TIP Working Party KNOWLEDGE TRIANGLE PROJECT (2015-16)

CASE STUDY: the Netherlands

"An Entrepreneurial eco-system approach to the Knowledge Triangle"

OECD

Concept

The Knowledge Triangle in the Netherlands

AN ENTREPRENEURIAL ECOSYSTEM APPROACH

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Table of Contents

1 Introduction

The Netherlands is a highly developed knowledge-based economy, performing very well in many science, technology, innovation and competitiveness rankings. Notwithstanding this good performance, there has been a policy debate in the Netherlands since the early 2000s on how to enhance the interaction between science, industry and government (the so-called triple helix), and more recently on how to stimulate entrepreneurship as a means to create value from science and technology, and to enable talent for innovation more broadly. Entrepreneurship is considered to be a key mechanism to turn research and education inputs into economic value, and in the meantime also stimulating the interaction between innovation, research and education.

The interaction between research, education and innovation does not take place in a vacuum, but is likely to depend on its immediate (organizational) and territorial (i.e. regional, national) context. In this report we focus on how the regional entrepreneurial ecosystem affects the interaction between research and education, and how this affects productive entrepreneurship. To understand how the interaction between research, education and entrepreneurship is coordinated, we analyse the networks and leadership in several regional ecosystems in the Netherlands.

This leads to our key question:

> How can the interaction between research [knowledge] and education [talent] be coordinated [by networks and leadership] in such a way that it enables productive entrepreneurship in regional ecosystems?

We will describe the Dutch context in general, and how specific knowledge triangles can be distinguished in regional entrepreneurial ecosystems. We build a detailed conceptual model to explore the fit between knowledge triangle and entrepreneurial ecosystem. We combine several specific theoretical perspectives within the broader entrepreneurial ecosystems framework. We specifically focus on regional governance (including networks and leadership).

The theoretical underpinnings of ecosystems are described in chapter 2. Chapter 3 describes a methodology for the analysis of some of the elements of the entrepreneurial ecosystems in this study. In chapter 4 we provide a first general overview of the structure of the national Dutch knowledge triangle and an assessment of its functioning. Chapter 5 and 6 describe and compare five ecosystems in terms of innovation networks and dynamics on the labour market. In chapter 7, 8 and 9 we describe three case studies in depth, describing their knowledge triangle structure within the ecosystem and assessing their functioning. Finally, chapter 10 provides an evaluation of all the data presented and draws conclusions on the knowledge triangle in different Dutch ecosystems.

2 Theoretical Framework

Human capital and technological change are widely acknowledged as the sources of economic growth in developed economies (Lucas, 1988; Malecki, 1997; Barro & Lee, 2015). Human capital accumulation and technological change, and the underlying expanding knowledge base, are in themselves not sufficient to create economic growth. Innovation is important as an intermediate between human capital and technological change (as inputs) and the outcome of economic growth (Nooteboom & Stam, 2008). In this respect, innovation requires innovator-entrepreneurs (Schumpeter, 1934). Policy makers around the globe are therefore counting on entrepreneurship to provide the engine of economic growth. In this chapter, we first review the theory and empirics on how knowledge and talent causes (knowledge based) entrepreneurship. Second, we will assess how the interaction of research, education and knowledge-based entrepreneurship takes place, focusing on the role of networks in the knowledge triangle. Third, the entrepreneurial ecosystem context of the knowledge triangle, and its governance (potential) by regional leadership will be discussed. Finally, a detailed conceptual model is presented.

2.1 Knowledge, talent and entrepreneurship

The generation of knowledge and the accumulation of human capital does not automatically lead to economic value. The knowledge spillover theory of entrepreneurship (KSTE) suggests that entrepreneurship provides a crucial mechanism in translating knowledge into new value, and ultimately economic growth (Acs, et al., 2005; Audretsch & Lehmann, 2005; Audretsch, et al., 2006).

Agents investing in research or technology development often end up facilitating other agents' innovation efforts, either unintentionally, as when inventions can be imitated, or intentionally as where scientists report on their research. Economists have termed this non-rival characteristic of knowledge 'knowledge spillovers' (Arrow 1962; Nelson 1959). Knowledge spillovers have been defined as *"any original, valuable knowledge generated somewhere that becomes accessible to external agents, whether it be knowledge fully characterizing an innovation or knowledge of a more intermediate sort. This knowledge is absorbed by an individual or group other than the originator"* (Foray 2004, p. 91).

Knowledge-based entrepreneurship is said to occur when knowledge workers respond to opportunities by starting a new firm. In this view, entrepreneurship is a rational choice made by economic agents who seek to appropriate the value they attribute to knowledge endowments, whether their own or their employers'. People might start a new firm because they are not able to commercialize their ideas and knowledge within the context of an incumbent firm or organization. Entrepreneurship therefore serves to transfer knowledge from the organization where that knowledge was created to its commercialization in the context of a new firm.

In principle, established companies are better placed to exploit opportunities as they have more resources to deploy than new ones. Knowledge and talent inputs also appear to be more related to entrepreneurship in established organizations than to independent entrepreneurship (Stam 2013a). But established firms face severe constraints in perceiving and responding to new opportunities. An established company tends to be *"guided in its expansion programmes as much by the nature of its own resources as by market demand, for every firm is (…) a more or less specialised collection of resources and cannot move with equal ease in every direction"* (Penrose 1995, p.224). Penrose thus argued that there are opportunities for small firms and potential entrepreneurs in the 'interstices' neglected by large companies. The entrepreneurs founding new knowledge-based firms may be very important for economic growth in a knowledge-based economy, but are also a minority of the overall group of entrepreneurs founding new firms (Shane 2008; Stam 2008; 2013b).

However, it is a misconception to prioritize new firms over established organizations, and/or small firms over large organizations a priori. A good mix of large and small knowledge-driven organisations provides the most fertile soil for exploring and exploiting new ideas (Rothwell and Dodgson 1994; Nooteboom 1994; Moore and Davis 2004).

While the rise of knowledge-based entrepreneurship in both established organizations and new firms is based on the expansion of knowledge in organizations, it also requires educated and experienced individuals who can absorb this knowledge. Entrepreneurship necessarily involves individuals and their response to economic opportunities (Shane and Eckhardt, 2003). Not only is the source of opportunities important (knowledge created in organizations), but so is the individual recognizing and commercializing these opportunities. Studies have shown that entrepreneurial opportunities are not exogenously given, but rather endogenously and systematically created under certain conditions. They are the outcome of investments in new knowledge and ideas (Schumpeter 1942; Audretsch et al. 2006) on the one hand, and the accumulation of knowledge in individuals (Shane 2000) and firms (Cohen and Levinthal 1989; 1990) on the other hand. Prior knowledge enables certain entrepreneurs to be alert to new opportunities (Shane 2000; Kirzner 1973). Both education and experience are therefore needed to absorb the knowledge that can serve as input for the entrepreneurial process (Shane 2000; Colombo and Delmastro 2002; Quian and Acs 2013). In addition, leadership experience (Stam and Wennberg 2008), the recruitment of talented students (Mian 1996) and experienced personnel (Audretsch and Stephan 1996; Audretsch and Lehmann 2006) is needed to scale up new firms and ventures.

Both talent and knowledge are therefore important resources for entrepreneurial activity. These elements are not only connected in a one-way causal relation. To accomplish economic growth, the interaction between these elements is critical – as discussed in the next section.

2.2 The interaction of research, education and entrepreneurship

The knowledge triangle has recently gained prominence in innovation policy thinking at the OECD and the European Commission. The OECD (2015) defines a knowledge triangle as ‘the interaction of education, research and innovation’, to raise the question: What are the factors that can enhance the capacity of education, research and innovation actors in the knowledge triangle to tackle jointly economic and social challenges while enhancing the responsiveness, adaptability and flexibility of local, national or international innovation eco-systems? The European Commission (2015) states that ‘the contribution of higher education to jobs and growth (…) can be enhanced through close, effective links between education, research, and innovation – the three sides of the knowledge triangle’. The EC also observes that the recent shift towards open innovation has resulted in increased flows of knowledge and new types of cooperation between education institutions, research organisations and business.

The central idea here is that creating new knowledge from research and high quality education in themselves are not enough to gain prosperity and economic growth. New knowledge and talented people need to be linked to innovation. Moreover, the knowledge circulation between these elements (resulting in a learning economy, WRR 2013) increases their ultimate impact on prosperity. Prosperity in a society is the accumulation of solutions to human problems (Beinhocker 2005; Stam & Nooteboom 2011). These solutions do not arise automatically with investments in research and education, but need to be explicitly linked to innovation. Even though innovation is a multiplayer game, a system with a large set of agents involved beyond the focal organization (Adler 2012), it ultimately depends on individual action by entrepreneurs. Entrepreneurial action is needed to experiment and reduce the uncertainties arising from

the long-term cycle of innovation (Stam & Nooteboom 2011). Different types of entrepreneurship are involved, from entrepreneurs forging radical new combinations, to entrepreneurs that realize the first successful applications of these new combinations, and entrepreneurs who scale up these initial successes. Further along the cycle of innovation, entrepreneurs are needed to transfer and adapt these innovations to new contexts, potentially leading to radical innovations again.

However, entrepreneurship in knowledge triangles does not evolve in a vacuum: it takes place in a broader entrepreneurial ecosystem, as discussed in the following section.

2.3 Entrepreneurial ecosystems and regional leadership

Research, education and entrepreneurship, and their interactions, are shaped and developed in a variety of ways in different regions. Each region has a specific context to organize the knowledge triangle. This variety, its causes and consequences can be analyzed by adopting an entrepreneurial ecosystem perspective (Stam 2015). The entrepreneurial ecosystem perspective is related to the innovation system approach, which argues that the quality and interaction of the elements of innovation systems (knowledge, producers, finance, demand) determines the innovation output of the system (Nelson 1993; Edquist 1997; Cooke 2001; Nooteboom & Stam 2008). In enabling the interaction between these elements, (local) governments can play a key role (Mazzucato 2015).

Both the entrepreneurial ecosystem and innovation system approach emphasize the systemic nature of innovation. However, agency and especially entrepreneurial action are more central to the entrepreneurial ecosystem approach. An *entrepreneurial ecosystem* is a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory (Stam & Spigel 2016). Productive entrepreneurship here refers to entrepreneurs creating and exploiting opportunities for innovation, in ways that lead to (significant) new value for society. The *aggregate value creation* therefore is the ultimate outcome of an entrepreneurial ecosystem, while *entrepreneurial activity* itself is more of an intermediary output of the system (see Figure 1). This entrepreneurial activity has many manifestations, such as innovative start-ups, high-growth start-ups, and entrepreneurial employees.

