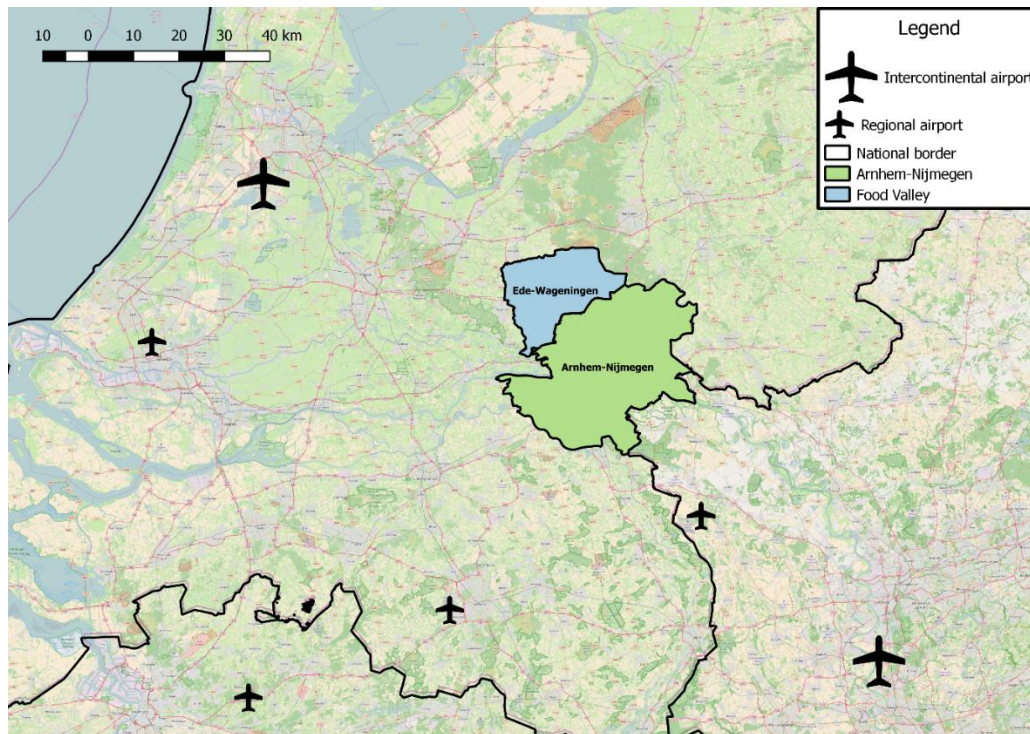


Figure 5 zoomed out overview of the case study area

The region is situated between De Randstad on the left side, Eindhoven Brainport on the south side and The Ruhr area to the east. There are five different airports in a relative short distance, two of which allow for intercontinental travel. The region is connected to the Betuwelijn, a railroad that connects the Rotterdam port to Germany. Given these circumstances the region is strategically located between both the beating heart of the Dutch economy, De Randstad and The Ruhr area in West-Germany.

5.2 Regional setting

5.2.1 Demographical development

Baring the natural barriers that separate the different centers within the region, the degree of urbanization is relatively high. But this was not always the case figures 6 through 10 provide a timeline of how the urbanization process of the region has developed as well as a demographical overview displayed in table 2.

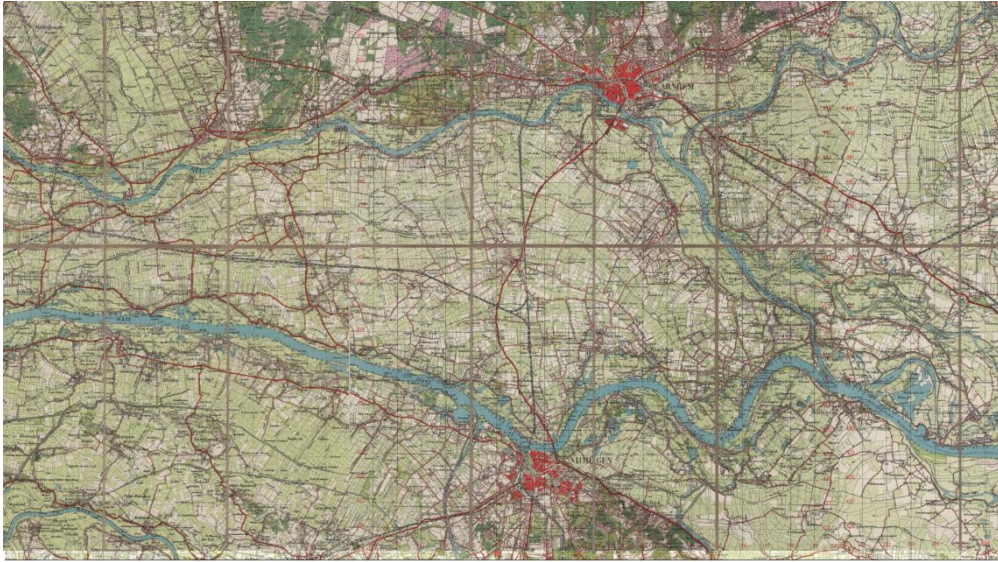


Figure 6 The region circa 1945



Figure 7 The region circa 1960

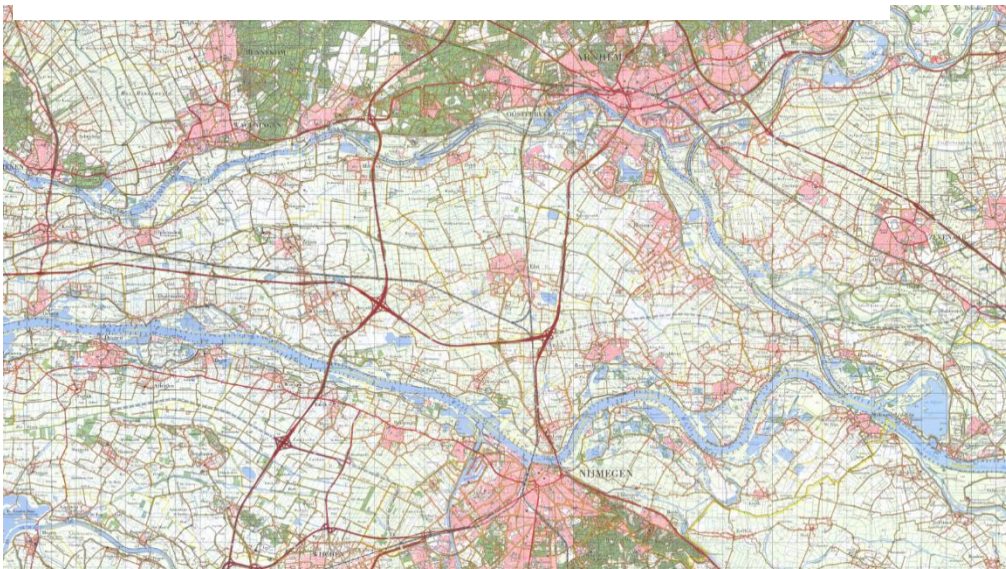


Figure 8 The region circa 1980

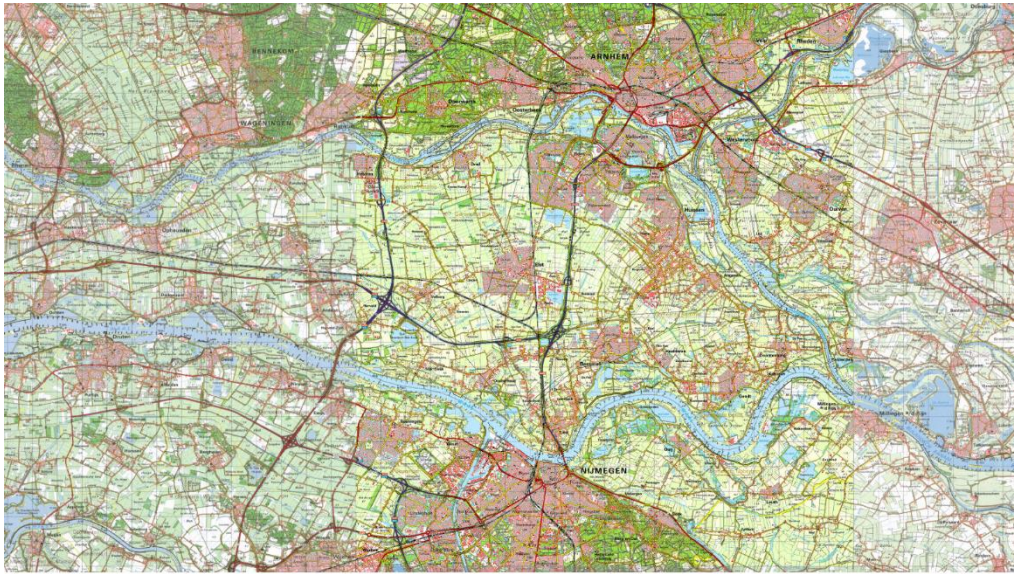


Figure 9 The region circa 2000

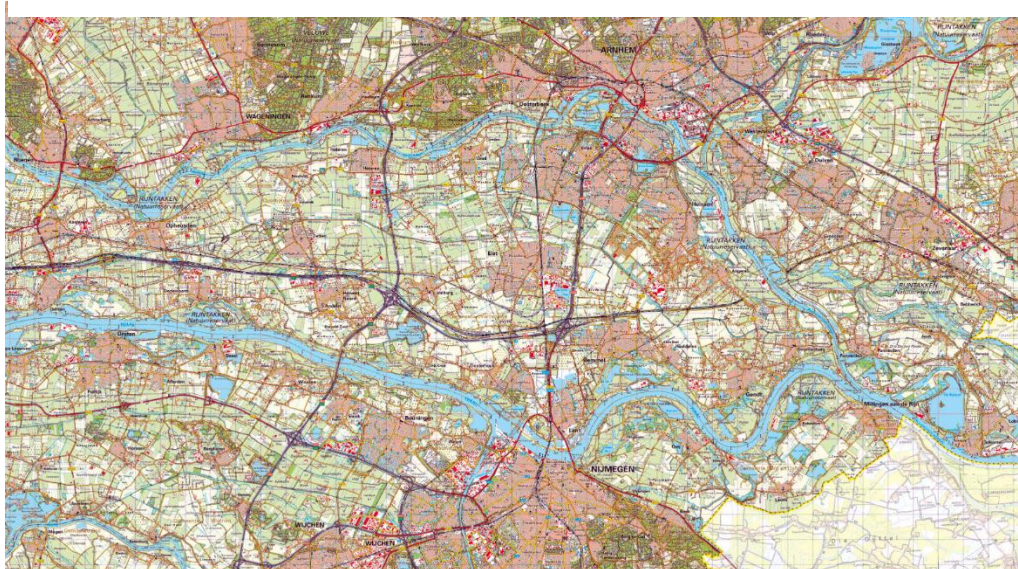


Figure 10 The region circa 2015

Number of inhabitants per municipality	1948	1960	1980	2000	2015
Arnhem	99,056	124,241	127,846	138,154	152,293
Nijmegen	107,354	129,576	147,614	152,200	170,681
Ede + Wageningen	42,883	55,785	82,829	101,700	111,575
Wageningen	17,529	22,704	30,447	33,440	37,786
Total larger cities	266,822	332,306	388,736	425,494	472,335
Regional total	-	-	-	825,696	871,673

Table 2 Regional demographics

When examining figures 6 through 10, it becomes evident that the distance between the large centers has become increasingly shorter from year to year. With currently 46% of all inhabitants within the region live in the smaller centers. Where in figure 6 it is still very distinguishable, the different cities, namely Arnhem and Nijmegen, in figure 10 it is very fuzzy to clearly see where city limits begin and end. The argument can easily be made that when showing this figure to someone unfamiliar with the region, that person would assume that the agglomeration in the figure belongs to a single city. The degree of urban sprawl in the region is therefore relatively high. Neither of the centers have the size to compete with larger cities or regions, however the accumulative size of the region is fairly reasonable.

Nijmegen and Wageningen have historically always been university towns, the Wageningen University and Research focuses on life sciences, food and environmental studies. While the Radboud University is classified as a broad university, meaning that they offer a wide spectrum of different studies. The university is divided into the Radboud University Medical Center and Radboud University. The former focuses as the name implies on the medical directions, the latter offers all non-medical studies. The region is also home to three different Universities of Applied Sciences. The largest is the HAN (Hogeschool Arnhem Nijmegen), with locations both in Arnhem and Nijmegen. As with the Radboud University, this institution also has the broad classification. The second University of Applied Sciences is located in Ede, the CHE (Christelijke Hogeschool Ede) is the Christian alternative to the HAN. VanHall Larenstein in Velp focuses, like the WUR on lifesciences, food and environmental studies. The region is also home to several institutions that cater towards the artistic part of society. Artez, located in Arnhem, is a University of Applied Sciences for the Arts and conservatorium. Furthermore Arnhem is home to Papendal, the national Olympic sport center. Wageningen and Nijmegen are the academic heart of the region while Arnhem has a stronger focus on the liberal arts and governmental functions. Arnhem is the provincial

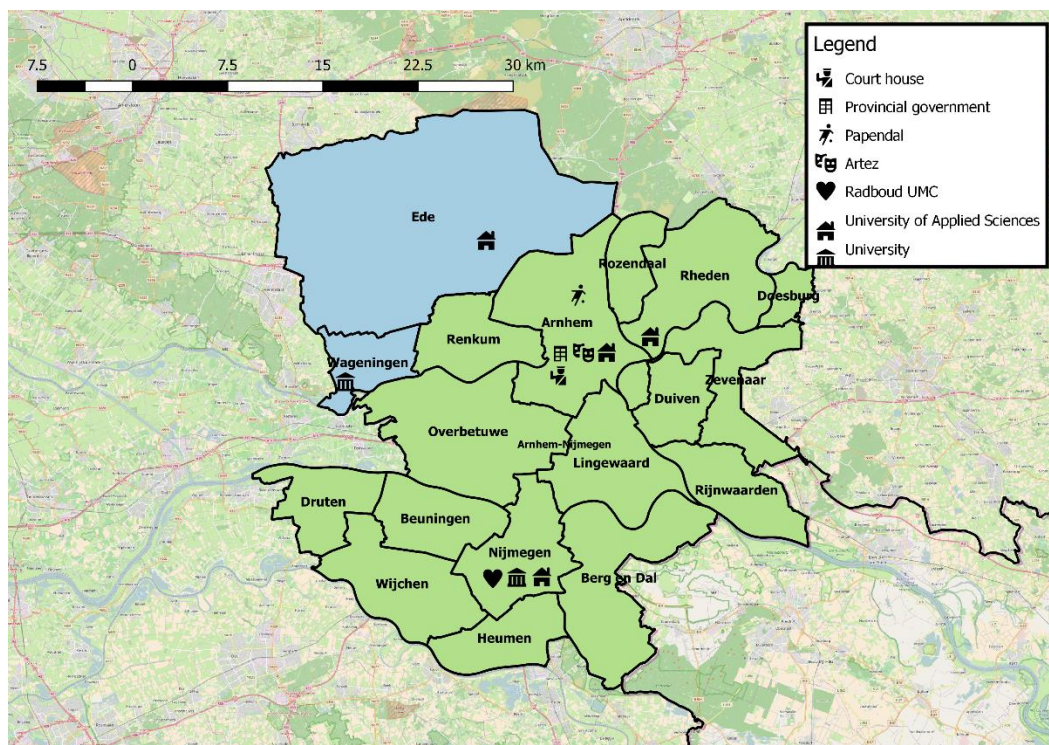


Figure 11 Institutions and government

capital of Gelderland and as such the province building and offices are located there. Moreover Arnhem houses the districts attorney's office and court house. Figure 11 gives an overview of where each of the previously mentioned institutions and organizations are. One of the strongest elements of the Arnhem-Nijmegen region is the relatively high educational level (ING Economic Bureau, 2016).

5.2.2 Institutional framework

5.2.2.1 Government

The institutional framework is build up from top-down. Each administrative level bring about its own governance structure. The highest level within the framework is the European level. On the European level Europe 2020 brings about a whole set of rules and ambitions. For the Europe 2020 policy, each country is separated into different regions. Each of those regions have to formulate their own their own Research & Innovation Strategy for Smart Specialization or RIS3 in short. Smart specialization strategies aim to foster a sustainable, inclusive and innovative economy (Commission, 2010). This is done through a process called entrepreneurial discovery, a process where both market as well as governmental actors together look for what unique selling point the region has, what sectors are the strongest and on what that region should be focusing on. The Arnhem, Nijmegen & Wageningen region is part of the Eastern-Netherlands region and focus on Agro Food, Energy and Milieu Technology, Health and High Tech Systems and Materials (OP-Oost, 2013). Firms are able to receive funding for R&D projects by participating in EFRO projects, the European Fund for Region Development. Bureau Brussel is embedded with the European Union to attract funding, interesting projects, broker deals and be a network hub for the Arnhem, Nijmegen & Wageningen region.