The elements of the entrepreneurial ecosystem can be distinguished in terms of framework and systemic conditions. Both are summarized in Figure 1. The *framework conditions* include the social conditions (i.e. informal and formal institutions) and physical conditions enabling or constraining human interaction. In addition, access to a more or less exogenous demand for new goods and services is also of great interest. This access to buyers of goods and services, however, is likely to be more related to the relative position of the ecosystem than to the internal conditions of the ecosystem. These conditions are the fundamental causes of value creation in the entrepreneurial ecosystem. To fully understand how these fundamental causes produce this outcome, we first need to understand how systemic conditions lead to entrepreneurial activity.

The *systemic conditions* are the heart of the ecosystem: networks of entrepreneurs, leadership, finance, talent, knowledge, and support services. The presence of these elements and the interaction between them predominantly determine the success of the ecosystem. Networks of entrepreneurs provide an information flow, enabling an effective distribution of labour and capital. Leadership provides direction and role models for the entrepreneurial ecosystem. This leadership is critical in building and maintaining a healthy ecosystem. This involves a set of 'visible' leaders who are committed to the region. Access to financial resources is obviously crucial for investments in uncertain projects and ventures with a long-term horizon. And perhaps the most important systemic condition of an effective entrepreneurial ecosystem is

the presence of talent, in terms of a diverse and skilled population of students, employees, entrepreneurs and other agents (Lee et al., 2004). Moreover, knowledge arising from both public and private organizations is an important source of opportunities for entrepreneurship. Finally, support services offered by a variety of intermediaries is likely to lower the entry barriers for new projects and ideas, and thus reduce the time to market of innovations.

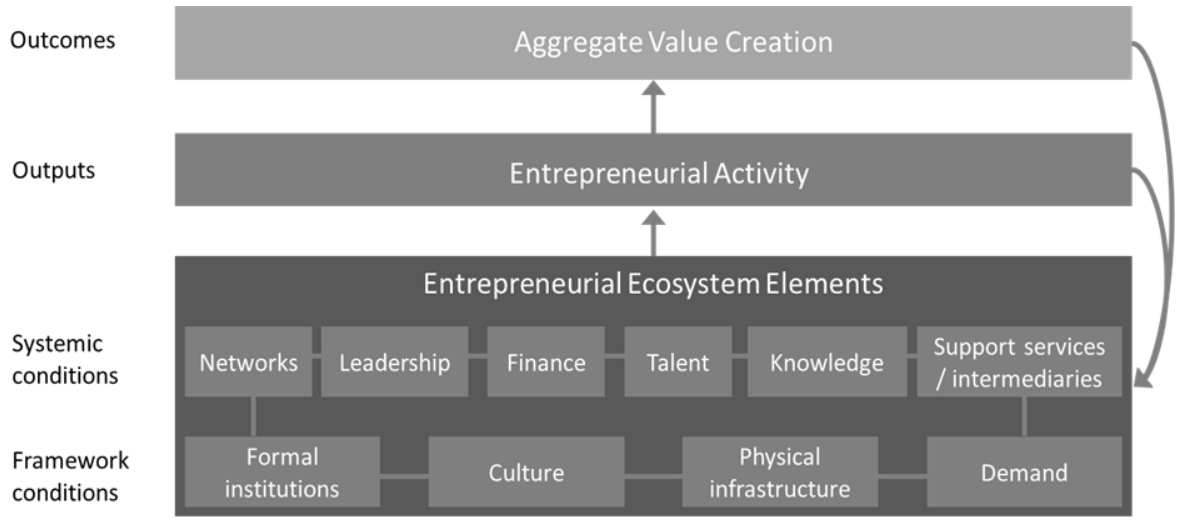


Figure 1: Key elements, outputs and outcomes of the entrepreneurial ecosystem (source: Stam and Spigel 2016)

Entrepreneurial activity is not only an (intermediary) output of the ecosystem: entrepreneurs are also important agents in co-creating the ecosystem and keeping it healthy. This raises highly interesting questions and challenges with regard to whether and how entrepreneurial ecosystems can be effectively governed and steered, and who needs to take up these leadership roles. In the remainder of this study, we address these questions of leadership in three case studies by collecting data on the most binding constraints within the ecosystem and the commitment among key stakeholders to invest in projects with collective and long-term returns. Based on a study of the Boulder entrepreneurial ecosystem, Feld (2012) argues that only entrepreneurs with a long history and commitment to the regional ecosystem can fulfil this role. A weaker version of this 'Boulder hypothesis' is that *the contribution of regional business leaders with a long-term commitment to the region is a necessary condition of effective governance of an entrepreneurial ecosystem.*

The knowledge triangle is at the heart of the entrepreneurial ecosystem (Quian et al. 2013): human capital is a necessary input to (knowledge-based) entrepreneurship, just like the creation of knowledge-based entrepreneurial opportunities. Taken together, we emphasize the role of knowledge and talent as inputs to entrepreneurial activity, which then is the proximate cause of aggregate value creation (prosperity). However, knowledge, talent and entrepreneurship do not automatically co-exist and match in the most effective ways. As such, a well-functioning entrepreneurial ecosystem is needed, enabled by regional governance, via network forms of governance and/or leadership. These relations are summarized in figure 2 below.

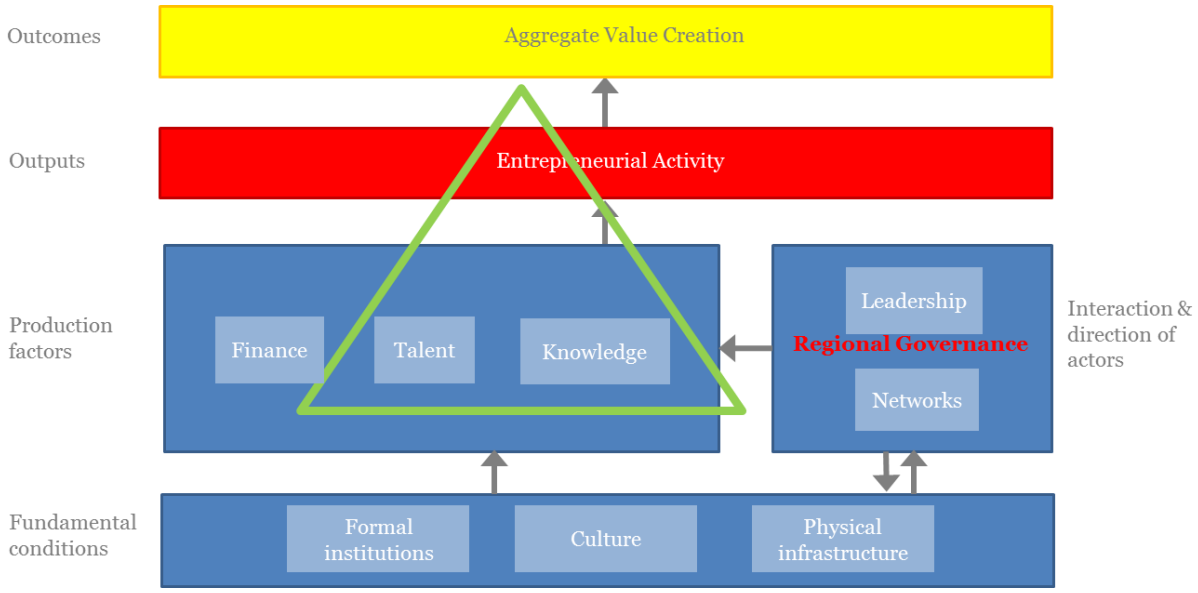


Figure 2: The knowledge triangle and regional governance in the entrepreneurial ecosystem

We will use this conceptual model as a starting point for answering our main question:

How can the interaction between research [knowledge] and education [talent] be coordinated [by networks and leadership] in such a way that it enables productive entrepreneurship in regional ecosystems?

3 Methodology

3.1 Case delineation

3.1.1 Primary rationale for ecosystem selection

The Netherlands has several regional ecosystems that encompass one or several cities and have an organisation that takes responsibility for the functioning of the ecosystem. In researching the functioning of the knowledge triangle (education, research and innovation) within different ecosystems we use two variables to select cases that contrast on two important dimensions, one reflecting the input to the ecosystem and one the outcome of the ecosystem:

- Governance of ecosystems, whether or not an ecosystem has a well-established governance structure to facilitate the collaboration of education, research and innovation within a long term perspective.
- Performance, whether or not an ecosystem provides (more) value (than the Dutch average) for a region in terms of productivity and employment.

This yields the selection of several cases that score differently on these dimensions.

		Performance	
		-	**+**
Governance	**-**	*Economic Programme South Wing South Holland*	Amsterdam Metropolitan Area *Economic Board Utrecht*
	+	Kennispark Twente	Brainport Eindhoven

Table 1: Governance and performance of Dutch ecosystems

Amsterdam and Utrecht have relatively new economic development board organisations and are amongst the better performing regions in the Netherlands. South Holland has recently founded its own ecosystem organisation. The Twente and Eindhoven region have a more established tradition of ecosystem governance. However, South Holland and Twente are amongst the regions with comparably poorer performance.

We analyse three contrasting cases on both quantitative and qualitative aspects:

- Amsterdam Metropolitan Area (MRA)
- Twente (Kennispark)
- Brainport

Additionally, we analyse two cases on a purely quantitative basis to ensure more comparability.

- Utrecht (Economic Board Utrecht)
- South Holland (Economic Programme South Wing)

3.1.2 Regional delineation

For each ecosystem we choose its regional boundaries after consultation with the governing organisation. For collection of secondary data we use the Dutch city region spatial unit COROP[1], which is the closest

[1] We use the COROP-regions division as this is a geographic demarcation used for analytic purposes that is often used by the Central Bureau for Statistics. With this division the Netherlands consists of 40 areas characterized by a large city or agglomeration and the surrounding area.

match with the regional ecosystem spatial unit. The different ecosystems have been geographically demarcated as follows:

- The Amsterdam Metropolitan Area consists of IJmond, Zaan region, Agglomeration Haarlem, Great-Amsterdam, The Gooi and Vecht region and Flevoland[2].
- Kennispark Twente covers the Twente region.
- Brainport Eindhoven consists of Southeast North-Brabant.
- The Economic Board Utrecht covers the Utrecht region which is equal to the province of Utrecht.
- The Economic Programme South Wing South Holland consists of Great-Rijnmond, Delft and Westland, Agglomeration The Hague, Agglomeration Leiden and Bollen region, East South-Holland, Southeast South-Holland, which equals the province of South Holland.