The second level of the institutional work is the national level. The Netherlands has a national innovation policy called the topsector policy. As the with the RIS3 policy, the topsector policy focuses on a specific number of sectors, these sectors form the economic backbone of the Dutch economy and are deemed vital to the nation's competitive position and future outlook.

The following nine sectors are considered as topsectors:

1. High Tech Systems and Materials
2. Life Sciences & Health
3. Agro & Food
4. Horticulture & Starting-Materials
5. Chemistry
6. Water
7. Creative Industry
8. Energy
9. Logistics

(Topsectoren, 2016)

The topsector policy allows firms in the earlier mentioned nine sector to apply for funding, get incentives, guarantees or have bureaucratic processes sped up. In doing so the national government aims to both attract foreign investment as well as bolster domestic economic activity.

At the third level, the regional level the Province of Gelderland aims to bolster the competitive position of the Province of Gelderland both nationally and internationally. The province focuses on the following points: Smart Manufacturing and Materials

1. Smart Food Production
2. Bio-based production
3. Health Technology and Delivery Systems
4. Healthy Brain
5. Personalized Health and Nutrition

(Provincie Gelderland, 2016)

The role of the province is very much a facilitating one, they aim to connect companies, clusters and networks. Moreover they aim to accelerate projects, developments, new forms of cooperation and business models, investments made by market parties innovation and growth (Provincie Gelderland, 2016).

At the most local level, the level of the municipalities, the role of the government is the most direct. Municipalities actively are involved in triple helix constellations, they are able to provide incentives for firms to locate tot their city as well as facilitating firm to the best of their ability. Firms for instance interact with municipalities to acquire the permits needed for industrial activity. Improving and strengthening the business climate is one of the main goals of municipalities. Investing in regional, national and international innovation programs helps firm with research & development to achieve innovation.

5.2.2.2 Semi government and non-governmental organizations

At the level of regional ecosystem, you find several different organizations that act as hubs that facilitate the proliferation of economic activity in the region. Between the municipal and provincial level, we find these triple helix cluster organizations that either represent a specific industry such as Health Valley, BCS and kiEMT or a specific region such as Food Valley and The Economic Board. As stated earlier one of their main functions is be a hub. Their aim is similar to that of the province, in that they aim to connect companies, clusters and networks as well as accelerate projects, developments, new forms of cooperation and business models, investments made by market parties, innovation and growth.

Having these different network organizations in the region can have tremendous benefits for the region. However one thing that is potentially troublesome is that each organization has a primary sectoral focus while the region itself has not one, but multiple sectors that it focuses on. Each of these organizations know exactly what goes on in their respective sector, though one thing that still lacks is a tool to connect each of these sectors. The Economic Board aims to be a hub that connects different hubs together. They do this by focusing on cross-over activity between the three main pillars of the region, food, health and energy.

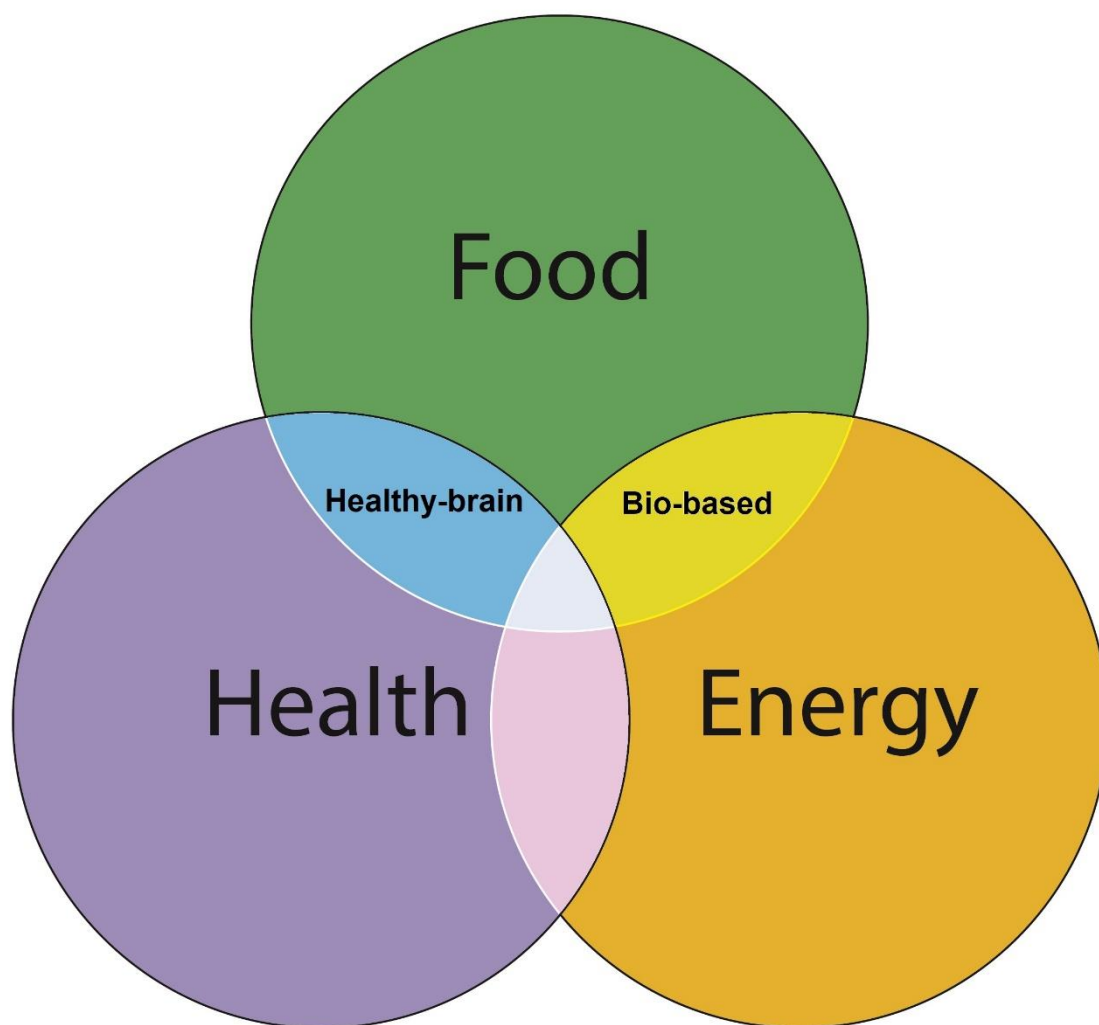


Figure 12 Cross-overs

Figure 12 as displayed above details how these sectors find cross-overs as present in the region. The two main cross-over sectors are Healthy brain for food and health and Bio-based for food and energy. These two cross-over sectors are also one of the priorities to focus on for the Province of Gelderland. The Economic-Board consists of two different elements: a day-to-day operation and a board of representatives.

The following people are in the board of representatives:

Hubertus Bruls	Mayor of Nijmegen
Toon van Asseldonk	Mayor of Overbetuwe
Kees Boele	Chairman of the board of executives of the HAN
Peter van Dongen	Chairman of the board of executives Van Hall Larenstein
Ben Geerdink	Chairman of the board of executives Rijn IJssel

Leon van Halder	Chairman of the board of executives Radboud UMC
Marcel Hielkema	Managing director Dirkzwager, Chairman VNO-NCW Gelderland
Cees van der Knaap	Mayor of Ede, Chairman of Food Valley
Ron König	Alderman Economic Affairs Arnhem
Peter Molengraaf	Chairman of the board of executives Alliander
Monique Noomen	Managing director Eiffel
Edwin de Rooij	Deputy CEO Synthon
Michiel Scheffer	Deputy of the Province of Gelderland
Daniël Wigboldus	Chairman of the board of executives Radboud University

All members of the board occupy important and strategic places at both government, business and knowledge institutions. This provides The Economic Board with a lot of decision making power allowing The Economic Board to potentially have a big impact in the direction the regional ecosystem is going. The Economic Board also provides the region with a single platform to handle international profiling and communication for all parties that have such desires. By focusing on cross-overs The Economic Board tries to establish more ties between the different industries and therefore focus on strengthening the territorial embeddedness of the firms and institutions within the regional ecosystem.

5.3 Economic performance

The economy of the Arnhem and Nijmegen region has been lagging behind the national average with regard to economic growth. In the period 1996-2015, the region had a GDP growth that was 15% lower than the national average (Walsweer, 2016). Despite this fact, it does not seem that the lower economic growth rate has an impact on other important economic centers. Instead it is most likely that a combination of complex demographic and social circumstances are at the base of the lower economic growth (Walsweer, 2016). Table 3 shows that the regional GDP during the period 2010-2014 only grew with 0.2 percent. This is much lower than both the Amsterdam region and the Eindhoven Brainport region (Zuid-Oost Brabant), who are numbers 3 and 1 with regard to regional GDP growth. The regional employment saw a 3,87% decrease in the Arnhem –Nijmegen region during that same period, of the large economic centers in the Netherlands only the Amsterdam region saw a strong increase during this period.

Table 4 is a breakdown of employment per sector. Here you can see the clear difference between the economy of Arnhem and that of Nijmegen. Business services and governmental functions are much more prevalent in Arnhem, while in Nijmegen the industry, education and health and welfare care are stronger represented. Both in Ede, Wageningen and Nijmegen the amount of specialized business services is much higher than in other municipalities. It is most likely that these difference are brought forth by the presence of an

university in the city in question or in very close proximity. Nijmegen also has strong industrial sectors, while Arnhem only has half the amount of employment in industry as Nijmegen has. The industrial sector in Ede is roughly four times smaller than that in Nijmegen. In line with the presence of Artez in Arnhem, Arnhem has the largest cultural sector of the region.

Table 5 and 6 breakdown the R&D expenditure in the Netherlands and the amount of VTE these investments have created. The province of Gelderland is right in the middle of the pack in both total investments as well as investments per capita. The amount of R&D expenditure has roughly stayed the same over the 2011-2015 timeframe. The provinces of North- and South-Holland both have a large total R&D expenditure total but when set of versus the number of capita, both provinces invest less in R&D than the province of Utrecht. The highest investment per capita can be found in the province of North-Brabant.

	GDP change 2010-2014	Employment 2014 (in thousands)	Employment change % 2010-2014
Achterhoek (CR)	-2	159,2	-2,57
Agglomeratie Haarlem (CR)	-6,3	81,8	-5,54
Agglomeratie Leiden en Bollenstreek (CR)	0,2	167,5	-2,9
Agglomeratie 's-Gravenhage (CR)	-2,9	380,2	-6,35
Alkmaar en omgeving (CR)	0,8	94,4	-3,67
Arnhem/Nijmegen (CR)	0,3	315,6	-3,87
Delft en Westland (CR)	5,6	119	1,88
Delfzijl en omgeving (CR)	13,3	15,5	-4,91
Flevoland (CR)	4,6	141,9	-7,01
Groot-Amsterdam (CR)	15	873,1	4,43
Groot-Rijnmond (CR)	2,8	643,2	-3,81
Het Gooi en Vechtstreek (CR)	-3,6	102,7	-3,84
IJmond (CR)	-1,4	71,6	-2,45
Kop van Noord-Holland (CR)	-2	139,1	-1,28
Midden-Limburg (CR)	1,8	97,4	-3,56
Midden-Noord-Brabant (CR)	1,7	213,5	-3,7
Noord-Drenthe (CR)	-0,6	72,3	-2,69
Noord-Friesland (CR)	-3,6	117,9	-10,21
Noord-Limburg (CR)	3,9	139	2,13
Noordoost-Noord-Brabant (CR)	1,9	301,1	-4,32
Noord-Overijssel (CR)	3,1	173,9	-2,69
Oost-Groningen (CR)	5	45,8	-3,98
Oost-Zuid-Holland (CR)	-8,6	119,4	-4,25
Overig Groningen (CR)	5	178	-3,89
Overig Zeeland (CR)	5,6	107,3	-3,51
Twente (CR)	-1,2	269,1	-2,64
Utrecht (CR)	-0,3	662,1	-0,59
Veluwe (CR)	3,2	309,9	-1,96
West-Noord-Brabant (CR)	3,4	290,6	-1,06
Zaanstreek (CR)	4,6	57	-3,23
Zeeuwsch-Vlaanderen (CR)	6,8	40,7	-5,79
Zuid-Limburg (CR)	2,4	250	-4,32
Zuidoost-Drenthe (CR)	-5,1	59,8	-1,97
Zuidoost-Friesland (CR)	1,6	79,2	-10,31
Zuidoost-Noord-Brabant (CR)	18,1	385,3	0,1
Zuidoost-Zuid-Holland (CR)	-0,5	170,7	-2,23
Zuidwest-Drenthe (CR)	4,5	62,4	6,85
Zuidwest-Friesland (CR)	15,3	45,1	16,84
Zuidwest-Gelderland (CR)	1,1	100,5	0,2
Zuidwest-Overijssel (CR)	-2,1	68,3	-2,15

Table 3 GDP and employment rates between 2010-2014

	B-E Industry (no construction) and energy	B-F Industry and energy	G-I Trade, transport and hospitality	G-N Commercial services	M Specialized business services	N Renting and other business services	O Public administration and governmental organizations	P Education	Q Health and welfare care	R-U Culture, Leisure and other services	Totaal A- U
Arnhem	8,2	0	18,2	42,7	0	18,3	12,4	8,2	17,1	6	97
Beuningen	0	0	2,3	3,4	0	0	0	0	1	0,2	6,6
Doesburg	0	0,5	1,4	1,7	0,1	0,1	0	0,1	0	0,1	2,9
Druten	0,6	1,3	0	2,7	0,4	0,3	0	0	1,4	0,1	6,4
Duiven	1,5	2	5,8	9,9	0,5	3,3	0,4	0,6	0,6	0,3	14
Ede	5,2	7,2	14	23,8	3,4	3,1	0	0	11,4	1,7	50,3
Groesbeek	0,3	0,6	0	1,9	0,2	0,4	0	0	2,2	0,2	5,5
Heumen	0,2	0,3	1,7	2,5	0,3	0,4	0	0	0,7	0,2	4
Lingewaard	1,6	2,2	3,2	4,9	0,5	0,9	0	0,7	0	0,4	10,4
Millingen aan de Rijn	0	0	0	0,4	0	0	0	0	0,1	0	0,7
Nijmegen	9,2	11,4	17,8	35,9	4,5	8,9	4,1	13,5	26,3	2,4	93,6
Overbetuwe	1,6	2,3	6,1	8,9	0,9	1	0,6	1,1	2	0,4	15,7
Renkum	0,4	0,6	2,1	4,6	0,7	1,3	0,5	0,4	3,7	0,7	10,5
Rheden	1,9	2,2	3,1	5,3	0,9	0,8	0	0,8	0	0,5	12,6
Rijnwaarden	0,8	0,9	0,5	0,9	0	0,2	0	0	0,3	0	2,3
Rozendaal	0	0	0,1	0,1	0	0	0	0	0	0	0,6
Ubbergen	0,1	0,1	0,5	0,8	0,1	0,1	0	0	2,4	0,1	3,7
Wageningen	0,8	1	2,5	8,2	3,7	0,6	0,7	4,1	2,3	0,6	17,4
Westervoort	0	0	0,9	1,2	0,1	0,1	0	0	0,5	0,1	2,2
Wijchen	2,2	3,2	4,4	7,2	0,8	1,5	0	0	1,6	0,5	13,7
Zevenaar	1,7	2,3	3,4	6,8	0,6	2,3	0,6	0,7	2,4	0,4	13,3
Eindtotaal	36,3	38,1	88	173,8	17,7	43,6	19,3	30,2	76	14,9	383,4

Table 4 Employment breakdown per municipality 2014

Periods	2011 In-house R&D expenditure	2011 Amount of labor	2012 In-house R&D expenditure	2012 Amount of labor	2013 In-house R&D expenditure	2013 Amount of labor	2014 In-house R&D expenditure	2014 Amount of labor	2015 In-house R&D expenditure	2015 Amount of labor
Subject										
Regions	mIn euro	VTE	mIn euro	VTE	mIn euro	VTE	mIn euro	VTE	mIn euro	VTE
Groningen (PV)	.	.	490	4387	510	4533	536	4778	542	5021
Friesland (PV)	172	2058	156	1859	158	1958	151	1642	154	1861
Drenthe (PV)	.	.	100	1231	98	1206	98	1578	111	1724
Overijssel (PV)	746	8542	608	7677	559	6770	614	6678	694	7808
Flevoland (PV)	170	1882	202	2246	189	2221	224	2859	185	2646
Gelderland (PV)	1464	13510	1516	15028	1529	15060	1506	15166	1473	14644
Utrecht (PV)	1138	10350	1148	10718	1338	12222	1335	11491	1325	11543
Noord-Holland (PV)	2234	22324	2390	23082	2296	22335	2248	21685	2437	23472
Zuid-Holland (PV)	2638	24840	2659	24811	2789	25254	3065	27771	3168	28031
Zeeland (PV)	43	573	61	761	78	801	77	723	70	740
Noord-Brabant (PV)	2329	20691	2499	23090	2535	23581	2733	22744	2837	24747
Limburg (PV)	715	6977	682	7325	666	7273	680	6951	699	6821