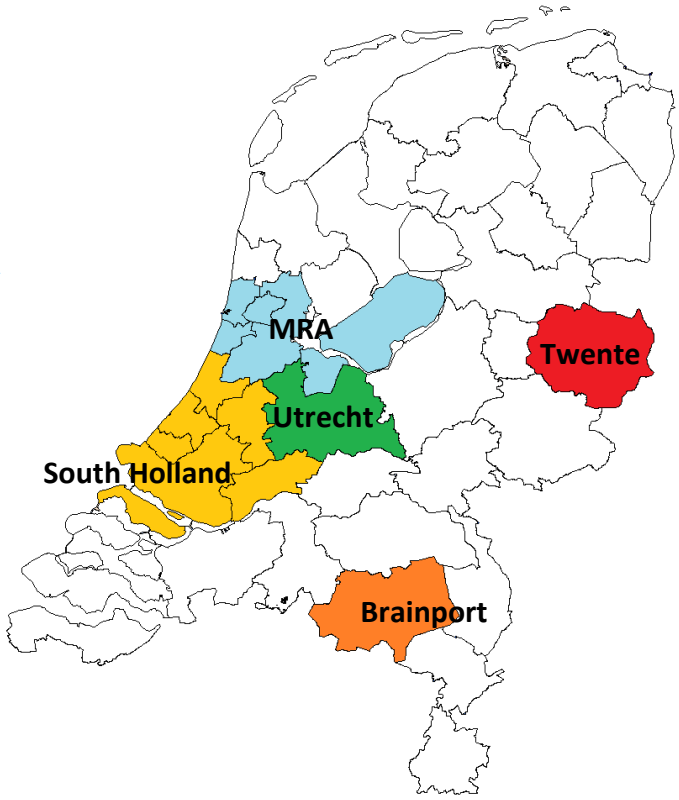


Figure 3: Map of the delineated ecosystems in the Netherlands

3.2 Comparative background data

In order to be able to compare ecosystems the different case studies are complemented with background data on various relevant indicators. These sketch the characteristics of the ecosystem and show the differences in size, scope and growth between them. It is attempted to use the most recent data available wherever possible.

[2] The Flevoland COROP is included to cover the municipalities of Almere and Lelystad. The rest of Flevoland is not officially a part of the Metropolitan Area. The MRA does collaborate with the provincial government of Flevoland. Furthermore, the municipalities of Almere and Lelystad account for almost all of the population in the province of Flevoland.

3.2.1 Comparison of ecosystems

In order to compare the ecosystems we compare the characteristics with the Dutch average. However, in some cases this image is skewed in favour of several ecosystems in more urbanised regions. Since the Netherlands has a very urbanised and economically strong 'Randstad' region that consists of the provinces Utrecht, North Holland and South Holland, any comparison of ecosystems outside of the Randstad with the Dutch average will be influenced by this. Thus, we also compare the ecosystems with regions that are similar to them in terms of urbanisation and economic development. Based on a spatial planners approach (Koomen, et al., 2008) we divide the Netherlands into 3 similar regions as see in Figure 3.

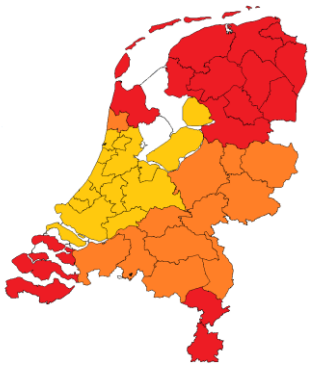


Figure 4: three comparative zones, Randstad (yellow), Intermediate (orange) and Periphery (red)

Here, the Randstad Zone is the most urbanised and economically developed and serves as comparison to the performance of the MRA, Utrecht and South Holland. The Intermediate zone consists of a somewhat more rural area of the Netherlands and thus serves as a better comparison for the performance of the Brainport and Twente ecosystems.

3.2.2 Labour force characteristics

The basic labour characteristics data is provided by the Central Bureau for Statistics (CBS). The CBS publishes this data yearly for each COROP level (CBS, 2015).

3.2.2.1 Active labour force

For determining the size and growth of the labour force within an ecosystem, the active labour force is used as indicator. The active labour force is defined by the CBS as all the persons receiving payment for their work and is displayed at COROP level from 2004 until 2014. For this period, the growth of the labour force is based on Compound Annual Growth Rate of the volume of the active labour force. This means that the unemployed labour force is not taken into account in the analysis. The CAGR provides a percentage of growth over a longer period of time through the following formula in which *LF* stands for the size of the active labour force and *fy* and *ly* stand for first and last year respectively.

$$CAGR(fy \rightarrow ly) = \left(\frac{LF(ly)}{LF(fy)}\right)^{(1/(ly-fy))-1}$$

The CAGR is used in multiple instances to show growth over several years, in which case the first and last year will mentioned.

3.2.2.2 Unemployment

Unemployment is represented as a percentage of the total labour force. The unemployed labour force is defined by the CBS as persons without paid work that are available for a job and have recently sought a new job.

3.2.2.3 Educational level of the labour force

The change in highest educational level is analysed by evaluating the change in education distribution between 2004 and 2014. Low education entails a finished vocational high school degree (vmbo), the first three years of high school (havo/vwo), or a level 1 VET degree. Middle education entails a high school degree (havo/vwo/) or a finished VET degree at level 2, 3 or 4. Higher education entails a degree from a university of applied sciences or a university.

In creating the education distributions the shares of the active labour force was used. In 2004, there were 76.000 persons in the Netherlands of which no CBS data on education level was available, in 2014 this value was 81.000.

3.2.3 Business demographics

The business demographic statistics are provided by the CBS. This is based on the number of establishments, which is defined as every separate space, terrain or complex that is used by a company for its activities. Each company consists of at least 1 establishment. Multiple locations of a firm within the same zip code area are considered a single establishment. We use the number of businesses in an ecosystem to show the scale of the ecosystem by relating it to the total number of businesses in the Netherlands. We use the CAGR from 2011 to 2015 to show the growth differences between ecosystems. According to the CBS, data for 2015 is preliminary (CBS, 2015).

3.2.4 R&D intensity

The CBS has converted the biennial Community Innovation Survey (CIS) to data that matches the COROP delineation of the CBS and supplemented it with data from their own R&D survey data and information from the general company register (ABR). Together, this provides data on the expenditures on research and development and innovation on a COROP regional level. This conversion was performed for the CIS years 2004, 2006 and 2008 from which we use the 2008 data (CBS, 2008). There is no more recent data available on a regional level. The data results from 15.000 surveyed Dutch firms, including all the large corporations that spend resources on R&D in the Netherlands. There was no data available for 8 out of 40 COROP regions: Leiden Agglomeration and Bollenstreek (South Holland), Alkmaar and surroundings, Gooi and Vechtstreek (MRA), Ijmond (MRA), Remaining Groningen, Zeeuwsch-Vlaanderen, South East Friesland, and South West Overijssel.

The survey distinguishes between R&D and innovation. Here, R&D expenditures cover own R&D expenses and outsourced R&D, whereas Innovation expenditures cover own R&D expenses, outsourced R&D, purchase of machinery and software and the purchase of external knowledge.

We show R&D and innovation expenditures as a share of Gross Domestic Product (GDP) of 2008, which is provided by the CBS.

3.2.5 Productive entrepreneurship

Lacking a comprehensive and measurable indicator for productive entrepreneurship, we choose to approach this outcome of the entrepreneurial ecosystem by observing the ‘gazelle’ firms within a region. Each year, an economic newspaper in the Netherlands compiles a list of the fastest growing firms in the

Netherlands. The criteria are that a firm must have a continuous growth in turnover over the past 3 years, with a minimum turnover of 100k Euros in the first year and a positive net result in the last year. The company must be economically active in those three years and financially healthy (Het Financieele Dagblad, 2014). For the year 2014 this results in a list of 332 firms with information on turnover and employee numbers.

3.2.6 Gross added value

All data for the calculation of added value is derived from the CBS. The gross added value is defined as the added value between production (base price) and the (purchase price). To obtain a comparable measure of added value we divide it by the volume of labour available to the region. The volume of labour is defined as the amount of labour over a period of time in labour years. This entails all persons that perform paid labour. This yields an average amount of added value for each labour year. The data considered is from 2004 to 2014. According to the CBS, the data for 2013 and 2014 are preliminary. Since 2010, the data conforms to the ESR 2010 guidelines (CBS, 2015).

3.3 Network analysis

3.3.1 Data Characteristics

The database used in analysing innovation networks is named NETWORKS FOR KNOWLEDGE (NfK) and is compiled of publicly supported innovation projects that are carried out by companies, research institutes, governments and other organisations. For most organisations there is background information available, including the location and type of organisation. The scale of the database is described in Table 2.

Table 2: scale of NfK database

Number of projects	**3270**
Number of unique organisations	**8366**
Average participants per project	**2,56**
Companies (SME's and large corporations)	**4973**
Knowledge Institutes (Higher Education and Public research)	**198**
Public organisations (Healthcare, education and government)	**542**
Intermediaries (Industry associations)	**350**
Unknown	**2303**

The data covers around two thirds of all innovation projects in the Netherlands that have started between 2006 and 2014. More details about the dataset and the characteristics of projects and organisations can be found in Annex I.

3.3.2 Data Selection

For each of the ecosystems the geographical delineation was used to define the network of the ecosystem. An ecosystem innovation network thus consists of all projects with at least one organisation from the geographical area of the ecosystem. These projects are also connected to a variety of organisations external to the region. An overview is given in Table 3.

Table 3: Overview of selected data for innovation networks

	Number of innovation projects	Number of regional organisations	Number of external connected organisations
Brainport	632	550	3715
MRA	912	900	4459

Twente	419	475	3214
Utrecht	641	758	4381
South Holland	1315	1429	4891

In the visualisations in the results section, only organisations from the ecosystem region itself are depicted, but the various indicators have all been measured including the connected organisations external to the region.

3.3.3 Method of analysis

Every organisation in the database can be connected to one or multiple projects by a tie. Doing so for every organisation results in a network of projects connected to one or more organisations, with some organisations overlapping across multiple projects. From this it is possible to construct relationships between different organisations. For example, if two organisations collaborate on the same project they are in a partnership and thus have a link. If one of these organisations is also involved in another project with three participants it has a total of 4 linkages in two projects.

Doing so for each organisation results in a network of organisations connected with each other through innovation projects. These forms of networks are known as 1-mode networks.