Table 5 Regional R&D spending and amount of VTE

Periods	2011 In-house R&D expenditure	2011 Amount of labor	2012 In-house R&D expenditure	2012 Amount of labor	2013 In-house R&D expenditure	2013 Amount of labor	2014 In-house R&D expenditure	2014 Amount of labor	2015 In-house R&D expenditure	2015 Amount of labor
Subject										
Regions	euro per inhabitant	VTE per inhabitant	euro per inhabitant	VTE per inhabitant	euro per inhabitant	VTE per inhabitant	euro per inhabitant	VTE per inhabitant	euro per inhabitant	VTE per inhabitant
Groningen (PV)			844	0,00755	877	0,00779	920	0,00820	928	0,00860
Friesland (PV)	266	0,00318	241	0,00287	244	0,00303	234	0,00254	238	0,00288
Drenthe (PV)			204	0,00251	200	0,00246	200	0,00323	227	0,00353
Overijssel (PV)	658	0,00753	534	0,00675	491	0,00594	539	0,00586	608	0,00685
Flevoland (PV)	434	0,00480	511	0,00568	474	0,00557	560	0,00715	460	0,00659
Gelderland (PV)	730	0,00674	754	0,00747	759	0,00747	746	0,00751	727	0,00723
Utrecht (PV)	926	0,00842	928	0,00866	1074	0,00981	1065	0,00917	1049	0,00914
Noord-Holland (PV)	830	0,00829	882	0,00852	843	0,00820	820	0,00791	882	0,00850
Zuid-Holland (PV)	748	0,00704	749	0,00650	783	0,00709	857	0,00776	880	0,00779
Zeeland (PV)	113	0,00150	160	0,00200	205	0,00210	202	0,00190	184	0,00194
Noord-Brabant (PV)	949	0,00843	1014	0,00937	1026	0,00954	1102	0,00917	1140	0,00994
Limburg (PV)	637	0,00621	607	0,00652	594	0,00648	607	0,00621	625	0,00610

Table 6 Regional R&D spending and amount of VTE per inhabitant

5.4 Sectoral setting

We can divide the region into four separate micro-regions, with each micro-region having its own specific focus. The first is the Food Valley, Food Valley is a larger region with its own dynamic and governance structure. Wageningen and to lesser extent Ede form the heart of this region. As part of the double triple helix, Ede and Wageningen are a part of the case study area. This region, as the name implies, is primarily focused on the food sector from knowledge generation, to food production and specialized business services surrounding food. The main anchor point for this sector is the Wageningen University. The second distinguishable region would be Arnhem. The primary focus for Arnhem is the energy industry, Arnhem has a large utilities sector that anchors the energy sector to the city. The Arnhem region extends eastwards, towards Duiven and Westervoort. They also have a focus that is in line with that of Arnhem. The third micro-region is Nijmegen, Nijmegen is the heart of the Health Valley. The Health Valley focuses on health care innovation and appliances. The last micro-region would be the hinterland that exists between Arnhem and Nijmegen. This area does not have a profile that is as strong as the earlier mentioned three regions. Food production is however one of the important pillars for the region, here you will find large glass house complexes and fruit farms.

The first three mentioned have sector specific governance structures in place to facilitate and proliferate economic activity in their own areas. Food Valley for Ede-Wageningen, Health Valley for Nijmegen and kiEMT (Institution for Knowledge and Innovation Energy- and Environmental Technologies) for Arnhem. A fourth entity has been established in 2016, The Economic Board. The Economic Board primary focus is to provide a platform to internationally promote the region and stimulate cross-over activity between the Food, Health and Energy sectors. These four organizations operate in the triple helix and play an important role in the regional ecosystem as hubs to connect people and organizations both regionally and supra-regionally. The institutional dimension has several different anchor points for the region. In the case of the Food and Health Valley this anchor point is a university. The universities and research institutes connected to them create a sustainable, steady stream of highly educated people for the companies located in the region utilize. The energy sector does not have such an anchor and because of it, capable and highly educated personnel is harder to come by, locally, for the energy sector.

Despite the strong focus on food, health and energy there are also other sectors that are notable within the region. The first is Legal Valley, Legal Valley was established in 2017 and aims to strengthen the position of Gelderland as a hotspot for legal activity. The region is home to an important court house and has 400 law firms that employ 1200 lawyers. Legal Valley however does not suffer from the regional focus on food, health and energy. Instead, the legal infrastructure that is present in the region can provide a supporting role for entrepreneurship and innovation in the food, health and energy sectors.

The second is Logistics Valley. Their goal is to create a business environment that attracts international companies to the region by offering all facilities and growth opportunities in a one-stop-shopping concept (Logistics Valley, n.d.) Logistics Valley tries to take advantage of the strategic location of the region as a connecting hub between the Western part of the

Netherlands and Germany. A good example of this is the distribution center of retail giant AS Watson in Heteren, which is one of the largest in the Benelux.

The third and last one is the Business Cluster Semiconductors, located in Nijmegen. The region is home to a number of companies that operate in the semi-conductor industry. The most notable is former Philips branch NXP. Around the NXP terrain now has grown a campus that focuses on Digital Health.

5.4.1 Hotspots

Rather than looking at each different micro-region, it's much more beneficial to examine at what physical locations the exchange of knowledge takes place. There are several different 'hotspots' that are integral for each different sector. The food industry can be broken down into several different sectors. For this research we are focusing on knowledge production and valorization hotspots, bio-based hotspots, EMT hotspots and health hotspots. Hotspots that focus on knowledge production have a high degree of knowledge intensive activities while bio-based hotspots are more likely to include industrial and food production activities. Bio-based hotspots are interesting in the sense that they can be both regarded as part of the food sector and the energy sector as biomass from agricultural processes can be used to make bio-fuel. A main focus of the bio-based sector is to stimulate circular solutions. By focusing on the circular economy less resources have to be used to achieve the goals that are set out. This is done through examining how the input and output of different companies can be combined. Or in other words, the waste of one company could very well serve as the resources for another company. Bio-based hotspots for that very same reason also often focus on EMT. For the health sector we can distinguish between knowledge production locations and medical locations.

Food hotspots

1. WUR campus

The main anchor point for the food industry is the WUR campus. Here you have the culmination of knowledge production and education. Lately there has been a trend of well-known organizations to move their R&D to the Wageningen campus, to have more proximity to their knowledge base. Having a R&D facility on the university campus helps companies to take full advantage of knowledge spillovers. Moreover the university gets the opportunity to improve their valorization capabilities.

2. NIZO campus

NIZO is a private research institute that does contract research for the food industry. On their campus in Ede they have all the facilities required for valorization research.

3. Agro Business and Science Park Wageningen

This business park in Wageningen is specially setup for companies that operate in the food, life sciences and health sector. The park has facilities to support both starters as SME's while being in close proximity of the WUR Campus.

Health and semi-conductor hotspots

1. Radboud UMC campus

The Radboud UMC is the main anchor for the health sector in the region. At this academic hospital you find both private research institutes as well as research institutes connected to the university. Radboud also has an organization that is dedicated to the valorization of knowledge produced at the university, SMB (Science Meets Business). Another organization that stimulates innovation is Radboud Reshape, which focuses on the health care of tomorrow.

2. Synthon campus

In West-Nijmegen Synthon is located, a former Radboud spin-off that has up-scaled to a large medicine manufacturer.

3. Novio-Tech Campus (NTC)

The NTC is the hotspot in the region for the combination of high-tech and health. As mentioned earlier, this campus is located on next to semi-conductor company NXP. The connection with health is made through the presence on the campus of SMB. SMB, which is located on the NTC acts as a hub for companies in both the digital health sector as the general health sector.

Bio-based hotspots

1. NEXTgarden

NEXTgarden is a large glass-house complex in the municipality of Lingewaard, located in the hinterland between Arnhem and Nijmegen. NEXTgarden works towards establishing a vital and futureproof glass-house area that is able to facilitate scale-ups or clustering of different locations.

2. Innofase Duiven

Innofase focuses on creating inter-firm synergies. This process is facilitated by selecting companies that fit within the context of the park. Innofase is part of the EMT cluster kiEMT. On this terrain bio-based and EMT is combined to achieve cross-sector synergy. An example of how this is done is by waste processing company AVR who process waste and turn it into thermal and electric energy.

3. West-Nijmegen

The bio-based hotspot in Nijmegen-West is also anchored by a waste processing company ARN. Also here you find the combination of bio-based and EMT.

4. Renkum

The hotspot in Renkum is the anchor point for the paper industry. At this plant paper is made from recycled paper. This process is almost fully fueled by bio-mass.

5. Industrial Park Kleefse Waard (IPKW)

At this location there is also a combination of bio-based and EMT activity. IPKW one of the main anchors of the energy industry for the region. The park aims to achieve inter-firm synergy and stimulate regional knowledge spillovers. Both traditional energy companies as the French Veolia is located there as well as firm that focus on the energy transition such as hydrogen orientated companies.

EMT hotspots

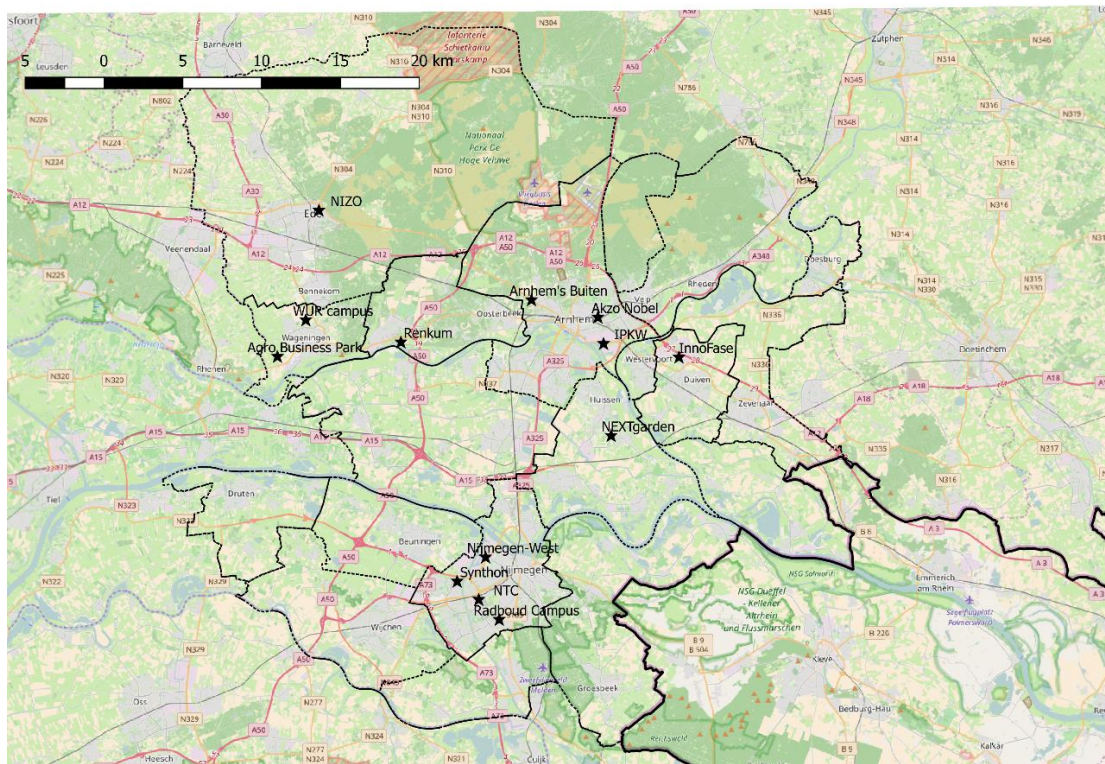
1. Energy Buisness Park Arnheims Buiten

This is the other anchor point for the energy sector in Arnhem. Large companies operating in the Energy sector such as DNV GL, Tennet and NRG are located on this terrain. Arnhem Buiten acts as a platform for sustainable energy developments and other innovations in the EMT sector.

Chemistry hotspots

1. Akzo Nobel campus

The Akzo Nobel campus in Arnhem is the main hub for all activity that centered on specialized chemicals. This location used to be the headquarters for Akzo Nobel, before they moved their headquarters to Amsterdam. On the terrain Teijin is also located, a transnational company that operates in the same branch as Akzo Nobel.



5.4.2 Champions

Regional ecosystems can consist manifest themselves in different ways. This can either be a collection of small firms working in harmony, through synergy getting a competitive advantage or for instance large anchor firm surrounded by a number of smaller firms (see §2.2).. Each regional ecosystem has its own dynamic, in trying to understand that dynamic it is important to analyze the structure of the regional economy. One of the main pillars of a regional economy are so called champions. A champion is an important firm or institution that acts as a regional anchor for their respective sectors. It might also very well be that a region has no champions but instead has a mix of smaller firms. A champion does not necessarily have to be a firm as research institutes or universities can fulfill the same role. For the definition of the term champion this research uses the following: large national or transnational corporations or institutions with medium to large local enterprises.

Food sector

The main anchor for the food sector in the region is the WUR. The Wageningen University provides an important knowledge basis to generate knowledge spillovers. Other notable champions in the region are food manufacturers Mead Johnson, Kraft Heinz and FrieslandCampina. NIZO acts as the commercial counterpart for the WUR and can also be regarded as a champion.

Bio-based sector

Schut paper in Heelsum (municipality of Renkum) is one of the big players in the bio-based sector. Other large players are French companies Veolia, Engie, and waste processing firm AVR and ARN.

Energy sector

The champions in the energy sector can be split up into different categories. Semi-governmental organizations, business support firms, traditional energy and the energy of tomorrow. The largest energy company in the region is utilities company Alliander, which in 2016 had 7150 employees (Alliander, 2016). Another large semi-governmental firm is TenneT, who are in charge of power lines in the Netherlands. Large transnational corporations such as DNV GL and DEKRA make up the business support side of the energy sector. The traditional energy market is made up of Shell and NRG while the sustainable energy sector is divided up into hydrogen firms Hyet, Hygear and Nedstack and electric car charge company Allego. The bio-based sector has as mentioned earlier also activities that could classify them as energy companies.

Health sector

The health sector is anchored by the Radboud UMC. At the Radboud UMC you also find research institutes such as the Donders Institute and the German Max Planck Institute. Radboud UMC spin-off Synthron is the biggest medicine producer in the region. The St.

Maartens Clinic specializes in posture and movement and is one of the leading experts in its field in Europe.

Semi-conductor sector

The main anchor for the semi-conductor industry in the region is former Philips branche NXP. NXP has recently been split up into three different companies: Nexperia, NXP and Amplion. They are all three located next to each other on the NTC. Another semi-conductor champion is Besi in Duiven. Other than Nexperia, NXP and Amplion, Besi focuses on assembly process equipment as supposed to chips and sensors.

Chemical sector

The chemical sector has two champions in the region, who are located on the same location, these are Akzo Nobel and Teijin Aramid.

6. A closer look at the regional ecosystem

In this chapter the results of the empirical data collection will be analyzed. This chapter will outline how each element of the conceptual model (§3.1), can be identified in practice. The conceptual model (§3.1) consists of a series of spheres that have been translated into a number of definitions and indicators in the operationalization scheme (§3.2). The analysis will first start at the regional sphere, from that point on the analysis will work through the conceptual model in a clockwise manner, ending at the firm sphere. After this is done it will be determined what makes the region 'sticky' or the lack thereof.

Firms from the following sectors have been interviewed:

Health	Energy	Food	Semi-conductor	Chemistry	Bio-based	E-Health	Cross sector
Synthon	Hyet	KraftHeinz	NXP	Akzo Nobel	Pectcof	Noviosys	TDI Group
	Allego				BKC/Miscancell		
					Veolia		

Table 7 Interviewed firms

The sizes of these firms span from startups, to SME's, large firms and transnational corporations. Having a good mix of firm sizes will help provide perspective how the regional ecosystem works at different firm levels. Having a good spread of sectors represented should help broaden the scope of the research in order to be able to measure cross-sector activity. Despite the fact that this research focuses on the Food, Health and Energy sectors, the firms as displayed above in table 7 are not just Food, Health and Energy based. Instead I think it is important to paint a broader picture, focusing on other large sectors as well. This way the regional ecosystem can be mapped in more detail, allowing for the network analysis to cover more bases.

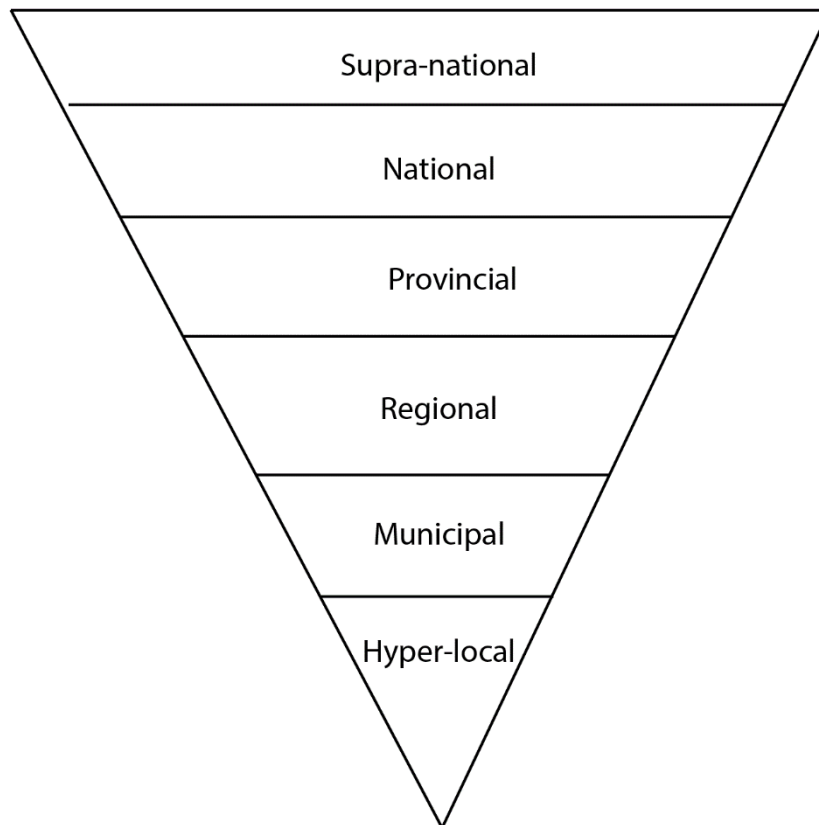


Table 8 Levels of scale

6.1 The regional sphere

6.1.1 Embeddedness

To better interpret the empirical data I would like to elaborate on the different scales of embedding that I have come across during this research. These levels are displayed in table 8. These levels are derived from both the empirical findings of the research as well as the levels of government. The highest level is the supra-national level such as the European level. The second level is the national level, the country level. The third level represents the provincial level such as the Province of Gelderland. The level of the regional economy or the regional ecosystem is the fourth level, this represents the level of the urban agglomerations and regional cooperation, in this case the Arnhem, Nijmegen & Wageningen region. The municipal level represents the lowest level of government, that of the individual city. For this research I have included a sixth level of scale which I have coined the hyper-local scale. The hyper-local scale I define as a scale lower than the municipal level. This scale represents the level of a campus or business park. This level is characterized by the extreme proximity between firms and / or institutions which allows for the potential development of a community.

6.1.1.1 Societal embeddedness

To measure the societal embeddedness of firms the location history of firms is looked at. Why are firms located where they are and what rational exists behind these choices.

6.1.1.1.1 Location history

Most of the companies had previous ties to the region prior to either moving here or being founded. The degree of societal embeddedness therefore is relatively high amongst most of the firms that were interviewed. Despite the fact that some of the firms are now located in the region does not mean that when given the choice again, that they will make the same choice the second time around. One of the main constraining factors for companies to move to a different region is their human capital. Multiple firms have expressed that they would consider Eindhoven as the optimal location choice if asked where they would want to be located if not in our region. Multiple reasons were given for this location. Eindhoven has a technical university, something that is missing in this region. That is a strong pull factor for Eindhoven. Also the branding of the region has been mentioned as being a pull factor to move to the Eindhoven region. Something that, as some have expressed, is lacking in this region. The Eindhoven region also has a large manufacturing industry, which another pull factor. However firms have expressed that the hyper-local ecosystem to be a very important factor in moving to this region or establishing a firm in this region. This is especially true for the firms located on IPKW and NTC. The business climate in those places as well as the proximity to other firms, both in the same industry as in related industries are deemed as an important factor for choosing for these locations. Noviosys for instance moved to the NTC because of the local ecosystem and the types of companies present. Being at the NTC for Noviosys, means that they are able to connect to a larger network that allows them to connect their Czech mother company to both Dutch networks as well as networks in other countries of firms located on the NTC such as Japanese Life Sciences company Tokyo Future Styles. The NTC then acts as a vital nod in a global network, it acts as a hub where different firms, from different backgrounds and sectors are able to connect and potentially do business together.

Kraft Heinz considered a multitude of locations but in the end decided upon establishing their R&D facility in Nijmegen because of the local knowledge base in this region. The measure of territorial embeddedness of the firms in the region is substantial with multiple companies investing heavily in local facilities or expressing the desire to do so in the future. Again the willingness to invest is mostly based on fostering and strengthening the hyper local and not necessarily because of the region itself. The proximity to the knowledge institutions is useful but the ultimate is not the deciding factor in choosing to move to the region or not. In some cases parts of the operation have already moved out of the region, to other places that are more suited for the activities in question. The business climate in the region does not compare to that of cities such as Amsterdam as per some respondents. This difference is not necessarily a negative element, more a differentiating one. Some respondents have expressed that competing large metropolitan regions should not be the goal for this region, instead focusing on strong points that the region has should be important. Part of this, as some say, is recognizing that this region is not a corporate environment, instead the green environment is perfectly suited for a slower paced family lifestyle. The fact that for a lower price than in the main Dutch economic centers, you are able to buy a house in a beautiful green environment is seen as positive element of the region. The reverse is

however also true, attracting foreign knowledge workers is seen as quite difficult. Several reasons have been provided for this. Firstly the region lacks an airport increasing traveling time when returning to the country of their origin. Secondly the lack or perceived lack of good international schools for their kids has been mentioned. Lastly the region does not provide the same metropolitan experience that you get in large global economic centers making moving to the region undesirable. Figure 14 shows how the region is situated between three important economic centers and the connections between them. A solution that some employees however have found is either locating in the west of the country or moving to cities such as Paris and commuting during the weekends.

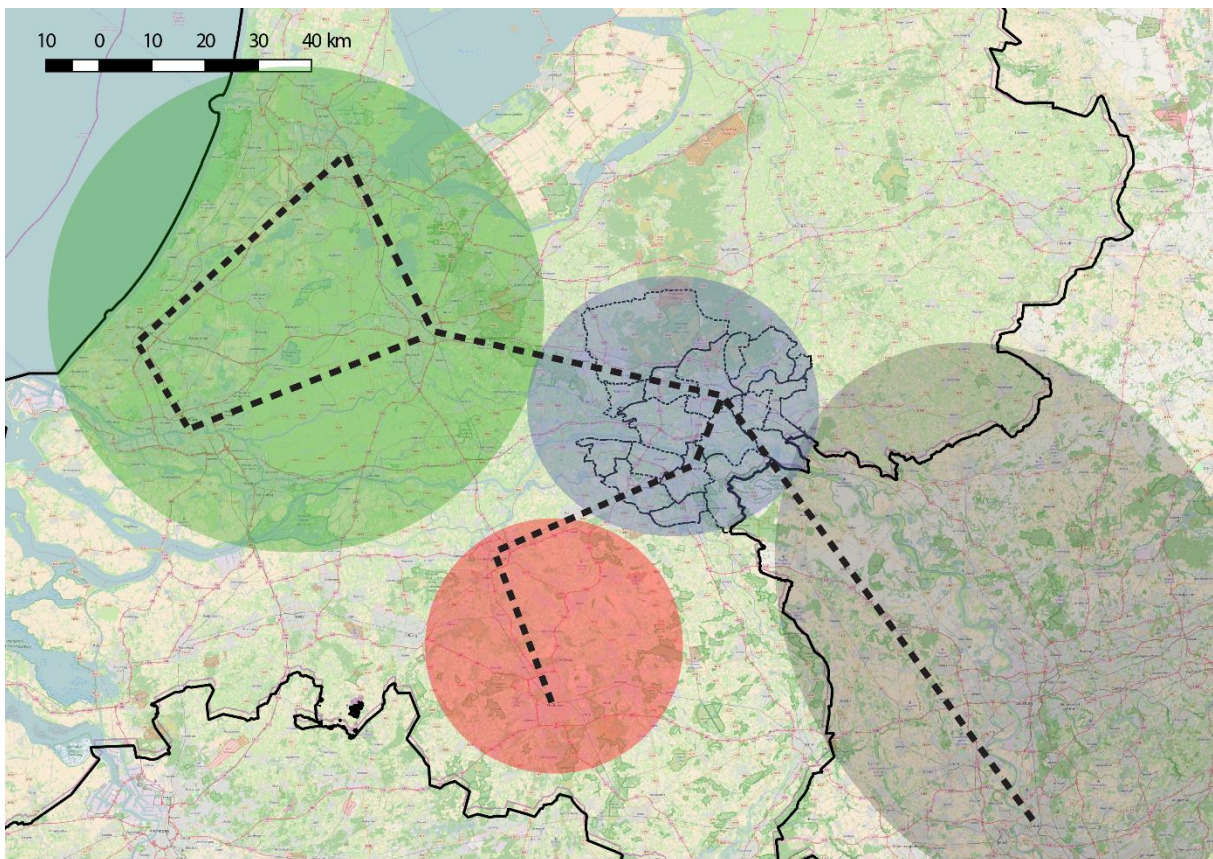


Figure 14 international corridors and regions

6.1.1.2 Territorial embeddedness

The second form of embeddedness is territorial embeddedness. To determine if and what advantages the location offers to firms. This will be look at in terms of advantages to the supply chain, their trade-linkages as well as infrastructural advantages

6.1.1.2.1 Location advantages

6.1.1.2.1.1 Advantage of the location with regard to the supply chain

Many of the firms that have been interviewed either do limited local manufacturing or do not do any manufacturing in this region. Instead most activity focuses on knowledge intensive activities. Because of this the location does not provide a direct advantage with regard to their supply chain. The exception to this are the firms located on IPKW. This location has the means to match input and output of companies through the existing grid. This way it is possible to for instance provide heating to companies on the terrain who are in need of heating by letting warmth that is generated as a byproduct of another firm's industrial activity. The port of IPKW also is seen as highly beneficial to the companies located there. At the hyper-local level the location can potentially provide advantages for the supply chain in terms of proximity. The NTC for instance has several firms that operate in the same industry but have a different focus. When a certain mass is created, it becomes interesting for firms in the supply chain to move a part or their entire operation to the campus, allowing them to take full advantage of that proximity. When focusing on creating synergies between different firms that are located on the same campus value can be created. Multiple firms have expressed that they would like to see to what degree the input and output of firms can be matched. Not only does this promote sustainable ways of doing business, this does also have a cost saving element, which is one of the main drivers behind this desire.

6.1.1.2.1.2 Infrastructure

Surrounding the infrastructure there are two different camps. One camp commends the infrastructure and the location of the region as being in a sweet spot between different important economic centers, mainly the position between the Randstad and the Ruhr area in Western-Germany. While others highly criticize the region for the lack of an airport. For intercontinental flights you either have to go to Dusseldorf or Amsterdam, while for flight within Europe you can choose to fly from Eindhoven or Weeze. Depending on where you are in the region, these airports are better or harder to reach. Figure 5 (§5.1) gives an overview of where these airports are located. The distance from Nijmegen to Schiphol Airport is especially seen as a hindrance. On the other hand, Nijmegen the closest to an airport of any major city in the region. Namely the distance between Nijmegen and Weeze Airport in Western-Germany is only roughly 50 kilometers. However there is no good way of getting to the airport by using public transport which makes it a difficult destination to travel to and from, from a business standpoint. Both by car and by train the region is not seen as favorable by multiple parties. The connection from Western-Germany into the region

is seen as an obstacle as well as the high ways with the region itself. The highways in the region are often congested. Despite the fact that a new connection will be created from Nijmegen to Zevenaar (to the east of Arnhem), some argue that the added roads will not relieve for the local road network but instead will only increase it further. On a more specific location basis, IPKW is seen as having inadequate connections that allow the delivery of large industrial shipment over the road. The roads surrounding the area are not set up to process the quantity of shipments that are needed to provide the bio-based industry with their input. The infrastructural situation is severely bottle-necked and has a high degree of congestion and traffic jams. Waterway transport however could prove to be a solution to this problem as multiple firms have pointed out. For the connections in the region to be adequate the region needs to have a better public transport connection from Schiphol to Weeze. The lack of a high speed railway is a negative aspect.

6.1.1.2.1.3. Local ecosystem

One of the most important things to discern for The Economic Board is how firms would like to see the ecosystem developed. What kind of firms or institutions they want to attract to the region and how that should be done. The answers to this question can be grouped into two different categories. The first category wants to have a stronger R&D and education sector, while the second category wants to have more industrial activity in the region. Both Synthon and Kraft Heinz subscribe to the notion that a larger R&D sector in the region would improve the overall competitiveness of the region. The added competition in terms of attracting qualified personnel could be perceived as an obstacle, but instead the mass that is then created will only attract more R&D activities to the region. Synthon also mentions that it is import for people to be able to grow within a sector, which growth cannot always occur within the same company. If such as person can find new work within the region then there is no brain drain. The reverse is also true, when there is a deep pool for talent, firms are able to fill positions with more ease, while at the same time having more choices to pick from. The local ecosystem does not only consist of highly educated people who have studied at the university. Also a strong vocational education is important, especially capable technical vocationally educated people are hard to find. A strong applied sciences sector is also very import for the ecosystem. For the semi-conductor industry having design and test houses in the region would improve their embeddedness even further as that would allow for very efficient and short communication lines between the designers, testers and the engineers, potentially speeding up the process. Again here the focus is on the hyper-local scale. The embeddedness of the industrial firms in the region can be improved by having more large industrial activity in the region and having a stronger manufacturing sector. For Veolia for instance, they would like to have other large industrial partners in the region while Hyet would benefit from a strong manufacturing sector. That manufacturing sector has connections with the semi-conductor industry as they use the same type of materials and production technics for different purposes. This is a potential link between both sectors.

6.1.1.2.1.4 Points of improvement for the region

The points for improvement of the region span quite a few different topics but some of them do have overlap. One of the points that the region can improve upon according to some of the firms is the regional governance. There is no real connection between the different elements within the region. One of the reasons for this is the (perceived) high turnover rate in the different elements within the public administrations. Having high turnover makes having continuation of strategies set out previously that much harder. However this seems to be improving. But not only has a high turnover rate made continuation difficult, also focusing on the wrong issues has been mentioned as being perceived as problematic. At the highest level of abstraction this can stem from the fact that there is no single umbrella that can connect the different element within the region. This makes it very difficult to present a united front to the outside world. It has been mentioned that for many firms and people The Netherlands often gets identified with Amsterdam and for instance few Nijmegen as a suburb of Amsterdam. When looking at the international scale, this is not difficult to imagine why this happens. Having a strong identity to unite the different elements with could change this. But also focusing more on the strengths that the region can be improved upon. A stronger focus on clean mobility can improve the embeddedness of firms in these sectors. One of the ways this can be done, as proposed, is for instance attracting and running pilot projects in the region. This does not always have to be done through a tender, as tenders bring about a whole set of rules that you need to adhere to in order to prevent firms getting favorable treatment. These pilot projects would be a workaround for these aspects. There is also enough expertise to justify the choice for granting certain pilot projects to local partners. On the European scale, firms say, that the region can profile themselves stronger and participate in European programs. In the same vein municipalities in the region should try and bolster their local ecosystems as much as possible. This should however happen in cooperation with the firms in that local ecosystem. Municipalities should listen more to what market forces are looking for in a region and what steps can be taken to improve the current situation. This can prevent money being spend on things that are not wanted or asked for. At the same time, it should be possible for firms to have some degree of ownership over what activities they want to perform in the region. The hyper-local scale plays an important role in this. An example of this is the Plus Ultra building in Wageningen, a building that is meant to house start-ups and provide them with all the tools needed to succeed. However firms say that such facilities are too expensive for the intended target group, resulting in such facilities being rented out by large commercial parties that do have the cash flow to afford it. Another big issue for the larger corporations are the amount of hotels and conference facilities. There are not enough high quality hotels with conference capabilities in the region according to some. Making it easier for expats to come here should also be a focus point. In the past the quality of international schools was an issue and made expats either choose not to move here or to house their families in different places in the country or even abroad, for the period that they worked in the region. The local knowledge base surrounding the food domain is of world class quality, Wageningen is the epicenter of this. Wageningen, has a strong focus on

fundamental research. Nijmegen however has the ability to focus on food applications as large companies such as Mead Johnson and Kraft Heinz are already located in the region. Lastly mobility always remains a vital issue that needs attention as pointed out in §6.1.1.2.1.2

6.1.1.2.2 Human capital

6.1.1.2.2.1 The availability of qualified personnel

The availability of qualified personnel differs strongly from sector to sector but also from firm to firm. The overarching result from the technical orientated firms is that locally the both highly educated personnel as technical vocationally educated people are very hard to find. Part of the problem is that some of the activities of some of the firms are so specialized that finding the correct people for these functions is becoming increasingly more difficult. This however is not the case everywhere as NXP pointed out. According to NXP, they had no difficulty in finding capable personnel in the US, while in this region finding people is very difficult. TDI group also notes that finding capable direction personnel is very hard. Both in the food and health sector a fair amount of foreign knowledge workers get hired. Most of these knowledge workers can however not be classified as expats as they usually were already living in The Netherlands. Many of them have for instance finished their studies here or have done their PHD here. These sectors are able to find qualified personnel with more ease than the technically orientated firms. Though there are also exceptions to that statement. Kraft Heinz for instance notes that they are really missing a packaging technology study. Again this could also be regarded as a technical study and therefore follow the trend of low numbers of available highly educated technical students. Hyet on the other hand state that they have no real trouble in attracting the correct personnel. The reason given for this, is that they are fairly well-known in their field and are able to attract qualified personnel because of it.