For each organisation the following characteristics are calculated:

- The number of projects an organisation participates in.
- The degree centrality through number of partnerships an organisation has, which indicates the amount of influence an organisation has through its relationships with others (Jackson, 2010).
- The betweenness centrality of the organisation within the network, which indicates the amount of influence an organisation has in the network through its position in relation to others (Freeman, 1977).

For the entire ecosystem network the following indicators are calculated:

- Density represents the intensity of interaction within a network (Friedkin, 1981) by measuring the number of potential links between organisations divided by the number of actual links between organisations.
- Connectedness represents whether organisations use the network to its full advantage by measuring the share of organisations that can be found by another organisation through existing ties in the network (Tichy & Fombrun, 1979).
- Average distance represents the amount of resources an organisation needs to find and connect to another organisation, which is measured in the average number of links it has to pass through on the shortest path to reach the other organisation (Newman, 2001).

Annex II describes the methodology of these indicators and characteristics in more detail.

3.4 Case studies

3.4.1 Respondent selection

The functioning of the ecosystems was further investigated by qualitative data. Desk research on relevant policy documents provided information on the framework conditions of specific ecosystems, but the primary source of qualitative data were interviews with representatives and participants of the ecosystem itself. In order to review all different perspectives on knowledge triangle interaction and organisation the

intention was to question six respondents for each case study. These six respondents included the following profiles.

- One or two representatives of an ecosystem governance organisation on both managerial and operational level.
- A representative of local government with innovation and entrepreneurship in his or her portfolio.
- Representatives of educational institutes that have innovation and entrepreneurship in the portfolio from a university, a UAS and a VET school.
- An executive of a large corporate which has made the conscious choice to establish offices or R&D within the ecosystem.
- One or two 'antitheses': people that do not necessarily see the benefit of the ecosystem organisation or have an outsider's role.

A full list of respondents can be found in Annex …

3.4.2 Approaching respondents

Respondents were approached by e-mail with a short summary on the contents of the research project and the question of whether they would be willing to participate. Subsequent telephone conversations would determine whether the respondent was positive and an appointment was made. Almost all interviews were carried out face to face. Two interviews took place through the telephone and two interviews took place via Skype.

3.4.3 Structure of the interview

The interviews were structured through a topic list, allowing the interviewer to continue a line of inquiry if they saw fit and covering all the relevant topics. The average time of an interview was around an hour. To review the interview protocol, see Annex IV

4 Overview of the Dutch Knowledge Triangle

This section gives a description of the three pillars of the knowledge triangle and the overall state the interaction between research, education and innovation. It discusses the position of higher education, funding, research, innovation policy and the role of place-based policies.

4.1 Higher education

The Netherlands has 13 universities, 37 universities of applied sciences and 69 regional schools for vocational education and training. These institutes are all publicly funded and accredited, this excludes any private schools and universities. On average, the share of public expenditure in an institute for tertiary education is 70% (OECD, 2015).

In recent years, the number of students enrolled in tertiary education has been steady around just under 1.2 million students. Simultaneously there has been a fall in the number of students that are enrolled in vocational education and training (VET), compensated by a rise in students enrolled at universities of applied sciences (UAS) and a slight rise of students enrolled in Universities (DUO, 2015).

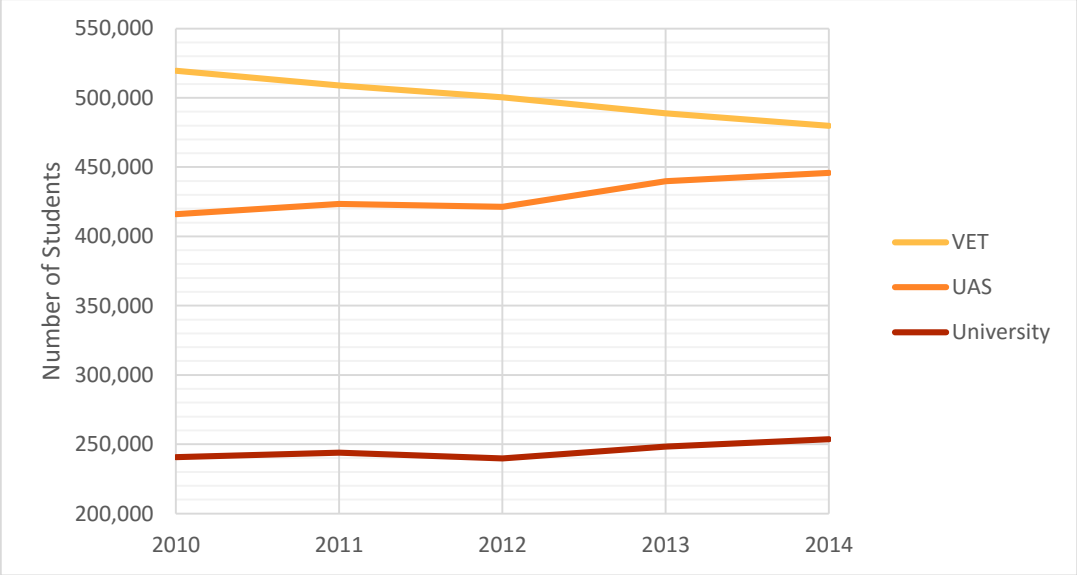


Figure 5: Trend in the number of students enrolled in tertiary education (DUO, 2015)

The general governmental policy in steering the universities and universities of applied sciences from 2011 onward contains three priorities. First, the education quality and success rate of students needs to be maintained and improved. Second, the differentiation within and between universities is required to be increasingly strong, with more delineated profiles and focus on specific areas by the universities. Thirdly, more attention to the valorisation of new knowledge is required.

4.1.1 Universities

The 13 accredited universities that receive funding from national government are divided into three technical universities (of which the University of Twente also offers non-technical education), 1 agricultural university (Wageningen University and Research) and 9 general universities. In total these universities offer 183 bachelor studies and 566 master studies (VSNU, 2012). Additionally, there are 8 medical centres (teaching hospitals), each attached to a university.

4.1.1.1 Position and strategy

In line with the policy strategy there has been more differentiation within education paths by using broader bachelor programmes, research masters and honours programmes. Simultaneously there has been a rise in students enrolled in university college programmes, that offer a more liberal arts and sciences approach to a bachelor's degree (VSNU, 2012). The profiling between universities occurs primarily in the area of research but this has consequences for the available education.

The strategic plan up to 2025 continues along the same lines as outlined in the previously drafted general government policy. This requires universities to further differentiate in terms of education and research, whilst increasing the quality of education (Ministry of Education, Culture and Science, 2015).

4.1.1.2 Education funding

Universities are dependent on three main sources of income. The first is government funding. The Dutch ministry of education, culture and science provides a lump sum for all universities in the Netherlands for both education and research. Additionally, a small part of the lump sum comes from the ministry of economic affairs. In the budget there is differentiation between education and research, but in practice it is also up to the universities how to divide the money over their efforts. In 2004 the education and research budget spent was 2.681 million Euros for a year, in 2014 this has risen to 3.676 million Euros. The amount of money a university receives depends on the number of students and the allocation universities have made amongst themselves. On average a university received € 7.327,- a year from the ministry for the education of a student in 2014 (Panteia, 2014). The second and third source are relevant for research and will be treated later in this chapter.

4.1.2 Universities of Applied Sciences

There are 37 UAS institutes across the Netherlands that receive public funding, which includes 5 schools for the arts. Together, these institutes offer 218 bachelor degrees and 60 master degrees. Additionally, since 2013 80 associate degrees are offered, which are meant to bridge the gap between vocational education and higher education with a two year program.

4.1.2.1 Position and strategy

The UAS have a unique position with their educational activities and connection to business. Since 2011, they follow the general government policy which means that for education their efforts are focussed on the quality of education and success rate of students. At the same time they are required to differentiate within their educational programmes, offering more differences in both content and difficulty to students (Ministry of Education, Culture and Science, 2011). The UAS are required to focus their research efforts more into specialties by strengthening the research infrastructure and allying themselves with other HEIs and the private sector. All research efforts are explicitly required to be connected to education. This strategy continues for education until at least 2025 (Ministry of Education, Culture and Science, 2015).

4.1.2.2 Education funding

The universities of applied sciences are dependent on three sources of income. Primary income consists of government funding which is almost entirely provided by the ministry of education, culture and science and for a small part by economic affairs. The budget for education in 2004 was 1.657 billion Euros and in 2014 this has risen to 2.688 million Euros. These budgets also contain the government funding for applied research. On average a UAS received € 6,226 for each student in 2014 (Panteia, 2014).

Since 2012, 7% of the funding is allocated to performance based agreements between the UAS and the government. The aim is to give UASs the opportunity to strengthen their activities in a specific area and

receive funding based on predetermined goals in this area. The UAS will be reviewed primarily on study success rates, increase in excellence of students and teachers, efficiency and centres of expertise that deliver high-level knowledge in cooperation with business sector. This should induce UASs to choose a sharper focus for which they can provide this (Ministry of Education, Culture and Science, 2011).

The second source of income comes from independent public organisations, such as the taskforce applied research of the NWO (SIA). The third source of income is project based funding from both public and private partners.

4.1.3 Vocational Education and Training

The institutes of vocational education are organised regionally, with each region having one 'regional education centre'. Additionally there are several schools that have a more sectoral focus, such as the four agricultural centres and ten schools for specific professions (such as silversmiths and seafarers). In total, there are 69 publicly funded VET schools in the Netherlands. Together they offer 1380 different education programmes at different levels and in different forms. Primary division is the difference between a theory based approach (BOL) which places the student in a classroom, and a practice based approach (BBL) in which a student obtains an apprenticeship with a company and is coached by the school. The education programmes are further organised in sector based qualification structures.

4.1.3.1 Position and strategy

In the four years up to 2016, VET schools have been pushed by the Dutch government to increase their quality as schools. This meant increasing the intensity of education, the quality of teachers and examination, and a more regional focus where not every school offers every qualification. At the same time, the governance was to be improved (Ministry of Education, Culture and Science, 2011). As a follow-up to this strategy the government has placed more importance on the connection of VET with the labour market. Rapid changes in the labour market will require more flexibility in switching education programmes for the student and more contact with (innovative) fields of labour during the student's education. Complementarily, the education path must be better connected to prior and following education possibilities and contain the possibility for an excellence track (Ministry of Education, Culture and Science, 2014).