6.1.1.3 Network embeddedness

6.1.1.3.1 Important partners

6.1.1.3.1.1 Location of the most important partners

Many of the firms have some connections to local knowledge institutions except for the semiconductor industry as there is no technical university in the region. They however have the most local partners, especially now that many of those partners have located to the NTC. Many firms however do point out that their networks are very internationally orientated and not necessarily have lots of local involvement. The Akzo Nobel for instance points out that most of their local involvement stems from their membership of local associations such as the OKA (Entrepreneurs Contact Arnhem) and the local network revolves around non business issues. Firms do attest to the fact that having a strong local network of both complementary firms as competitors is highly beneficial to the overall competitiveness and competence level of the region. Cooperation however does need to be organic and cannot be too orchestrated. Firms do subscribe to the notion that is always beneficial to source locally when possible. The local network is the strongest amongst the firms operating in the food and bio-based sector. Especially in the field of the food application there is a strong network

here with the WUR and NIZO, however these institutes are very expensive and which in turn makes smaller firms not always able to afford them.

6.1.1.3.1.2 Trade-linkages

When looking at the network embeddedness of the firms, many firms focus on the global market and as such have trade-linkages all over the world. Multiple firms have expressed that they will always choose for the best suited company for each part of the operation. Locality does not really play a part in this decision making process. This however does differ from sector to sector. The Eindhoven / Nijmegen area is an important area for the manufacturing of complex materials. The semi-conductor industry and the hydrogen fuel cell industry for instance both rely on laser edging technics to manufacture parts for their products. Despite the fact that the sectors are totally different, they have common elements within their supply chain. This can potentially be something that can be taken advantage of in terms of embedding. Multiple firms have also expressed to have strong ties to the Utrecht area, especially to the University of Utrecht. For the bio-based industry local linkages are the most important as when you are able to get your input from local sources, you will save costs compared to when you need to get your input from the international market due to the difference in logistical costs. Therefore you find more local connections here than with firms that are mostly involved knowledge intensive activities such as R&D. Synthon for instance has their production plants abroad and only do R&D and business services in the region. This is something that you see with more firms such as Akzo Nobel, who mainly perform business services tasks in the region.

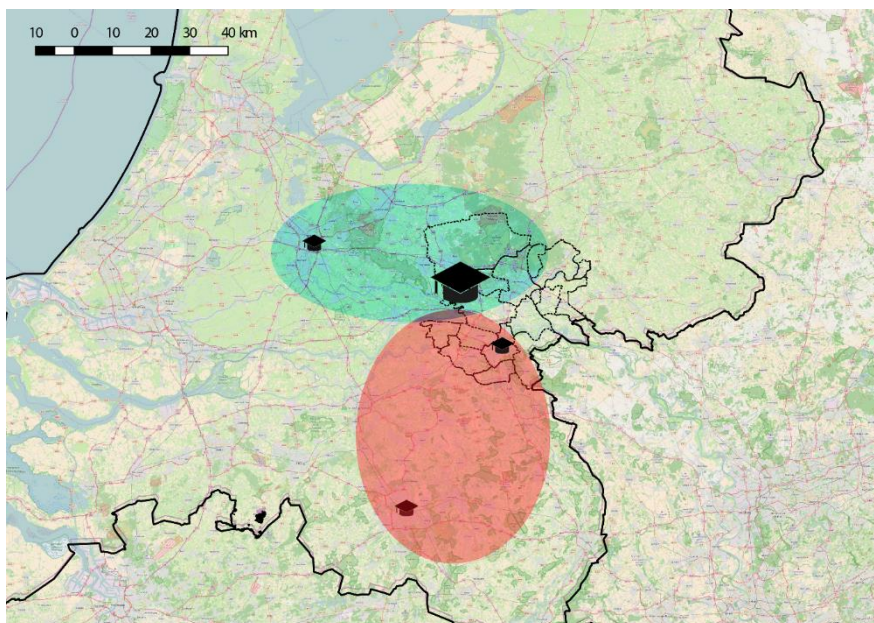


Figure 15 Extended regional scope

6.2 Institutional framework

6.2.1 Institutional setting

6.2.1.1 Triple helix involvement

The level of triple helix involvement differs between firms. For the most part, the larger firms and transnational corporations that have the most involvement with the local government. One of the possible explanations for this, is that the larger firms have a bigger stake in the region. There is an overarching theme were firms want to protect their local investments and influence the direction governmental policy is going. This is done in a number of ways. In Nijmegen, the department of Economy has account manager for large firms such as Synthon. The account manager serve as the connective element between the large firms and the municipality. Akzo Nobel states that most of the triple helix activities are through the associations which they are a part of such as the OKA. The network organizations such as Food Valley, Health Valley, kiEMT and BCS are also important vehicles that firms use to get involved with the triple helix. The Economic Board is actively trying to both instigate and be receptive for contact with both firms as knowledge institutions. This is especially useful or the firms that do not have the size nor the means to participate in triple helix constellations to the same degree as a transnational corporation might. Overall most of the firms know how to get involved with the triple helix. One firm has expressed that they are moving a part of their business to the US. They state that the region they are moving to have a very strong triple helix and say that the local government as well as the university in question there provide a lot of support. Having a strong local triple helix certainly can be beneficial for the proliferation and fostering of economic activity. However as Akzo Nobel expressed, too much triple helix activities can also definitely be a danger for a region. They state that firms and institutions should not cooperate for the sake of cooperation. Regional cooperation also can bring about a conflict of interest between the different actors involved, especially transnational corporations can at times have conflicts of interest in regional cooperation constellations. Effective governance is also important as stated by Miscancell founder Alfred Hakvoort. Public money should not be spend on research for the sake of researching but rather focus to spend money on results instead.

6.2.1.2 Regional economic governance

6.2.1.2.1 The role of the local government in the regional economy

Multiple firms expressed frustrations with either the way how the local government is run or the decisions that they make. Many of the frustrations that firms are experiencing pertain to business support and the business climate in the region. Some firms express that the municipality is very slow in their decision making and have stated that this has led to firms forgoing their decision to move to the region. Other firms state that the municipality invests in the wrong things or are doing inefficient investments. A concrete example of this, is the situation that the TDI Group encountered. They wanted to strengthen their core business, e.g. establishing and supporting start-ups and innovative companies. Instead of receiving funding they learned that, the money already had been invested in a new, fancy building

Ultra Plus, a building that in the end provided the region with good publicity but ultimately was too expensive for the group that they were targeting. Another example is of the NTC. The NTC is growing at steady rate and will as NXP explained, get increasingly larger problems with parking, valuable space on the terrain will, as it stands now, be converted into a mosque. NXP states that they have no problems with having a mosque on the terrain in theory. In practice however that space could also be converted into parking space or house a firm that is more suited for the environment, like a high-tech or e-health firm. On the other side of the argument there are also firms that are very content with the way the local government handles things and how they facilitate them in their business ventures. There does not seem to be a lot of overlap in economic focus with regard to where municipalities focus upon. This might be inherent to what sectors are the most prevalent in those municipalities. On hyper-local scale, all municipalities are committed to some degree to strengthening their different campuses.

6.3 Inter-firm sphere

6.3.1 Inter-firm relations

6.3.1.1 Cross-sector opportunities

6.3.1.1.1 Diversification

Diversification can be interpreted in a number of different ways. It can refer to the diversification within the core business of firms but it can also refer to related variety or in other words, a diversification in types of firms that operate in the same branch of industry. A good example of this, is Miscancell. Bio-based start-up Miscancell uses an extruder to extract different types of materials from plants. These materials can be used in a multitude of different sectors. Bio-based firm Pectcof also extract different types of materials from their biomass and their materials are also useable as input for different industries. Diversification within a region therefore can really be empowered by the matching of different input and output streams. TDI Group is another example of how diversification can lead to the development of new technology and the establishing of new firms. TDI Group uses knowledge spillovers from one sectors and applies them to another. This often results in very disruptive and novel technology. They state that a strong diversification within their core business is integral for stimulating innovative practices. Diversification within the region can also be a tool to connect unrelated industries such as the semi-conductor industry and the hydrogen industry. Their core business is totally different, however the production technique shows a degree of similarity. For diversification to be successful firms and knowledge institutions need to have a degree of proximity in both their thinking, business culture, core business and locality. Physical locations such as IPKW and NTC are perfect melting pots to stimulate organic growth of such activities. These hotspots also provide the perfect environment for spin-out and spin-off activities. Multiple firms have stated that employees have either left the firm to start their own company or have left other firms to help start-up one of the interviewed firms. TDI group argues that it is important to be able to valorize knowledge if knowledge workers have a good idea and want to turn that into a

business. Being in an environment that stimulates such diversification is paramount for the success of such an endeavor, an environment that TDI group tries to create to enable such practices.

6.3.1.1.2 Involvement in cross-over activity

A business model or a project can both be an intentional cross-over between different sectors or it can be an unintended result of certain choices. That's why we can identify a host of different forms of cross-over activity in the region. The forms range from highly disruptive to the optimization of an existing product or service. If we regard matching the output of one firm with the input of another's as a cross-over then the most prevalent form of cross-over in the region occurs between the Food and the Energy sectors, resulting in the Bio-Based sector. Cross-over activity in this sense flows both ways. On the one hand biomass is a rest product of the Food sector, this biomass can in some cases be used as fuel for biomass installations. On the other hand, the glasshouse industry needs Co₂ to grow their plants and flowers. Co₂ is a rest product that is produced as a result of the incineration of the biomass. Waste processing firms are in theory able to capture that Co₂ and use that as the input for the local glasshouse industry. Other examples are the different forms of output that a Bio-Based firm such as Miscanell produces, which can provide the input for several other industries. In the case of Miscanell these cross-overs came into being through the existing local network that the firm already possessed. Bio-Based firm Veolia states that they would very much be interested in seeing what synergies are possible on IPKW and how they can connect the different input and output streams that exist on the park.

Not all cross-over involve the matching of input and output streams. This is nowhere as evident as on the NTC. Here you see that physical proximity and being connected to the same networks helps stimulate cross-over activity. One of the most important actors here is Radboud University valorization firm SMB. Through different events, firms are able to get to know each other and see how their different competences can lead to cross-over opportunities. These events serve as the initiator for such activity. Here we see that the combination of high-tech and health leads to the development of new products and procedures. This can be in the form of robots for the medical sector, software to detect diseases or medical sensors in your electronic devices. Doeco Terpstra from NXP states that having these different sectors close together allows them to learn from each other. Which in the future can potentially lead to the development of new products and services. Another important actor that stimulates cross-over activity in E-Health is start-up accelerator Rockstart, which is also located on the NTC. Rockstart provides a platform where innovative start-up firms in the E-Health sector can get guidance and help their growth process. Leading to the proliferation of cross-over activity in the region.

Cross-over activity also gets instigated by the different knowledge institutes. One of such examples is between the Food and the Health sector. For the Food & Cognition project both Food and Health firms and institutions worked together to get more insight into how food impacts the brain. Amongst the participators where the WUR, the RU, NIZO and Kraft

Heinz. These forms of cross-overs are purely focused on gaining scientific insight and are therefore fairly fundamental of nature. Kraft Heinz Technology Manager Dick van Olderen, however states that such projects can at times be a bit more difficult to get off the ground. More concrete forms of cross-overs between the Food and Health industry is research done by Kraft Heinz to reduce the amount of salt in their Ketchup without losing any of the taste.

Of all the firms that were interviewed, two explicitly expressed the value that cross-over activity has for their operation. The first is Allego and the second is TDI Group. In the case of Allego, they expressed that their core business has a lot of elements that crosses over into the realm of other industries such as IT, Electro technique and Finance. Therefore they argue that having the correct 'cross-over' mentality is vital for their firm. TDI Group stated that cross-overs are vital for the development of new business ventures, knowledge spillovers from other industries are an important source to develop disruptive innovations.

Akzo Nobel had the most interesting interpretation of how they utilize cross-overs. They state that because of the type of activity the firm has in Arnhem, e.g. business support, cross-overs only take place outside of the core business sphere. Instead Akzo Nobel tries to seek a connection with the creative industry that Arnhem is known for. The combination of both worlds do not necessarily improve the bottom line, or so Akzo Nobel states. Rather it challenges both to come out of their comfort zone and are able to look at the other's activities with a fresh look. Akzo Nobel director Peter de Haan explains how the people working in the creative sector at times serve as a source of inspiration for him. At the same time, he offers solutions and guidance any way he can to those people in return.

6.3.1.2 External linkages

6.3.1.2.1 Outsourcing

With regard to outsourcing there are differences both in the amount of work that gets outsourced, as well as the type of work that is being outsourced. Many of the firms that use outsourcing, first orientate regionally for firms to outsource work to. Many of the firm that use outsourcing, outsource more than just catering and building maintenance such as cleaners and security. The technical firms outsource the production and test activities. While Kraft Heinz outsource contract research. The reasoning behind outsourcing contract research is that, this way they can always call upon the best in the business when it comes to every single subject. Because of this, the research does not necessarily get outsourced locally but as Kraft Heinz explains, they have worked with local knowledge institutions such as NIZO in the past. The technical firms do outsource locally. NXP states that proximity is very important for the design and testing activity due to the analog nature of the work. How closer those partner are, the more beneficial it is for the process. Hyet still outsources all the production locally but has since started looking at where the best producers of laser edge technology is and came to the conclusion that most of these firms are in fact not located in the region or even in the Netherlands. The bulk production however still is done in the Netherlands. The Eindhoven / Nijmegen area is the epicenter for these activities. Other companies use outsourcing as a means to see how well people fit into the organization. Allego for instance, has a relatively high rate of independent entrepreneurs that they employ

and other outsourcing business. If the independent entrepreneurs perform to a degree that they become interesting acquisition targets, Allego is then able to sign them to a contract.

6.3.1.3 Innovation climate

6.3.1.3.1 Local practices of information sharing

On the question how firms regarded local practices of information sharing, the answers differed quite a bit. The interesting thing is that some firms were rather negative about the local practices of information sharing while others were rather positive. The firms that were positive about the local practices of information sharing expressed that this could be attributed to their connectedness to different networks. Through these networks information is able to flow easily and for the most part unobstructed allowing for innovation to occur. The firms that were more critical over the local practices of information sharing stated that a lot more synergy could be realized when the exchange of information would go more freely. Better information sharing would allow for better analyzing how the different input and output streams of different companies can be utilized. Most of the information sharing now occurs in the pre-competitive sphere, for instance for EFRO projects, or other European research programs. If firms would be more transparent, cooperation and innovative practices could be stimulated, making it easier for firms to discover what possible companies there are. At this moment, a lot of communication does not happen in a manner that encourages open innovation, instead through NDA's and licensing deals firms contractually protect their own business interests. One of the pitfalls of cooperation and information sharing, especially when done through research consortia, is that firms might have hidden agendas or try to freeload. This has dissuaded some of the firms to participate in consortia with partners outside of their regular network or even dissuaded them from working with local partners as a whole. It is also important for the regional ecosystem that there is a good mixture of both large firms, SME's and knowledge institutions within these consortia. Smaller firms are able to make big growth spurts when involved with the correct consortium. It can create a fly wheel which in turn helps propel these firms to new heights. Alternatively people might leave (larger) firms and start-up their own company and spread knowledge within the region in that way. This has happened on a number of occasions. The transfer of personnel from firm to firm is both an opportunity as a pitfall for firms. Synthon for instance states that they have been able to make a tremendous amount of progress when starting up their innovative branch due to the hiring of ex-MSD employees. The tacit knowledge that these people possessed where invaluable for the development of the innovative branch of Synthon. On the other hand Kraft Heinz states that competitors have been headhunting employees of their quite a bit in the last few years, even though this proves that firms value the education that people receive at Kraft Heinz, this does pose a threat to the company.

Some firms have stated that information sharing in the Netherlands is harder due to cultural disposition. One of the reasons given for why Dutch firms are not keen on sharing too much information hinges on The Netherlands being a trade nation that is very export orientated and therefore has a stronger short term focus rather than long term. Other firms also reiterate the point that being part of a network should help your bottom line in some way, if it does not then the smarter thing might be to step out of that network. Right now, there are a

plethora of networks, some of which according to some firms, do not attribute as much as others do.

6.3.1.4 Information sharing

6.3.1.4.1 The role of trust

The role of trust between partners is the most important for the knowledge intensive firms, who mostly focus on R&D. Being able to have knowledge flow easily between nodes in a network helps the adoption of innovative practices. At the same time many firms state that the communication between firms only intensifies when NDA's are signed. When firms are strongly embedded in their network, trust seems to be at a very high level. While firms that are less embedded in their network, meaning that they do not have a number of partners they intensively cooperate with, the trust factor seems to be a lot lower. Therefore it seems that for knowledge transfer between actors to be successful, network embeddedness is vital.

6.3.2 Cognitive proximity

In order to be involved in any kind of cross-over activity, inter-firm cooperation or firm-research institute cooperation a certain measure of cognitive proximity is required. Within this case study the cognitive proximity seems to be the highest between firms that are located in close proximity to each other. Especially the firms located on IPKW and NTC display a high degree of technological relatedness. Examples how technological relatedness can lead to new connections are the matching of input and output streams of the different companies involved to reach optimal synergy. But also the combining of technological knowledge and medical knowledge are examples of how the correct cognitive proximity is able to lead to the development of new products and services. The following firms displayed a measure of cognitive proximity in the following sectors that either has led to developments or that would allow for future developments:

• Food and Bio-Based	High-Tech and Health
Pectcof	Noviosys
TDI Group	NXP
• Food and Health	• High-Tech and Energy
Kraft Heinz	Hyet
TDI Group	Allego
Synthon	• Bio-based and chemistry
• Bio-Based and Energy	Miscancell
Veolia	Akzo Nobel

From the 11 firms that were interviewed all 11 firms have expressed that they either had previously participated in activities that could be regarded as cross-overs or stated that they could potentially engage in such activities if they would see an opportunity for it. Figure 14 gives a schematic overview of the different relations between. What you can see here is that

except for the chemistry industry, every sector has two sectors that display a form of relatedness. This figure however does not say how big the cognitive proximity or difference between the sector is, only that the proximity is deemed sufficient for future interaction.

6.4 Firm sphere

6.4.1 Technological knowledge base

6.4.1.1 R&D

6.4.1.1.1 In-house R&D

Integral to a firm's technological knowledge base is in-house R&D. The more a firm invests in R&D, the more resilient a firm becomes to shifts in the market. A prime example of this is Synthon. Originally Synthon produced generic medicine, meaning medicine from which the patents had been expired and were allowed to be produced and sold by other firms. They noticed that less and less medicine was being developed, a fact that potentially would jeopardize their future earnings. To combat this Synthon opened an innovative branch that aimed to develop new medicine treatments to strengthen their competitive position on the market. They did this by investing a significant part of their revenue into the innovative branch, so that the branch would have the best possibility to succeed. This is a trend that can be identified with multiple of the interviewed firms. A large part of the regional activity that these firms display either solely involves R&D activities or heavily focuses on R&D activity. This proves that firms value R&D and the effect it can have on their business. Open innovation is highly regarded by many firms, multiple firms have expressed that a high degree of openness has a positive effect on one's ability to innovate. However a large part of the firm interviewed are still wary about open innovation and how it can impact their intellectual property and in turn their competitive advantage. As such most of the open innovation occurs in the pre-competitive phase, in large fundamental research projects. Of all R&D done by the firms, only a fraction is geared towards or involves cross-over activity. Firms that have participated in cross-over R&D efforts state that it does not always necessarily add to the bottom line. Of all the firms that were interviewed, only a single firm stated that they only focus on the product development side of the R&D. The research element is fully outsourced to ensure the best scientists in every field work on the correct projects. All other firms did all the R&D in-house.

6.4.1.1.2 Extra industry knowledge

Extra industry knowledge is a very important source of knowledge for firms. Staying connect to knowledge and research institutes allows firms to keep up with all the latest developments in the market.

Academic Universities	Number of connections
Wageningen University & Research	5
Radboud UMC	2(3)
Radboud University	0
TU Eindhoven	2
TU Delft	2
TU Twente	2
University of Utrecht	2
Universities of Applied Science	Number of connections
HAN	5
Van Hall Larenstein	1
HAS	1

Table 11 Knowledge institutions connections

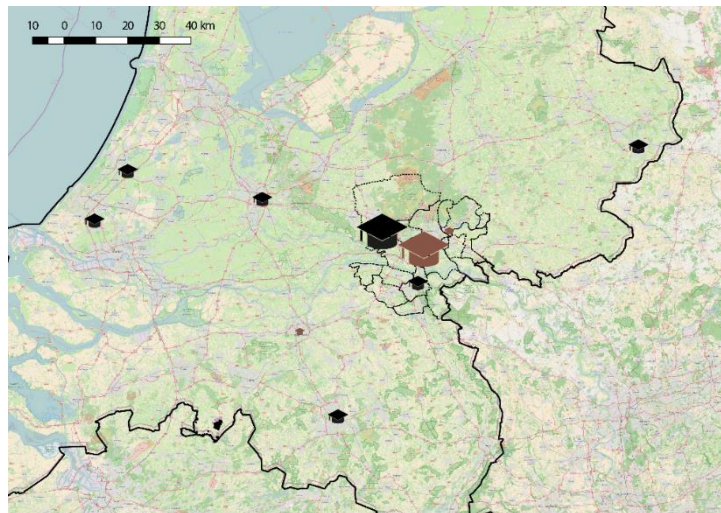


Figure 16 Knowledge institutions connections

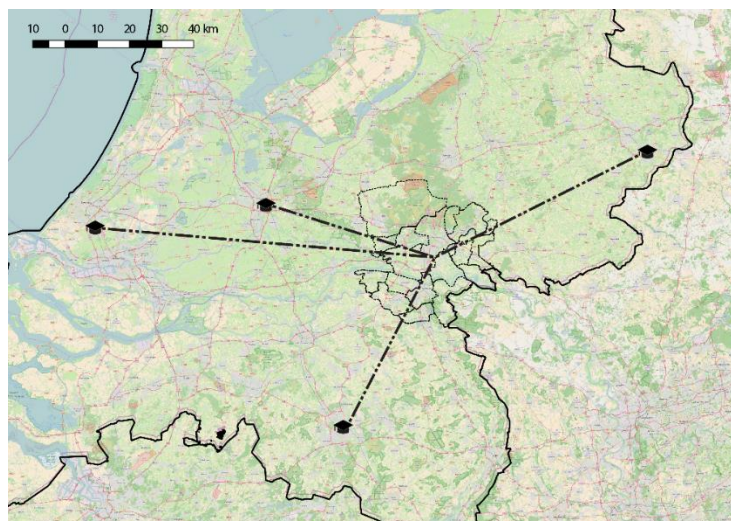


Figure 17 Technical universities or universities with technical connections to the region

Table 11 gives an overview of out of the 11 interviewed firms, how many times a knowledge institution was mentioned as a connection. A few conclusions can be drawn from the results as displayed in table 11. From the two universities in the region, the WUR is significantly more important to the interviewed firms than the Radboud University. Out of the 11 firms, none had any connection to the Radboud University when discounting Radboud UMC. The medical part of the University does have ample connections in the region, this can be partially attributed to the efforts of SMB. It comes to no surprise to see a fair number of technical universities on the list, something that the case study area is missing. The University of Applied Sciences Arnhem Nijmegen (HAN) on the other hand has connections to just under half of the interviewed firms. Despite this fact the value the institution has differs from firm to firm. Some firms say that the curriculum of the HAN connects well with the core business of those firms. While other firms state that the HAN focuses on the wrong issues, instead of following the market, setting out their own course, regardless of the added value to the market. The level of coordination between Van Hall Larenstein and the HAN can also be improved according to some, as doing so would increase the efficiency and effectiveness for both. Another critical observation that was made, is that a great number of institutions offer the same study. Some feel that having too many institutions that focus on the same thing will have a negative effect on the overall quality of the studies. It is therefore argued that it would be better to have certain studies only be taught on a select number of institutions. Doing so would potentially have a positive effect on the quality of those studies.

Many firms are not directly involved with the academic universities. Instead something that can be identified across most of the firms is that through the network of employees, firms are connected to those universities. There are multiple firms with employees who are also (associate) professor at a university. Other firms also employ people that have done their PhD at a local university or have employees that are (recently) graduated from these institutions. Therefore the network embeddedness of most firms is fairly strong allowing them to have ample knowledge of the developments at those universities and where to ask which questions when encountering knowledge barriers.

6.4.1.2 External funding

6.4.1.2.1 The usage of grants

Public funding plays a vital role in a firm's ability to innovate. That is the message multiple firms have given off. It was interesting to find out that, grants and other governmental subsidizing tools were so important for both large and small firms alike. That having said, this is also where the main problem lies. Multiple firms have indicated that their ability to innovate has been curbed by the administrative nature of governmental grants. The way these grants are worded leaves very little room for interpretation. This creates a situation where only a specific field is able to apply for that grant, in doing so the market is artificially nudged into a certain direction. This has as number of different effects. On the one hand, this crowds a certain market and places a strain on the supply of a certain resource as firms are forced to use a certain type of product in order to be eligible for that grant. On the other hand this discourages firms to look for different innovative avenues as then they would not

be eligible for that same grant. This has dissuaded multiple firms from applying for funding as they did not want to be limited by the strict formulation of the grant. At the same time firms express that they are not always aware of the total scope of all possible grants. The landscape surrounding all the different subsidies is experienced as fuzzy and unclear. These factors can have a hindering effect on firm's ability to innovate and thus have a negative impact on the competitive position of the region.

6.4.1.2.2 The ease of which to acquire funding

Many firms state that they have been fairly successful in their efforts to obtain governmental subsidies. However as stated above, the ease of acquiring that funding is quite a bit lower when a certain project does not fit the requirements needed to be eligible for such grants. Firms have stated that in trade for company shares they try and acquire funding while others have a single large investor that provides the firm with all the funds needed to run the business outside of governmental grants. The large transnational corporations are even though they are listed on the stock exchange, provided with the budget by the mother firm and need to look for funding via that route.

6.4.2 Spillovers of competitors knowledge

6.4.2.1 Competitor overview

6.4.2.1.1 Origin of competition

From the 11 firms that were interviewed, 10 of them operated on the global market. For the most part these firms were very aware of where their competition is located and how the competitors' products and services stacked up against theirs. At the same time, most firms indicated that if they were affected by globalization in any way, that they were experiencing benefits rather than stiff competition. Some firms even stated that globalization as a phenomenon has been vital to their ability to operate globally and allow them to reap full benefits of globalization. One important thing to note, is that some of the firms already moved most of their production activities abroad, to places where the wages are lower and therefore allow them to operate under more favorable circumstances. Only their very knowledge intensive, specialized and business services activities are still present in The Netherlands.

6.4.2.2 Information sharing

6.4.2.1.1 Imitation

Locally knowledge does not generally unwillingly get transferred through means of imitation. There are a few reasons for this. Firstly many of the firms do not have direct competition locally, instead most of their competition comes from abroad. Secondly because of the nature of most activities most firms do, it is very difficult to benchmark and imitate. However firms do attest to the fact that imitation occurs on the global scale, sometimes to an extent that firms have experienced some form of repercussions such as damage to their image. At the same time, many firms also admit to focusing on benchmarking products put out by competitors as much as possible. This is either done through disassembling competitors' products or analyzing patents. In the past this has led to either the development of new products or gaining valuable insights about what choices the competition has made.

6.4.3 Future outlook

Most of the interviewed firms were very positive about their immediate future. Only those firms that were in the start-up phase were more hesitant of the future. Many firms were also quite positive about their future outlook when looking at how the region as a whole. The region however does have one major issue as pointed about by some firms. The focus of the region is not always consistent with the qualities it has. Moreover there is not a single umbrella under which all activities can be represented. As it stands the region has chosen to focus on the Food, Health and Energy sectors. This focus is both very broad and at the same time not broad enough for some. It kind of lacks the cohesion to connect it all together while at the same time excluding other sectors that are of note in the region. Some feel that to be able to compete with regions with a stronger identity, this region should also work on creating a uniform identity, with which all parties can identify with. One such identity, as proposed, could for instance be 'Healthport' a region where all activities are geared towards healthy living, sustainability and a clean environment.

6.4.4 Absorptive capacity

Absorptive capacity is, just like cognitive proximity, very hard to clearly define. It can manifest in many forms and there a multitude of factors that affect the absorptive capacity of firms. Investing in R&D will increase a firm's ability to absorb knowledge, but also being embedded in the correct networks will help a firm accomplish this. Absorptive capacity and regional knowledge spillovers influence each other. They do this in a manner that both the input of a company as well as the output can lead to regional knowledge spillovers and therefore are subject to the absorptive capacity of firms. When looking how well firms are able to take advantage of cross-sector knowledge not many firms actively focus on strengthening their ability to take advantage of these cross-sector knowledge spillovers. What can be identified is that most firms are very well embedded in networks that would allow them to build up the absorptive capacity needed to be able to translate cross-sector knowledge spillovers into a workable format. Staying in contact with research and knowledge institutions is vital if firms want to be able to invest in such capabilities when the opportunity arises. Also the nature of the business is an important factor in determining how suitable cross-sector knowledge spillovers are, as some sectors have such specialized processes and end products that finding suitable replacements or complementary elements outside of their own sector is much harder than in other sectors. There also seems to be a positive connection between physical proximity and a firm's absorptive capacity. Being in close proximity of each other, there is a higher chance of being exposed to each other's innovative activities as well as being able to have firms come to together in early stages of development. The pre-competitive stage is deemed the most effective for shared development. At the pre-competitive stage, firms are able to use the same technology to work towards a different end goal, this ensures that firms are not in direct competition at a later stage. Two combinations can be identified where absorptive capacity has led to the development of new technologies. The first instance is matching the output of Bio-Based firms to the input of firms in the Paper industry and the Food industry. The second example is of developments in the Energy sector having led to changes in the high-tech and Automotive industry.

6.5 Regional stickiness

Paragraph 6.1 to 6.4 have focused on detailing how the different elements of the conceptual model (§3.1) can be identified and how they manifest themselves in practice. The knowledge gained from these insights will now be distilled into what makes the region attractive or in the words of Markusen (1996) 'sticky'. This paragraph will take both an inductive as a deductive approach for determining the 'stickiness'. The former will focus on the spatial structuring within the region, while the latter is more process-orientated.

6.5.1 Inductive elements

When looking at how the regional economy is structured and what the largest contributors to the embeddedness of firms in their corresponding sectors are, then the observation can be made that the region is home to a number of governmental institutions and large universities. In the state-centered district these large institutions serve as anchor points for the regional economy. Markusen (1996, p. 307) states that the long-term growth in such a district is highly dependent on both the prospects of these facilities and their ability to encourages growth within the region by spawning local suppliers, spinning off new businesses, or supplying labor or other factors of production to the local economy. In the case study area these organizations all correspond with the three sector as focused upon by the local government, Food, Health and Energy.

The food sector is anchored by the WUR, a world renowned institute in the field of agrofood.

The health sector is anchored by the Radboud UMC, an academic hospital with multiple research institutes as well as the home for medical education in the region.

The energy sector is unlike the previous two sectors not anchored around a university. Instead the energy sector is historically present in the region because of utilities company Nuon. Nuon used to handle the transmission, product and distribution of the electricity, natural gas and warmth for multiple areas in the Netherlands, including the province of Gelderland. After a policy change, the company was sold to the Swedish company Vattenfall. After the sale, the company got divided into N.V. Nuon Energy and Alliander. Currently Alliander provided one in every three people in the Netherland with energy (Alliander, 2016). The company also has two daughter companies called Liandon and Liander. The headquarters of Alliander, Liander and Liandon are all in the case study area. These companies are not public property, however they do serve the public sector and the government has a large stake in the companies. Another large energy firm in the region is TenneT, who are in charge of all the power lines in the country. Encourages growth within the region by spawning local suppliers, spinning off new businesses, or supplying labor or other factors of production to the local economy.