4.1.3.2 Education funding

The VET schools are primarily funded by the ministry of education and receive some additional funding and subsidies from the ministry of economic affairs. This budget totalled 2.858 million Euros in 2007 and has risen to 3.355 million Euros in 2014. In total, the ministry of education on average spent € 6.855,- on each student in 2014 (Panteia, 2014).

Since 2015 part of the funding, around 400 million Euros, is based on performance in reducing the number of dropouts, increasing the success rates, the quality of teachers and the quality of internships. Furthermore, excellence trajectories in VET that focus on craftsmanship and skills are encouraged by this funding (Ministry of Education, Culture and Science, 2014).

To stimulate the establishment of links with private partners, the VET schools establish the so-called Centres for Innovative Craftsmanship. These centres are a place where researchers, teachers and students can collaborate in improving the quality of technical education in the region together with private partners. The profile of these centres is formed based on a top sector that is strongly represented in the region (Van der Meer, Van den Toren, & Lie, 2016). As of 2014, 18 centres are in varying stages of development (Platform Bèta Techniek, 2014). Since 2015 similar possibilities for public-private cooperation in vocational education are funded by the Regional Investment Fund of Dutch Government.

4.2 Research

The Dutch research strategy has hinged on three primary goals in the past decade; strengthening prominent research groups for scientific excellence, stimulate innovation in economically important areas and combating fragmentation by creating sufficient focus and mass in the separate institutes. In the nearby future the focus is on creating a profile within an international context, guided by the Top Sector policy and the research- and innovation programme of Horizon 2020. This has its consequences for the characteristics of research and funding for HEIs. The innovation strategy includes establishing public-private consortia for knowledge and innovation which requires the participation of HEIs (VSNU, 2012). Overall, in 2012 the Netherlands spent 1.85% of its GDP on research and development and the share of GDP that goes to R&D and is publicly financed is 0.75% (OECD, 2012). In 2013 the Netherlands spent 1.98% of its GDP on R&D and is on track to reach its target of 2.5% in 2020 according to the Dutch government (Ministry of Economic Affairs, 2015).

4.2.1 Universities

The primary research funding source of universities is the lump sum, discussed in the Education section. An increasing amount of this funding for research is taken out of the first source of income and allocated to the second source which is performance based. From 2000 to 2010 the primary source has decreased from 2 billion to slightly above 1.7 billion Euros (VSNU, 2012).

The second source of income comes from independent public organisations, of chief importance being the Netherlands Organisation for Scientific Research (NWO) which gives out grants to scientists and research programmes. On average it has a budget of 625 million Euros, rising to 680 million in 2015 of which 275 million is earmarked for the Top Sector strategy (NWO, 2013). Several agencies operate under the wing of NWO. The Foundation for Fundamental Research on Matter (FOM) focuses on grants within physics. The Technology Foundation STW has the objective of knowledge transfer in the technical sciences. Finally, the Netherlands Organisation for Health Research and Development focuses entirely on healthcare. All these agencies have influence in setting the research agenda of the Netherlands.

The third source of income is project based funding from both public and private third parties and public private consortia. This accounted for 1.696 billion Euros of funding in 2012, a 96% growth compared to 2003 (Ernst & Young, 2014). According to the united universities, the Dutch universities gained around 1.700 billion in project based funding in 2014 (VSNU, 2015)

The government strategy has resulted in a relative decrease of the primary source of income and an increase in the second and third source. As a consequence the guidance of research has moved towards the agencies that provide the funding. The universities have responded by creating stronger focus in research programmes through choices in long term investments in infrastructure and human capital and a matching with the Top Sector strategy (VSNU, 2012). The strategy includes establishing public-private consortia for knowledge and innovation (TKI), with the aim of a public-private budget of 500 million Euros by 2015 (OECD, 2012).

4.2.1.1 Valorisation

The universities have adopted specific strategies to cope with the increasing importance of their third mission. The establishment of incubators and centres of technology transfer and entrepreneurship have led to both an increase in new companies founded by (former) university students or employees but also an increased interest in entrepreneurship education. Furthermore, the intensity of collaboration with private partners has increased and each university now has made valorisation a part of the research structure and human resources policy (VSNU, 2012).

4.2.2 Universities of applied sciences

Since 2001 the Dutch UAS are officially appointed as a research institute with a focus on applied research. This is done through the so-called lectureships, branches of the UAS with a specific research task in which lectors fulfil both a teaching and a research role. The relationship with education is paramount, as insights from the research are required to be applied in the educational programme.

The strategy of UASs for research will focus primarily on focus and valorisation. Focus formation is required to prevent fragmentation and reached through investments in infrastructure, bundling activities and alliances with knowledge institutes and private partners that are regionally or thematically aligned. Valorisation efforts are required to translate applied research into new products, services, processes and economic activity (Ministry of Education, Culture and Science, 2011).

Since applied research lies close to education in the UAS model, the first source of income is the lump sum of the ministries which is described in the Education section. The second source of income is provided by a subsidiary agency of NWO, the Taskforce Applied Research (SIA) which was provided with a 32 million Euro budget in 2014 (NWO, 2013). The subsidies of SIA are aimed at applied research and valorisation.

The third source of income is project based funding from public and private third parties. A part of this project based research is done within Centres of Expertise Since 2010, the aim is that each UAS establishes at least one Centre of Expertise of its own. These are branches of the UAS in which high quality education is connected with applied research in collaboration with (regional) firms and public organisations. The centre's aim is to provide more knowledge spill-overs and valorisation (Ministry of Education, Culture and Science, 2011). There are currently 28 government funded public private initiatives in various stages of development throughout the Netherlands of which almost all (26) are connected to a Dutch top sector (Van den Toren & Lie, 2014). Additionally the UAS have established centres with UAS and business sector funding but without government funding.

4.3 Innovation policy

Since 2010, the ministry of economic affairs is responsible for innovation policy in the Netherlands, whilst the ministry of education, culture and science remains responsible for education and research policy. The Netherlands Enterprise Agency (RVO) was created as a central contact point for information concerning innovation and financing, networking and regulatory matters.

4.3.1 Top Sector policy

In 2011, the Netherlands have reformed their innovation policy to focus on nine top-performing sectors (agro-food, horticulture and propagating stock, high-technology materials and systems, energy, logistics, creative industries, life sciences, chemicals, and water). This focus is based on stimulating, demand-driven innovation through access to corporate financing, better utilisation of knowledge infrastructure, and use of fiscal incentives (OECD, 2012). The relationships and sectoral plans are formalised in the top consortia for knowledge and innovation (TKIs) of which some Top Sectors have more than one. By aligning investments from separate ministries with the Top Sectors it is possible to integrate interventions across departments. The TKIs receive specifically designated funding and are partly funded by private partners (Ministry of Economic Affairs, 2015).

The Top Sector policy is aimed at existing sectors and does not automatically contain a search regime for new niches, making it less dynamic. To address this, several cross-cutting themes have been introduced (ICT, bio-based economy and nanotechnology). Also, some top sector committees have started a program

for new niches and new business. Although the policy is consistent, SMEs are still underrepresented within the Top Sectors. The monitoring and evaluation of top sector policy is relatively sophisticated, taking into account a lot of indicators. (OECD, 2014).

4.3.2 Entrepreneurship and innovation stimuli

The main package for stimulating R&D within companies is the Research and Development Promotion Act (WBSO) which provides tax deductions on the wages of R&D workers. Next to this, the innovation fund offers loans and risk capital for SMEs (OECD, 2012). In 2014 almost 40.000 companies used the WBSO fiscal incentive (Ministry of Economic Affairs, 2015). There are also innovation performance contracts that provide incentives for SMEs collaborating on innovation projects. Within the Top Sector policy an instrument aimed at SMEs provides funding for feasibility studies, innovation vouchers and collaborative opportunities if there is affiliation with a Top Sector. Overall the system is heavily focused on providing tax incentives, which has been evaluated as well designed but may be less suited for more long-term or risky innovation (OECD, 2014).

4.3.3 European programmes

Dutch knowledge institutes together with private partners have attracted significant amounts of funding from the European Horizon 2020 programme, the follow-up of FP7. In 2014, 537 million Euros where attracted for R&D projects, in which 31% of the cases was accomplished together with the private sector. (Ministry of Economic Affairs, 2015).

4.3.4 Place based policies

To be eligible for funding from the research and innovation strategies for smart specialisation (RIS3) of the European Union, The Netherlands have adopted regional agendas for the regions North, East, South and West. These agendas focus mostly on characteristic sectors that are strongly represented in the region, in line with the Top Sector approach. There is less attention for regional clustering of related industries, although the agendas stress the importance of crossovers between sectors and regions. Further national strategies aimed at the development of regions are also sectoral in focus. Since the Top Sectors are often strongly represented in a particular region, regional government agencies are involved in the execution of Top Sector policy (AWTI, 2014). Since 2015 new funding for EFRO is realised as part of the new EU program period and the Netherlands is expected to gain 500 million Euros funding up until 2020. Some provinces in the Netherlands have own funds to stimulate R&D. Also since 2005 several regions have started a tripartite board for stimulating innovation (the case of Amsterdam region, Brainport and Twente are elaborated in other chapters in this study). This regional organisation is not stimulated nor funded by national government, but national government strongly cooperates with these boards in regions where they exist. An exception is the Groningen region that experiences earthquakes as a consequence of gas exploitation. There, national government facilitates regional investments and stimulated starting cooperation in the ‘Economic Board Groningen’.

4.4 Evaluation of the Knowledge Triangle

In 2014 the OECD evaluated the innovation system of the Netherlands with the following strengths and weaknesses (OECD, 2014).

4.4.1 Strengths

- Multinationals with global reach, including in R&D and innovation.
- Strong technological capabilities and performance of Dutch firms.

- A strong science base with strong research universities and public research institutes and excellent output in terms of the number and quality of scientific publications, and high productivity.
- Strong participation in European Framework Programmes and other international co-operative efforts and networks.
- Innovative approaches, design, and delivery of innovation policy.
- Strong evaluation culture.

4.4.2 Weaknesses

- Some aspects of the framework conditions for innovation, e.g. in the area of financing (small and medium sized) enterprises.
- Low R&D expenditure and low propensity to collaborate with knowledge institutions in parts of the business sector.
- Frequent changes in innovation policy.
- Limited public recognition of the benefits of science and technology; some weaknesses in the culture of entrepreneurship.
- Low graduation success rates in tertiary education.

In this case study we will elaborate on the Knowledge Triangle in the Netherlands and evaluate the Triangle from the perspective of Entrepreneurial Ecosystems.