The high-tech sector or the semi-conductor sector however is more structured as a hub-and-spoke network with a single large anchor firm or a former large anchor firm, being the main reason for the clustering of economic activity surrounding that sector. In 1988 then Philips, NXP, opened a chip production factory in Nijmegen and has ever since served as the main anchor for high-tech and semi-conductor activity in the region.

Following the definition of an industrial district of Becattini (1990) the region does not consist of a single large industrial district, but is made up of a collection of smaller industrial districts, each with their own community and a set of homogenous values. Other than in an Italian industrial district (see §2.1.2), firms are less locally entangled and as such the region does not have a strong uniform identity as Italian industrial districts display.

6.5.2 Deductive elements

Many firms exhibited traits that would suggest that when taking a more process-orientated approach, the model that fits the best is the social-network model. The scale of the economic activity does not warrant it to be able to label it as a true-agglomeration economy. The case study area is just too small for that. The region also lacks any true industrial and organizational clustering to be able to label it a true industrial complex. However the degree of social interaction between firms and institutions is relatively high. Firms are well connected and express that informal connections are an important source for information and business relations. Also integral to the social-network model and identifiable in the empirical data is the relative low importance of the physical dimension. Despite the fact that firms do attest to the fact that proximity can have a beneficial effect on their ability to innovate, the physical location of the firm has little bearing on their ability to communicate with their network. With multiple firms stating that they would probably be able to flourish in other regions as well.

6.5.3 Measure of stickiness and embedding

A strong argument could be made for a positive connecting between the territorial embeddedness of a firm and the measure of stickiness a region exhibits. Namely, if a region has a high degree of stickiness, there is also a good chance firms will be strongly territorially embedded. So how sticky is the case study area and how embedded are the interviewed firms?

Many firms display a high degree of network embeddedness, firms are well connected, which allows them to utilize their network to find new business opportunities, find solutions for R&D obstacles and attract the necessary personnel to help them keep up with the workload.

Most of the territorial embeddedness firms exhibit is due to investments in local real-estate. Investing in real-estate signifies that firms are committing to the region to a certain degree and investing in the local ecosystem. However the embeddedness of many firms is much stronger at the hyper-local level compared to the regional level. This can be attributed to the wide spread differences between the different sectors. There are also factors that threaten the likelihood of some of the sectors. Firstly the region severely lacks in the availability of technically educated people. Firms have stated that a large part of their territorial embeddedness can be attributed to human capital and the valuable knowledge that these people possess for the company. This can in the long run cause firms who are currently investing in local real-estate to move their operation to places where job vacancies are more easily filled. Some firm have already started up locations in places where finding the correct people is a lot easier. The territorial embeddedness of firms is also hampered by both the

availability of suitable facilities as the bureaucratic nature of how is decided what is possible facilities wise. This is especially true for Wageningen. Firms have stated that the municipality could make smarter investments if it aims to facilitate and stimulate start-ups and spin-off activities, as well as creating an environment where firms are able to experiment and innovate.

The degree of territorial embeddedness currently is at a reasonable level. However it becomes more evident as to why the territorial embeddedness is at the level where it is, when you factor in the societal embeddedness. When factoring in the societal embeddedness, one could pose the question: how strongly is a region's development influenced by path dependency and how easy is it to break free of such path dependency. The food, health, energy and high-tech / semi-conductor sectors are all to some degree subject to path dependency. If the WUR would be located in any other region, the argument could easily be made that many of the knowledge intensive food firms would also not have been located in the case study area. Large institutions such as universities are, fortunately for this region, extremely territorially embedded. Therefore there is little to no danger of these sectors seeing an abrupt exodus of important firms and institutions. Out of the 11 firms that have been interviewed, the 2 only firms that were not founded in the region, but explicitly choose to come to the region, were in food and health sector, one of which is the R&D center of one of the largest food brands in the world. All other 9 firms were either founded in the region or have been here for a very long time. The degree of societal embeddedness of the firms are thus also quite high. Because of this the argument that these firms are in part, territorially embedded due to their path dependency can be made. For the region this can turn into a problem down the road. The food and health sectors are strongly embedded regionally. The bio-based sector is due to the nature of the activities very immobile. Moreover I suspect that larger agglomerations will always need a bio-based sector, due to the fact that every large center will generate waste. The sector also has ties to the food industry and therefore can be considered to be safe as well. The high-tech and energy sectors however are at the highest risk of seeing a decline regionally, in the future. At this moment, these sectors are heavily investing in the hyper-local, investing in creating a campus where innovation and the exchange of ideas can be stimulated and facilitated. Aside from their physical presence, these sectors are not very embedded regionally. Their knowledge base resides outside of the region, as well as most of the production activities. The availability of highly educated human capital is also a negative aspect for these sectors.

7 Conclusion

7.1 Answering the research question

7.1.1 Context

The regional scale is seen as the most important scale to encourage, stimulate and facilitate innovative practices. Having a healthy and stable regional ecosystem is therefore paramount. One of the ways to work on this, is to focus on the embeddedness of firms and stimulating cross-sector activities or cross-overs between the different sectors within a region. The Arnhem, Nijmegen & Wageningen region has chosen to focus on three different sectors, food, health and energy. These sectors are deemed vital for the regional ecosystem. This research however extended the scope from three to five sectors: food, health, energy, bio-based and high-tech / semi-conductor. By focusing on five sectors instead of three, this research tried to construct a complete overview of important economic activity in the region. The research set out to contribute to the following statement:

“Improving the embeddedness of firms within the region and stimulating cross-over activity in order to stimulate innovative practices within a regional economy”.

In order to be able to accomplish this a research question with a set of corresponding sub questions have been formulated. This was the **main research question**:

“How is cross-sector value being created, enhanced and captured, through means of a cross-over network, between the (related and unrelated) food, health & energy, bio-based and high-tech / semi-conductor sectors in the Arnhem, Nijmegen and Wageningen region?”

The sub questions will first be answered, after which the **main research question** will be answered. The chapter will finish with recommendations for future research and a reflection on the research

7.1.2 Sub questions

This research had four sub questions, of which number two till six will be answered in this paragraph. The answer to the first sub question can be found in §2.2.

The second sub question was:

“How is the regional ecosystem embedded in the geographical context?”

This sub question focuses on how the regional ecosystem is geographically embedded. Or in other words what value does the geographical location of the region has to firms. On the surface this question does not necessarily relate to the activity of a firm. Instead this question aims to determine how the proliferation of cross-over activity is impacted by the geographical dimension. The findings of this research indicate that the Arnhem, Nijmegen & Wageningen region is valued both highly for its geographical location as well as regarded as lacking by others. Firms state that the geographical location of the region can both be regarded as a strength and a weakness. On the one hand, it has a strategic location between the Randstad on the left and the German Ruhr area on the right. Accessible by both water, road and railway. On the other hand the region lacks a true metropolitan area as well as an airport. As such the region cannot compete with large metropolitan areas in terms of its

international competitive position. This can be a threat for retaining and attracting successful and upcoming knowledge intensive firms who either want to be close to airports or have employees that prefer to live in large metropolitan cities. The regional scale for many firms does not coincide with the regional scale of the (local) government. At the lowest abstraction scale, the scale I call the hyper-local scale, firms are often embedded in local networks. At an intermediate scale, the regional scale, the regional ecosystem stretches out far beyond the borders of the administrative regional demarcation.

The third sub question was:

“How are Food, Health and Energy, bio-based and high-tech / semi-conductor firms in the Arnhem, Nijmegen & Wageningen region connected through a network?”

There does not seem to be a network dedicated to cross-over activity. Cross-overs are not the highest priority for most firms. The potential for a diversification effect relies on a few factors. On the one hand firms and knowledge institutions need to share a certain knowledge base and a certain degree of cognitive proximity in order to understand each other. On the other hand diversification needs to be a priority for the core business of firms. Meaning that firms need to dedicate part of the R&D efforts for the development of these cross-sector ties to be able to take full advantage of regional knowledge spillovers. As it stands right now the R&D efforts are mainly focused around the core business with cross-over activity being seen as a secondary focus, its regarded albeit interesting, still very much is seen as a nice extra but not crucial. This feeds the idea that cross-over activity is hard to stimulate, cross-sector knowledge spillovers seem to occur on an incidental basis, rather than a structural one. Cross-overs do not necessarily occur only between sectors, also firms in the same supply chain can developed activities that would be considered cross-overs. The key to these interactions for the most part is physical proximity and network proximity. Being in close proximity to firms in different sectors or different parts of the supply chain increases the exposure firms get. Especially the role of formal and informal events are an important initiator for establishing contact between firms. That can be having lunch in a common cafeteria or formal events, as long as firms get exposed to influences of other sectors and firms, the greater the chance that something will develop.

The third sub questions was:

“To what extent are Food, Health and Energy, bio-based and high-tech / semi-conductor firms able understand, absorb and implement external knowledge from the other sectors?”

In order for firms to be able to understand, absorb and implement external knowledge from other firms, having a suitable degree of cognitive proximity is required. Figure 14 (§6.3.2) gives a good overview of how the different sector stack up to each other. However the most important aspect for firms if they want to be able to take advantage of regional knowledge spillovers is for firm to build out their knowledge base and make sure they are embedded in different networks. Doing so will improve a firms absorptive capacity and allow them to be able to understand, absorb and implement a greater degree of external knowledge. No connections were found between energy firms and health firms. Other combinations should

be able to lead to new developments. The current extent to which firms are able to understand, absorb and implement external knowledge from other sectors is for the most part low as cross-over activities are for a large extent seen as interesting side projects when possible.

The fifth sub question was:

“How well are firms facilitated in their ability to innovate by the government and other institutions?”

For cross-over activity or novel technological practices to be stimulated a number of issues need to be addressed. Findings from this research suggest that efforts to stimulate innovation by the government at times can have an adverse effect. Narrowly defined innovation grants can curb the possibilities that firms have if they want to be eligible for governmental funding. In other instances some technologies might be so novel that they do not fit the regular criteria at all. Broader framing of innovation grants would allow very disruptive and novel approaches to fund their innovation.

The sixth sub question was:

“What steps can be undertaken to improve cross-over activity in the Arnhem, Nijmegen & Wageningen region?”

Aside from cross-over activity resulting from network contacts the hyper-local scale seems to be the ideal scale if you want to stimulate cross-over activity. There have been examples where cross-over activity has been initiated without proximity playing an important role. These examples are however very much the exception and were regarded as difficult to get off the ground. For these linkages to be improved, the aim should be to achieve combination on industrial parks and campuses that provide synergy, aim to create a sense of community, however cooperation should not be a goal in itself. Instead always keep focusing on the business case and explore how influences of different sectors can help the bottom line. So if one would want to improve the cross-over activities in a region or stimulate the organic convergence of different influences the best thing would be to foster the hyper-local scale and facilitate their development as much as possible. Listening to what the wishes of the firms and institutions are at those places should be important. Combine efforts to attract the correct firms or institutions to the correct locations. This cannot be achieved at a municipal level, instead this should overarch any municipality. The idea should settle in that, it does not always matter where new activities take place as much as it should matter what added value the place itself will hold for that activity and what in turn, it will add to the ecosystem. Having a stronger communication line between municipalities, park owners and firms and institutions, will lead to a stronger ecosystem that should benefit the region as a whole in the long run.

7.1.3 Main research question

Having answered the research sub questions, I can now proceed to formulate an answer for the main research question. The goal of this research was to measure the embeddedness of firms and the degree to which they engage in cross-over activity. The embeddedness of the different sectors has been discussed in §6.5.2 and will serve as the basis for answering the

main research question. The conceptual model (§3.1) theorizes how regional knowledge spillovers occur. The model suggests that through the interaction between firms, knowledge is able to get absorbed by the regional ecosystem by means of knowledge spillovers. The absorptive capacity of firms determine what extent such knowledge spillovers are able to be translated into workable concepts while the cognitive distance between firms determines whether firms are able to understand each other or not. When this does happen one thing that can develop are cross-overs. The interaction between firms of two different industries. This interaction can both be intentional and sought after or incidental. The findings in this research suggests that capturing cross-over opportunities for the most part happens on incidental basis. Most firms do not see cross-over activities as a standalone issue to focus on, but instead have a very opportunistic attitude towards cross-overs. The cross-over activities that have developed are almost all the result of being connected to the correct networks. From all the forms of embeddedness, network embeddedness seems the most important for cross-over activities, one of the reasons for this is that strong network connections increases the absorptive capacity of firms. It allows them to expand their technological knowledge base to be able to better understand the knowledge spillovers from different sectors. At the lowest scale of abstraction, the scale I call the hyper-local scale knowledge spillovers are more likely to occur due to both physical and cognitive proximity between firms. In this sense the territorial proximity allows firms and institutions to develop stronger ties to neighboring firms and institutions, improving their network embeddedness at the same time. For this to occur firms should be open to new connections and constantly looking to expand their knowledge base. A strong institutional framework to facilitate and support firms helps to connect firms to each other, increasing the likelihood of the occurrence of knowledge spillovers between firms. In the case study area the institutional framework is highly developed. Supporting organizations exists for both the separate industries as well as ones that aim to connect the different industries and help capture opportunities. However it would seem that there is room for improvement when it comes to finding combinations that create synergy. It can thus be stated that there is still untapped potential for cross-over activities and in turn a higher degree of regional knowledge spillovers. Open innovation is crucial for these cross-over innovations to occur as well as creating an environment where firms of different competences organically are exposed to each other. Therefore campus development as happens at the NTC and IPKW are good examples of how to stimulate cross-over activity.

When looking at how knowledge is then transferred, interpersonal relationships are among the most common forms of knowledge transfer. In other cases spin-off activities have led to the proliferation of cross-over activities. The higher the degree of territorial embeddedness, the higher the chance that new activities will stay within the region. At the same time, there have been examples where a low degree of territorial embeddedness has led to situations where firms have opted to look for opportunities elsewhere. The regional ecosystem appears to have a very fluid border demarcation. Many firms do not necessarily use the same region demarcation as the local governments do. Depending on the size and nature of the activity, the regional scale takes on different forms. Finding connections to both related as well as unrelated industries locally can improve both the embeddedness of these firms as well as

stimulate the development of innovative, new technologies. For this to be possible firms need to have an appropriate measure of cognitive distance. Matching the input and output of different companies is an example of how this is possible. A stronger regional identity could increase the cohesion in the region, encouraging firms to decrease the cognitive distance between them to stimulate the development of innovative technologies. Right now the focus differs between firms and between sectors. Especially firms that have a strong technical focus are less embedded due to the region lacking a strong technical knowledge base. The current identity excludes the high-tech / semi-conductor sector to some degree. This can have negative consequences with regard to supra-regional exposure and lead to potential interesting firms not being aware of the strengths of the region. This can have a dampening effect on the cross-over potential in the region. Concluding this research can be stated that investing in combining firms at the hyper-local scale which are able to have the most synergy, facilitate their activities and connect the different regional hotspots will help stimulate the development of a strong regional ecosystem that is optimal for cross-over activity.

7.2 Recommendations for the Arnhem, Nijmegen & Wageningen region

This results of this research can provide a number of recommendations for all actors involved in the regional governance structure. However before these recommendation can be formulated a few critical notes have to be stipulated. Firstly, the scope of this research has been limited to a small numbers of firms, while at the same time spreading that number out over different sectors. Therefore one could argue that the numbers of firms per sector are not representative enough for their entire sector, to base any conclusion on. I dismiss this critique with the argument that the firms are carefully selected on the one hand and on the other hand having been embedded at the Economic Board during the course of the research has provided me with a sense of what is deemed critical in the region. Moreover the position has allowed me to keep track of all the latest developments of the relevant actors in the regional governance structure as well as talking to a great number of relevant people. This research is therefore the culmination of both the empirical data collection as well as the experiences gained through the research internship at the Economic Board. This having said, the recommendations for the region can be formulated. The results of this research can be extrapolated into a number of critical observations.

Regional cohesion

The cohesion within the region is relatively low. There are a few factors that contribute to this fact. Firstly the region lacks any collective identity which could unity the region. The current focus and 'slogan' if you could even call it that, food, health & energy provides an indication of the substance but lacks any name recognition. On the other hand the focus seems to exclude an important pillar of the region, namely the high-tech / semi-conductor sector. The argument could be made that high-tech and semi-conductors can be relegated to the other three sectors but I feel that this does injustice to the importance of the sector itself. A second argument that could be made is that it belongs to the health sector as the digital

health sector or E-health sector but again I feel that this does not cover the entire scope of the sector and therefore does injustice to the high-tech and semi-conductor industry. The region as a whole consists of a number of smaller entities that together make up one large regional ecosystem. This can be a negative aspect but does not necessarily have to be. Re-evaluating both the focus of the region and the outward profiling of the region can potentially improve the position of the region as a whole.