5 Knowledge Networks in Ecosystems

5.1 Project intensity

To illustrate the difference between ecosystems we look at project intensity first. Based on the amount of companies in a specific ecosystem and the number of innovation projects with at least one participant from the ecosystem a measure of project intensity emerges. Here the average number of projects for each 1000 firms in a region is compared to the Dutch average in Table 4.

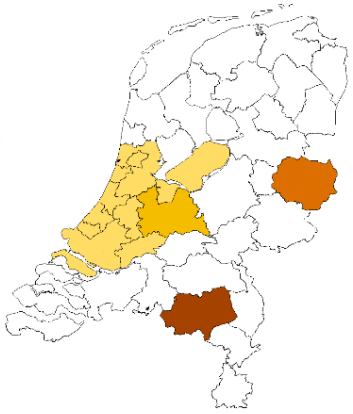


Table 4: Project intensity across ecosystems

	Number of companies in 2014	Number of projects	Projects/1.000 companies
Netherlands	1.363.265	*3.270*	*2,40*
Brainport	62.500	632	**10,11**
MRA	247.655	912	3,68
Twente	44.585	419	9,40
Utrecht	110.850	641	5,78
South Holland	274.810	1.315	4,79

Overall the Brainport and Twente ecosystems far exceed expectations in number of innovation projects in comparison to the amount of companies that reside in the region.

5.2 Visualisations and key characteristics

To gain insight in the structure of the regional network of an ecosystem we create visualisations of each separate ecosystem. In practice there is overlap in the connected organisations to each ecosystem, as organisations can collaborate both with organisations from the same region or with their counterparts elsewhere in the country. To interpret the regional network the visualisations are limited to those organisations that have their address within the geographical boundaries of the ecosystem. However, in determining network characteristics, leaders and the involvement of HEI's we also take into account the organisations external to the region.

The visualisations consist of nodes each representing a separate organisation, which are connected to the other nodes i.e. organisations with which it collaborates on an innovation project by ties in the form of lines. The nodes have been colour-coded to indicate the type of organisation that they represent. The legend for all graphs is:

- Companies
- Knowledge Institutes
- Intermediaries
- Public Organisations

Figure 6 shows the distributions of organisation types across ecosystems, taking only into account the organisations that are located within the borders of that ecosystem.

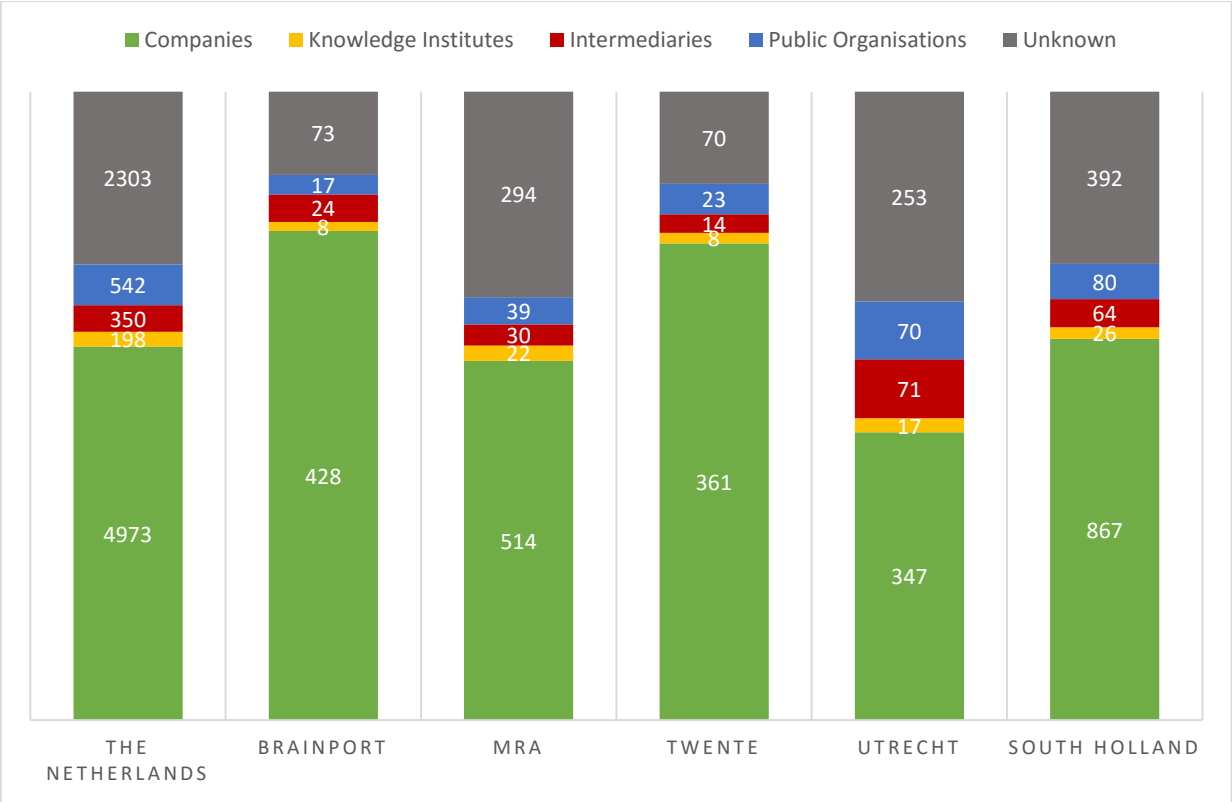


Figure 6: Distribution of organisation types across ecosystems

In each network graph the leading organisations are labelled, including the central HEIs and if available the regional board organisation. These labels are chosen based on the amount of projects organisations participate in. Nodes that are not connected to any other nodes represent organisations that are either soloing an innovation project or are only connected to organisations outside of the ecosystem. Note that therefore regional network visualisations appear more fragmented than the connected network actually is, as some regional organisations are connected to the network through external organisations.

5.2.1 Brainport network

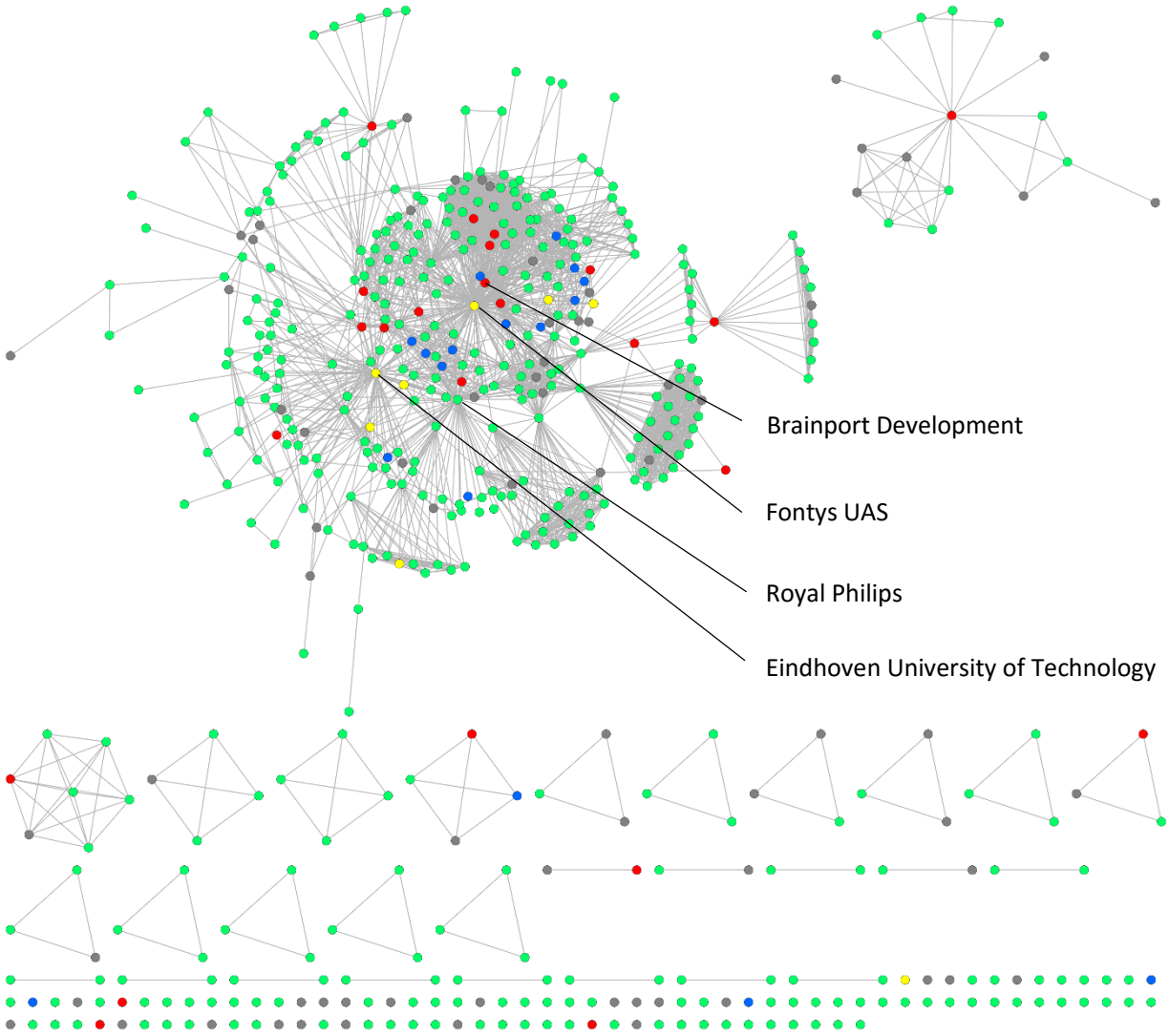


Figure 7: Network visualisation of the Brainport regional ecosystem

Projects	632
Organisations connected to these projects	4259
Organisations in regional ecosystem	550 (12.9%)
Average number of organisations per project	6,74

The Brainport network is well connected with a main component that connects almost two thirds (352 organisations) of all regional organisations. The two HEIs have central positions in the network, with the TU/e participating in a large share of the projects and the Fontys UAS connected to many partners in the region. The municipalities of Eindhoven and Helmond are relatively close to the centre of the main component and cooperate with both the TU/e and Fontys UAS. Brainport Development acts more as a hub node for different companies. The companies that participate in the most projects are the high tech giants NXP Semiconductors, ASML and Royal Philips. Of these, Royal Philips is most well-connected with other regional partners. With high clustering in the main component it should be relatively easy for

organisations to find regional partners through existing ties. There are a 103 organisations that are not connected to any of the other regional organisations.