Investing in synergy

This research has provided evidence that investing in the hyper-local can improve the attractiveness of the region as a whole as a destination for firms and institutions to turn to. At the moment most of these industrial parks and campuses are mainly governed by a park owner and the municipality where it is located. However a higher degree of synergy can be achieved when activities would be directed towards the most beneficial location within the region. A higher degree of regional coordination can in the end provide benefits for the bottom line for everyone. This is in line with the previous recommendation, as this would be a move towards a higher degree of regional cohesion. At the same time, municipalities and park owners should facilitate innovative practices throughout the region. Providing business support to those who seek it. Moreover firms should not have to seek outside of the region if they want to engage in explorative and innovative practices such as building test plants. In the same vein, it would be beneficial if municipalities, park owners and firms would together actively engage in dialog regarding what facilities to invest in. By looking for a stronger connection with the local market, capital can be used more effectively for strengthening the local ecosystem.

Prioritize the embeddedness of the energy, high-tech and semi-conductor sectors

On the surface these sectors seem very healthy as they have strong societal and territorial embeddedness. However when analyzed further a warning sign arises. Despite the fact that these sectors are currently investing in regional real-estate, a big part of their embeddedness stems from the fact that their employees live in the region. Their knowledge base for the most part is located outside of the region, seeing how the region does not have any technical university. At the same time firms express that they have trouble finding capable and qualified highly educated technical personnel. Multiple firms have expressed that they had little trouble starting up activities in places outside of the region and a future where a big part of the innovative elements move to places outside of the region is not far-fetched. Many firms are located in this region because of decisions made in the past, their current investments can be seen as a sign of the path dependency of the region. Strengthening the local knowledge base for these sectors should be a priority, if this does not happen then the value the region has for these firms might decrease over time. This would decrease their embeddedness and make it easier for these firms to gradually move their business elsewhere. Especially if firms are unable to fill their vacancies.

7.3 Recommendations for future research

The regional profile of the Arnhem, Nijmegen & Wageningen region is that of a mid-level economic center outside of the nation's core economic region. Further research could delve

deeper into how the regional economy is structured compared to other comparable regions in Europe with the same profile. One of the problematic elements of the regional governance structure is that the Arnhem, Nijmegen & Wageningen region lacks any true hegemonic entity that can have any sort of power over the other actors. A comparative study could lead uncover how this issue is tackled in other regions with the same profile. The second recommendation would be to conduct a larger, more thorough research in the Arnhem, Nijmegen & Wageningen region into the same subject to increase the validity of the research results. The focus of this research should be less theoretically orientated and be more focused on providing concrete steps and interventions to be undertaken in order to strengthen the local ecosystem.

7.4 Reflection on the research

Looking back at how the research has been conducted I can clearly define three different stages. During the first stage of the research, the focus of the research was determined as well as the selection of the relevant academic literature and methods. During the second stage of the research, I was mainly involving myself in activities of the Economic Board. As a result, I did not work a lot on the research in terms of pages written. Instead this stage of the research allowed me to get familiar with the regional ecosystem and embed myself in the network through participating in network events and attending meetings. During the third stage of the research the relevant actors were interviewed and the research itself was translated into pages written. The transition between the three stages was a natural one and really helped me get a good grasp of both how the regional ecosystem was structured and how the theoretical framework applied to the ecosystem.

When I started my internship I had little clue as of to what added value I could provide to the institution as well as what my workload would be. This however proved to be a positive aspect as it formed me to go out of my way and discover ways of contributing. At the time of writing this, six months later, I feel that the internship has provided me with a good insight into the way the regional governance structure is and the role an institution like the Economic Board has in it. It has proven to be a great resource for the research as a whole by allowing me to be embedded in the network and have the opportunity to easily contact important regional actors. At the same time, being embedded at the Economic Board has given more legitimacy to both me as a researcher as to the research itself.

Applying the chosen research methods and academic literature to the research at times proved to be difficult. The research object was hard to define as there are a great number of interpretation of what the region is. Adding to this, the research methods themselves can be regarded as relatively vague. Statistical analysis allows for stronger research results, this research, being a qualitative orientated research, the results are different. I do believe that the results of this research are valid and have potential implications for future governmental policy. I also believe that this research might provide some actors with a legitimate basis that they can use to pursue their goals.

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Statistical Data and figures

Figures

Figure 6, 7, 8, 9 and 10

200 jaar topografische kaarten (N.D.)

<http://www.topotijdsreis.nl/> Accessed 01-08-2017

Tables

Table 2

CBS Historische collectie (N.D.)

http://historisch.cbs.nl/detail.php?nav_id=0-1&positie=24&id=236172809

http://historisch.cbs.nl/detail.php?nav_id=0-1&id=120854988&index=17

http://historisch.cbs.nl/detail.php?nav_id=0-1&id=120853220

http://historisch.cbs.nl/detail.php?nav_id=0-1&positie=42&id=120851605

Accessed 01-08-2017

CBS Statline (N.D.)

<http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=03759NED&D1=0&D2=129-132&D3=94,237,547,785&D4=27&HDR=T&STB=G2,G3,G1&VW=T>

Accessed 01-08-2017

Table 3

CBS Statline (N.D.)

<http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=82800NED&D1=0&D2=0&D3=18-57&D4=14-18&HDR=T&STB=G1%2cG2%2cG3&VW=D>

<http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=83582NED&D1=0&D2=0&D3=19-58&D4=0,4&HDR=T,G2&STB=G1,G3&VW=T>

Accessed 02-08-2017

Table 4

CBS Statline (N.D.)

<http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=83582NED&D1=0&D2=0,2-3,9-10,18-19,22-25&D3=83,105,152,160-161,164,199,232,279,312,332,364,375,378,381,391,439,470,479,486,507&D4=4&HDR=T,G2&STB=G1,G3&VW=T>

Accessed 02-08-2017

Table 5

CBS Statline (N.D.)

<http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=82352NED&D1=a&D2=5-16&D3=a&HDR=G2,T&STB=G1&VW=T>

Accessed 02-08-2017

Table 6

<http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=82352NED&D1=a&D2=5-16&D3=a&HDR=G2,T&STB=G1&VW=T>

<http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=03759NED&D1=0&D2=129&D3=5-16&D4=23-27&HDR=T&STB=G2,G3,G1&CHARTTYPE=1&VW=T>

Accessed 02-08-2017

Appendix I Table explanations

Table 4

A-U Alle economische activiteiten

Alle economische activiteiten

Deze categorie is een samentelling van categorieën:

A Landbouw, bosbouw en visserij

B Winning van delfstoffen

C Industrie

D Productie en distributie van en handel in elektriciteit, aardgas, stoom en gekoelde lucht

E Winning en distributie van water; afval- en afvalwaterbeheer en sanering

F Bouwnijverheid

G Groot- en detailhandel; reparatie van auto's

H Vervoer en opslag

I Logies-, maaltijd- en drankverstrekking

J Informatie en communicatie

K Financiële instellingen

L Verhuur van en handel in onroerend goed

M Advisering, onderzoek en overige specialistische zakelijke dienstverlening

N Verhuur van roerende goederen en overige zakelijke dienstverlening

O Openbaar bestuur, overheidsdiensten en verplichte sociale verzekeringen

P Onderwijs

Q Gezondheids- en welzijnszorg

R Cultuur, sport en recreatie

S Overige dienstverlening

T Huishoudens als werkgever; niet-gedifferentieerde productie van goederen en diensten door huishoudens voor eigen gebruik

U Extraterritoriale organisaties en lichamen

Appendix II Empirical data collection – List of interviewees

Allego – Anja van Niersen – CEO Allego Group

Akzo Nobel – Site Director Arnhem & Amsterdam Akzo Nobel

BKC/Miscancell – Alfred Hakvoort – CEO BKC

Hyet – John den Brave – Operations Director

Kraft Heinz – Dick van Olderen – Technology Manager

Noviosys – Pavla Jansova – Branch Manager

NXP – Doeco Terpstra – Senior Director of Enabling Technology and Operations

Pectcof – Director and Co-Founder Pectcof B.V.

Synthon – Director Corporate Communications

TDI Group – Owner TDI Group

Veolia – Marianne Mulder – Communications & Marketing Officer / Executive Assistant

Appendix III Theoretical framework extended

1. The traditional artisan model

The first model considered is that of the *traditional artisan*. The period is the 1950s and early 1960s, when the south of Italy was still fairly underdeveloped and possessed quite a number of small artisan firms producing goods destined to be replaced over the next 20 years by massproduced goods. (Brusco, 1999). The early research mainly focused on the nature and the role of small firms, in terms of a dualism between the North and the South (Brusco, 1990). The assumption was that in the North you mainly found large, capital-intensive and effective firms whose primary focus was the national market. While in the South it was believed to be characterized by small, labor-intensive and inefficient firms who mainly focused on “made-to-measure” production – producing for specific people (Brusco, 1990). The idea was that only large firms were efficient and able to pay high wages, thus the proposed interventions focused on bridging the gap between the North and the South by imposing wage restrictions on the North and moving companies to the South. The idea that the small firms were inefficient and were unable to pay high wages was always stressed (Brusco, 1990).

2. The dependent subcontractor model

The second model identified by Brusco (1990) is the *dependant subcontractor model*. Chronologically, this model followed the *traditional artisan model* on the back of a decentralization wave, which occurred in Italy at the end of the 1960's (Brusco, 1990). During this period the degree of vertical integration greatly decreased. Graziani and Brusco (Brusco, 1990) both observed how the production of large and smaller firms began to deviate from one another. Brusco (1990, p.12) explains: “We contended that the large firms sold on the final market - for either consumer or investment goods - while the small firms simply produced intermediate goods - parts and components - for other, larger, units and certainly did not face the final market”. Previously it was thought that small firms were inefficient and not able to compete with larger firms but were also small firms that had technology and an efficiency that was comparable to that found in large ones (Brusco, 1990). It is from this point on that economists began to think that the efficiency of a small firm could be as great as that of a large one, provided the same machines were used (Brusco, 1990). This meant that a region could still be successful and innovative despite consisting of mostly smaller firms.

3. The model of the Industrial district Mark I

The third model as identified by Brusco (1990) as Mark I and found its prominence in the mid 1970's. This model is based around specific regions and sectors becoming economically successful. Becattini (1979) had a big role in reevaluating Marshall's notion of an industrial district, in an article Becattini argued that the unit of analysis had to change. The unit of analysis he argued needed to shift from a single firm to a cluster of

interconnected firms located in a small area (Brusco, 1990). The products within an industrial district can be divided into three categories. The first category are firms who produce a final product. Firms in the second category can be characterized as 'stage-firms', firms who are involved in one stage of production. Firms in the third and last category are firms that belong to a different sector but are vertically integrated with the sector as the final firms (Brusco, 1990, p.14). A district thus consists of a cluster of firms who produce something related while positioning themselves in a different manner on the market. An important feature of industrial districts is the prevalence of the tension between co-operation versus competition. Brusco (1990) notes that competition occurs between equal firms. Therefore co-operation is the most likely between firms who are different while firms that closely resemble each other will be competing against one another (Brusco, 1990).

4. The model of the industrial district Mark II

The fourth and final model provided by Brusco (1990) is Mark II. The emergence of new technologies and new markets posed great challenges for small and large firms alike. Being able to translate and adopt new technologies is paramount for firms, this fueled a culture of continual informal interaction in café's and bars and in the street (Brusco, 1990). This informal interaction allowed information and ideas to be spread. Brusco (1990) notes that unlike a large company, a district does not have a board of directors which can push for the adoption of a new technology. Because of this adopting new technologies can provide a tough obstacle for industrial districts. The solution that some areas in Italy employed was to provide "real services" rather than financial help (Brusco, 1990). Such services provided information to those who desired it, allowing smaller firms to operate much more efficiently. For example, a given small firm would find it very difficult to get accurate information about developments in Bavaria and may not be able to find out that Bavaria is perhaps stipulating that its railway lines must be no more than 35 cm above the ground (Brusco, 1990, p.17). Without this information it is very likely that this small firm would have much more trouble exporting to Bavaria compared to now that the firm possesses this knowledge.

5. Hypothesized Features of New Industrial District Types

Marshallian industrial districts

- Business structure dominated by small, locally owned firms Scale economies relatively low
- Substantial intradistrict trade among buyers and suppliers Key investment decisions made locally
- Long-term contracts and commitments between local buyers and suppliers Low degrees of cooperation or linkage with firms external to the district Labor market internal to the district, highly flexible
- Workers committed to district, rather than to firms
- High rates of labor in-migration, lower levels of out-migration Evolution of unique local cultural identity, bonds
- Specialized sources of finance, technical expertise, business services available in district outside of firms Existence of "patient capital" within district
- Turmoil, but good long-term prospects for growth and employment

Italianate variant (in addition to the above)

- High incidence of exchanges of personnel between customers and suppliers
- High degree of cooperation among competitor firms to share risk, stabilize market, share innovation
- Disproportionate shares of workers engaged in design, innovation
- Strong trade associations that provide shared infrastructure-management, training, marketing, technical or financial help, i.e. mechanisms for risk sharing and stabilization
- Strong local government role in regulating and promoting core industries

Hub-and-spoke districts

- Business structure dominated by one or several large, vertically integrated firms surrounded by suppliers
- Core firms embedded nonlocally, with substantial links to suppliers and competitors outside of the district
- Scale economies relatively high
- Low rates of turnover of local business except in third tier
- Substantial intradistrict trade among dominant firms and suppliers
- Key investment decisions made locally, but spread out globally
- Long-term contracts and commitments between dominant firms and suppliers
- High degrees of cooperation, linkages with external firms both locally and externally
- Moderate incidence of exchanges of personnel between customers and suppliers
- Low degree of cooperation among large competitor firms to share risk, stabilize market, share innovation
- Labor market internal to the district, less flexible
- Disproportionate shares of blue-collar workers
- Workers committed to large firms first, then to district, then to small firms
- High rates of labor in-migration, but less out-migration
- Evolution of unique local cultural identity, bonds
- Specialized sources of finance, technical expertise, business services dominated by large firms
- Little "patient capital" within district outside of large firms
- Absence of trade associations that provide shared infrastructure-management, training, marketing, technical or financial help, i.e., mechanisms for risk sharing and stabilization
- Strong local government role in regulating and promoting core industries in local and provincial and national government
- High degree of public involvement in providing infrastructure
- Long-term prospects for growth dependent upon prospects for the industry and strategies of dominant firms

Satellite industrial platforms

- Business structure dominated by large, externally owned and headquartered firms
- Scale economies moderate to high

- Low to moderate rates of turnover of platform tenants
- Minimal intradistrict trade among buyers and suppliers
- Key investment decisions made externally
- Absence of long-term commitments to suppliers locally
- High degrees of cooperation, linkages with external firms, especially with parent company
- High incidence of exchanges of personnel between customers and suppliers externally but not locally
- Low degree of cooperation among competitor firms to share risk, stabilize market, share innovation
- Labor market external to the district, internal to vertically integrated firm
- Workers committed to firm rather than district
- High rates of labor in-migration and out-migration at managerial, professional, technical levels; little at blue- and pink-collar levels
- Little evolution of unique local cultural identity, bonds
- Main sources of finance, technical expertise, and business services provided externally, through firm or external purchase
- No "patient capital" within district
- No trade associations that provide shared infrastructure-management, training, marketing, technical, or financial help, i.e., mechanisms for risk sharing and stabilization
- Strong local government role in providing infrastructure, tax breaks, and other generic business inducements
- Growth jeopardized by intermediate-term portability of plants and activities elsewhere to similarly constructed platforms

State-anchored industrial districts

- Business structure dominated by one or several large, government institutions such as military bases, state or national capitals, large public universities, surrounded by suppliers and customers (including those regulated)
- Scale economies relatively high in public-sector activities
- Low rates of turnover of local business
- Substantial intradistrict trade among dominant institutions and suppliers, but not among others
- Key investment decisions made at various levels of government, some internal, some external
- Short-term contracts and commitments between dominant institutions and suppliers, customers
- High degrees of cooperation, linkages with external firms for externally headquartered supplier organizations
- Moderate incidence of exchanges of personnel between customers and suppliers
- Low degree of cooperation among local private-sector firms to share risk, stabilize market, share innovation
- Labor market internal if state capital, national if university or military facility or other federal offices for professional/technical and managerial workers
- Disproportionate shares of clerical and professional workers
- Workers committed to large institutions first, then to district, then to small firms
- High rates of labor in-migration, but less out-migration unless government is withdrawing or closing down
- Evolution of unique local cultural identity, bonds
- No specialized sources of finance, technical expertise, business services
- No "patient capital" within district
- Weak trade associations to share information about public-sector client
- Weak local government role in regulating and promoting core activities
- High degree of public involvement in providing infrastructure
- Long-term prospects for growth dependent on prospects for government facilities at core

Adapted from (Markusen, 1996, pp. 298-299)