5.2.2 Amsterdam Metropolitan Area Network

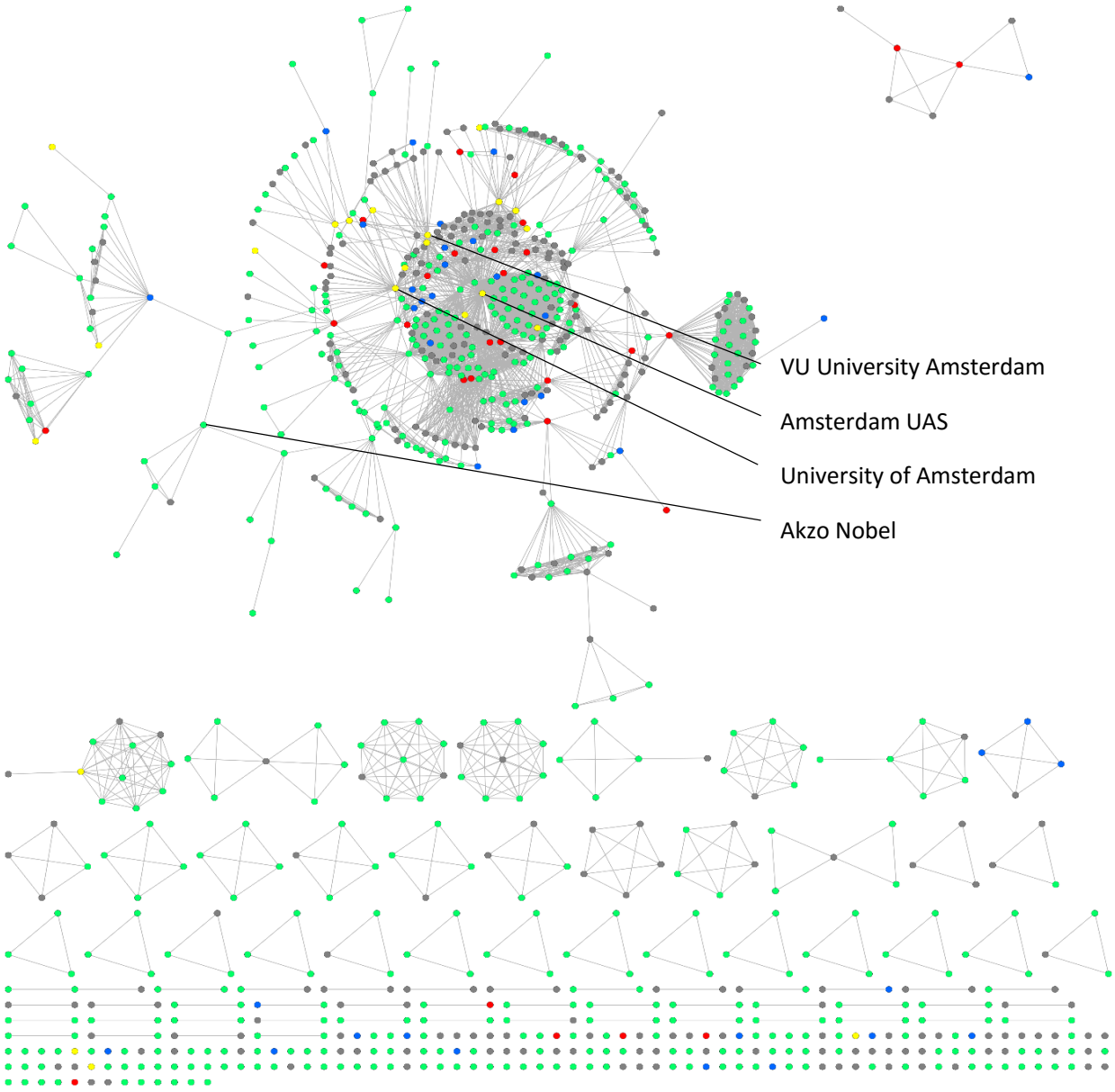


Figure 8: Network visualisation of the MRA regional ecosystem

Projects	912
Organisations connected to these projects	5353
Organisations in regional ecosystem	899 (16.8%)
Average number of organisations per project	5.87

The Amsterdam Network is somewhat fragmented, with only approximately half of the organisations in the main network component. The three HEIs have fairly central positions, with the Amsterdam UAS taking the lead in partnerships and the University of Amsterdam ranking highest in project participations. The VU University is a less active participant, indicated by the position on the fringe of the main

component. The first large corporate to appear is Akzo Nobel, also taking a fringe position. In total, 194 organisations are not connected to other regional organisations in the network.

5.2.3 The Twente Network

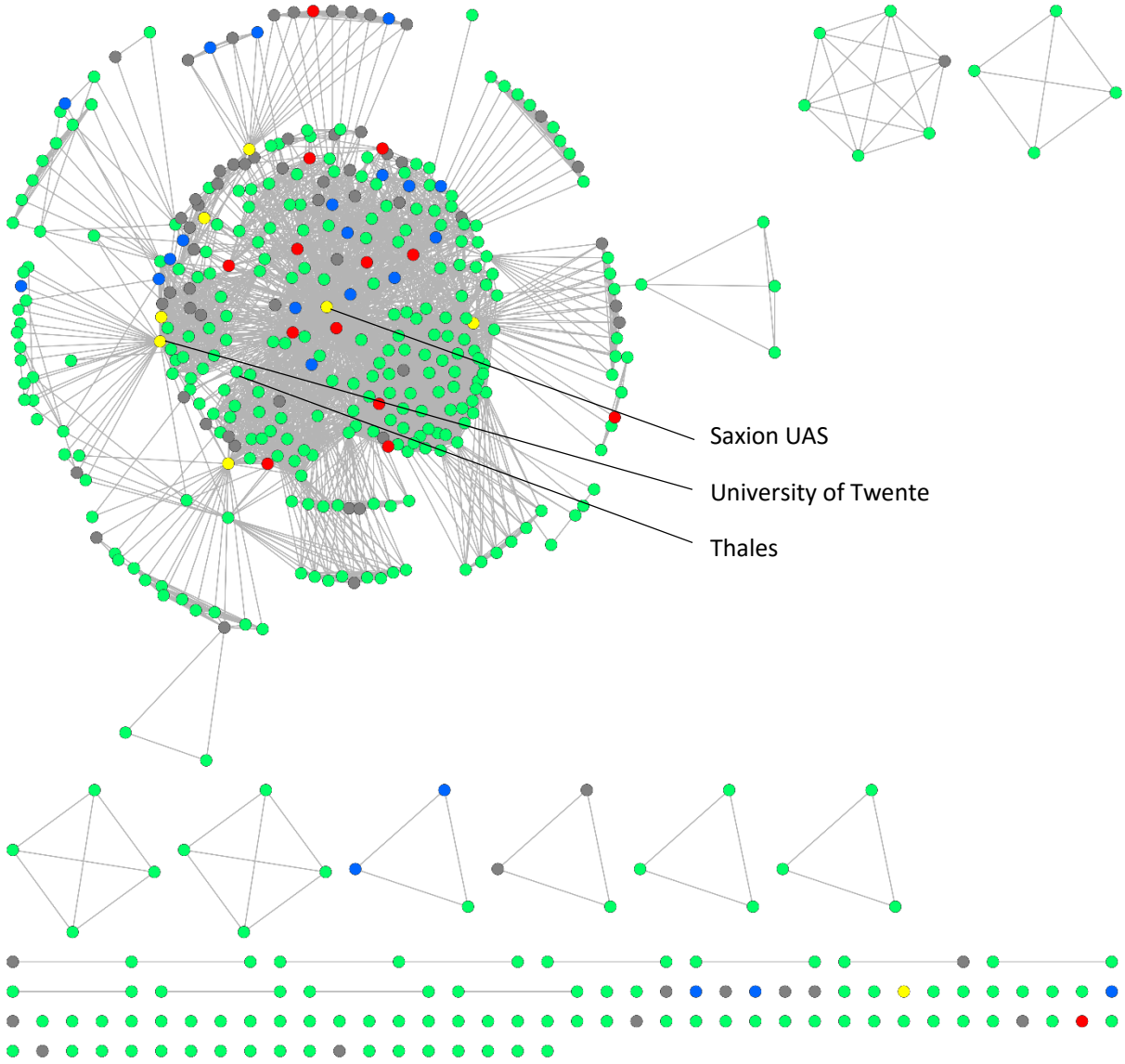


Figure 9: Network visualisation of the Twente regional ecosystem

Projects	419
Organisations connected to these projects	3686
Organisations in regional ecosystem	476 (12.9%)
Average number of organisations per project	8.80

The Twente network is well connected, featuring a main component that contains almost three quarters (349 organisations) of the regional organisations. The main HEIs are central to the network, with the Saxion UAS taking the centre stage in partnerships and the University of Twente, although more at the

fringe, connecting many companies to the network. The large corporate that is most well connected is Thales. The main component features high clustering, making it potentially easier for innovating organisations to find each other. A small share of 75 organisations are not connected to any of the other regionally active organisations.

5.2.4 The Utrecht Network

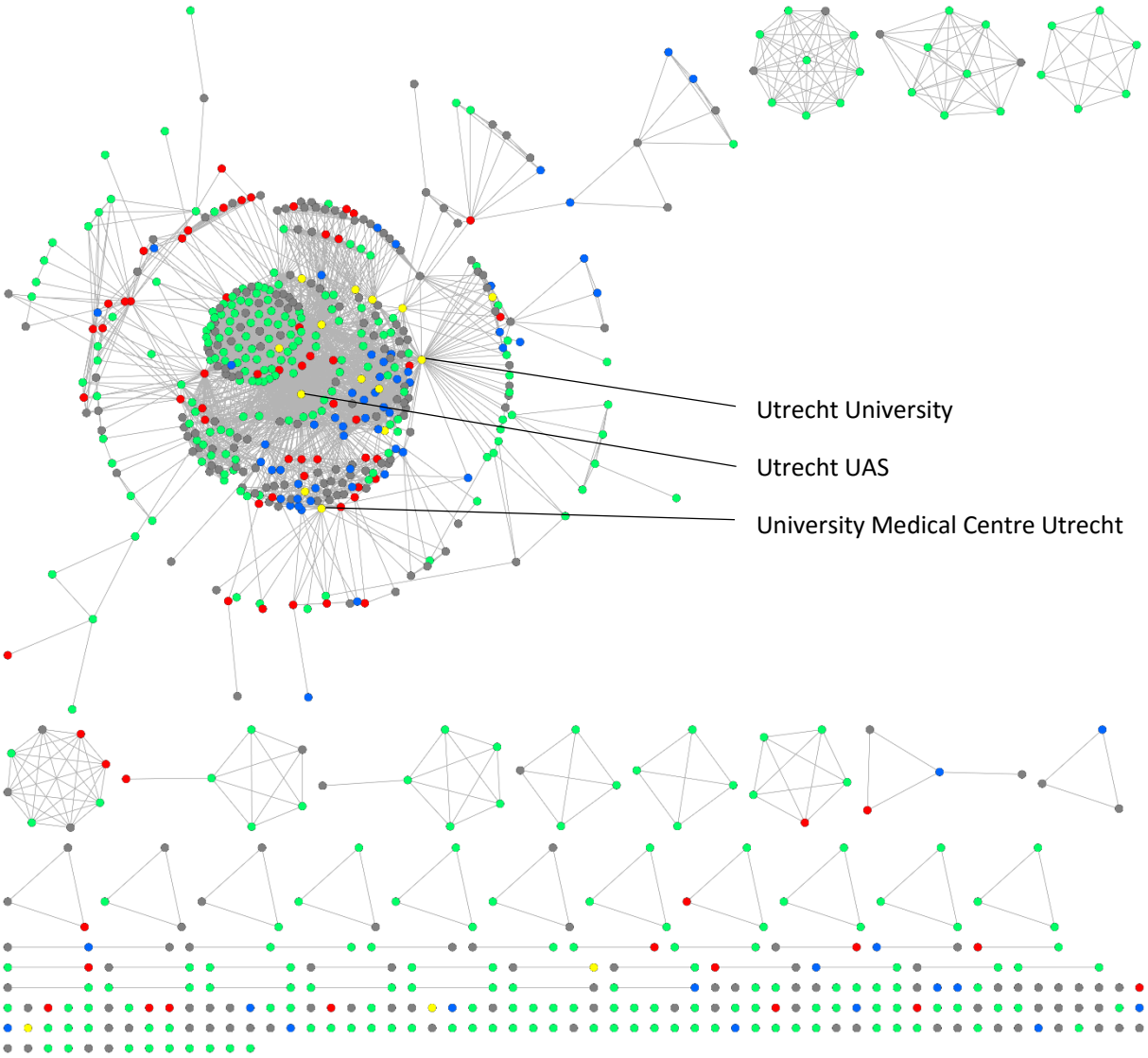


Figure 10: Network visualisation of the Utrecht regional ecosystem

Projects	641
Organisations connected to these projects	5131
Organisations in regional ecosystem	758 (14.8%)
Average number of organisations per project	8.00

The Utrecht network is reasonably connected with around two thirds of the organisations (455) involved in the main network component. The Utrecht UAS is the most connected organisation in the region and takes the most central position in partnerships. The HKU University of the Arts is also one of the most frequent participants in projects in the region. Both the university and medical centre are able to connect more organisations to the main network but are mainly involved in a large share of projects. There is a high number of public organisations involved in the main component of the network. A total of 149 organisations is not connected to the regional network at all, making Utrecht relatively fragmented.

5.2.5 South Holland Network

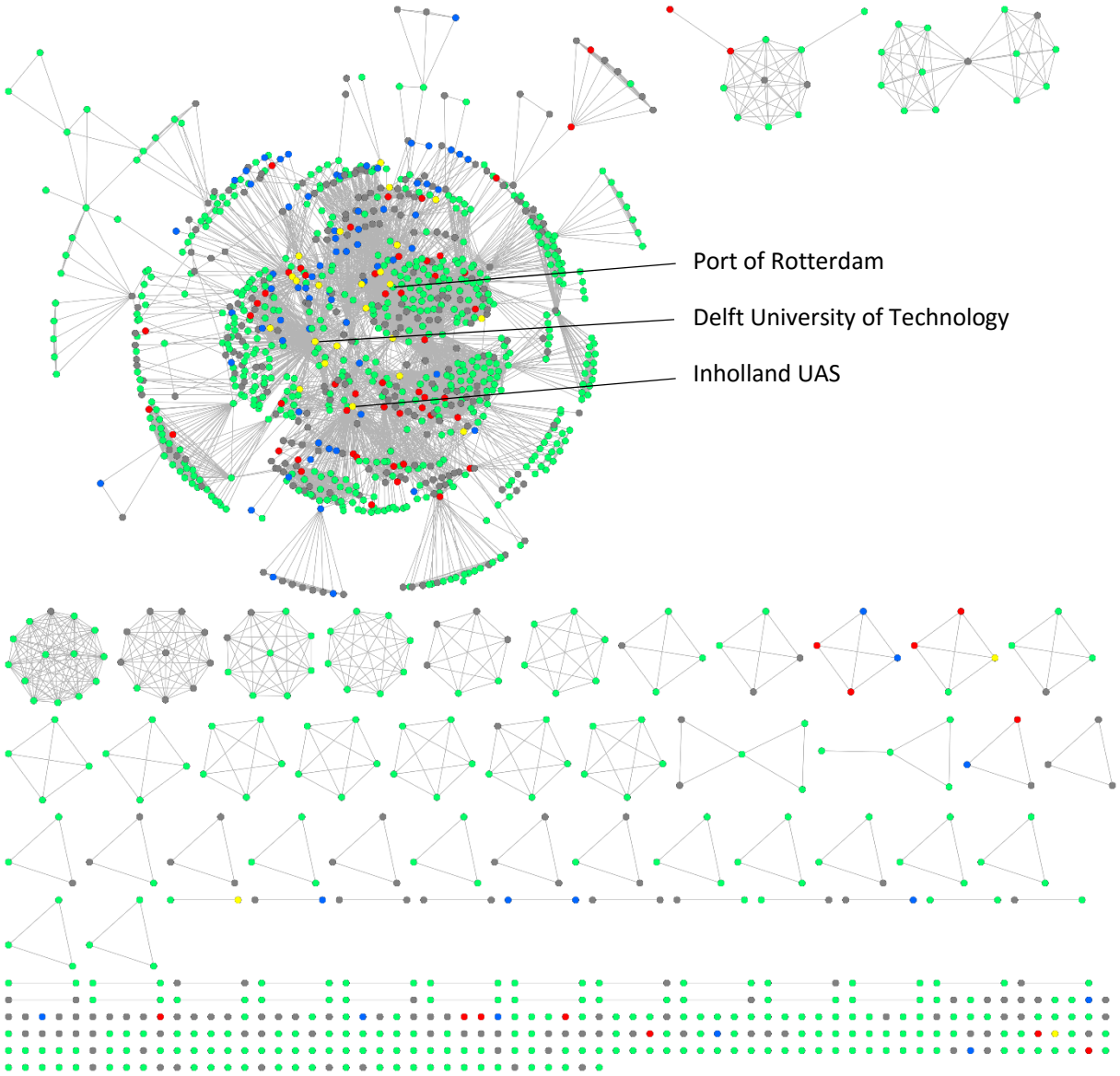


Figure 11: Network visualisation of South Holland regional ecosystem

Projects	1315
Organisations connected to these projects	6312
Organisations in regional ecosystem	1429 (22.6%)
Average number of organisations per project	4.80

South Holland has a large network with a relatively well connected main component which features around two thirds (918) of the organisations active in the region. Since South Holland is the largest region in this analysis in terms of number of projects and connected actors and features multiple HEIs in its different municipalities, only the most active institutes are highlighted. These are the Delft University of Technology and the InHolland UAS, both interacting with the most partners within the ecosystem. The Delft University participates in almost one fifth of all projects. There are a multitude of government organisations active in the main component. A large network also means that not all organisations are equally connected, 245 organisations are not connected at all to the regional network.

5.3 Network characteristics

As seen in the visualisations, each network consists of a large and several smaller components. Smaller networks often have relatively less components. The less separate components there are, the more connected the network is. As an indication of frequency of interaction, the average number of partnerships is included.

For each network its characteristics can be quantified to assess the potential functioning of the network in different ways. This is done by calculating three different indicators for each network, namely density, connectedness and distance. Density measures the intensity of interactions in a network. Connectedness reflects the chances of being able to find another organisation in the network using existing ties. Distance indicates the amount of effort an organisation needs on average to reach another organisation. For more background on these indicators, more details are provided in Annex II.

Note that we calculate these indicators for the entire connected network of organisations of an ecosystem, not only those that are visualised above and present geographically in the region, but also those elsewhere in the country connected through innovation projects. This gives a better representation of the reach of each ecosystem. We compare the indicators with the national average based on an analysis of the entire database.

Table 5: Overview of network characteristics

Variable	Brainport	MRA	Twente	Utrecht	South Holland	The Netherlands
Number of organisations	4259	5353	3686	5131	6312	*8366*
Average partnerships	46,2	42,9	**52,5**	44,9	40,6	*35,5*
Components	44	87	**25**	63	148	*463*
Density	0,0108	0,0079	**0,0143**	0,0087	0,0064	*0,0042*
Connectedness	0,89	0,90	**0,96**	0,92	0,88	*0,84*
Average distance	3,10	3,16	**3,02**	3,04	3,11	*3,18*
Standard deviation of distance	0,765	0,733	0,759	**0,688**	0,693	*0,72*

Controlled for the number of participating organisations in the region, the Brainport and Twente Ecosystem have attained the greatest reach in attracting other organisations. These regions also feature a higher collaboration rate on average. All the ecosystems feature a higher collaboration rate in average partnerships than the Dutch average and have less components than the Dutch network. The Dutch network features 407 organisations that participate in only one project with no partners, which increases the number of components. Twente is by far the smallest but also relatively the most connected network.

In terms of density, Twente and Brainport are able to utilize a larger share of the possible links between organisations compared to other ecosystems. Not only are there less separate components but also the participating organisations do so more frequently.

Although all the networks are well connected, the Twente ecosystem features the highest connectedness, enabling present organisations to use the existing partnerships to reach each other, creating more potential for new and unexpected combinations. This high degree of connectedness is assisted by the smaller scale of the network.'

There is very little variation in average distance, meaning that organisations within ecosystems have to use three links ('handshakes') on average to reach another organisation within the network. Organisations in Utrecht and Twente have slightly more proximity to each other compared to other ecosystems.

5.4 Involvement of knowledge institutes

5.4.1 Involvement of KIs in general

To assess the involvement of research and education in a region the organisations with the classification of knowledge institute are selected. This does not only include HEIs but also public research organisations such as for example, the Dutch Polymer Institute in the Brainport ecosystem. For each ecosystem we investigate the involvement of both KIs within and external to the region. We also view collaborations between KIs from within and outside the region.

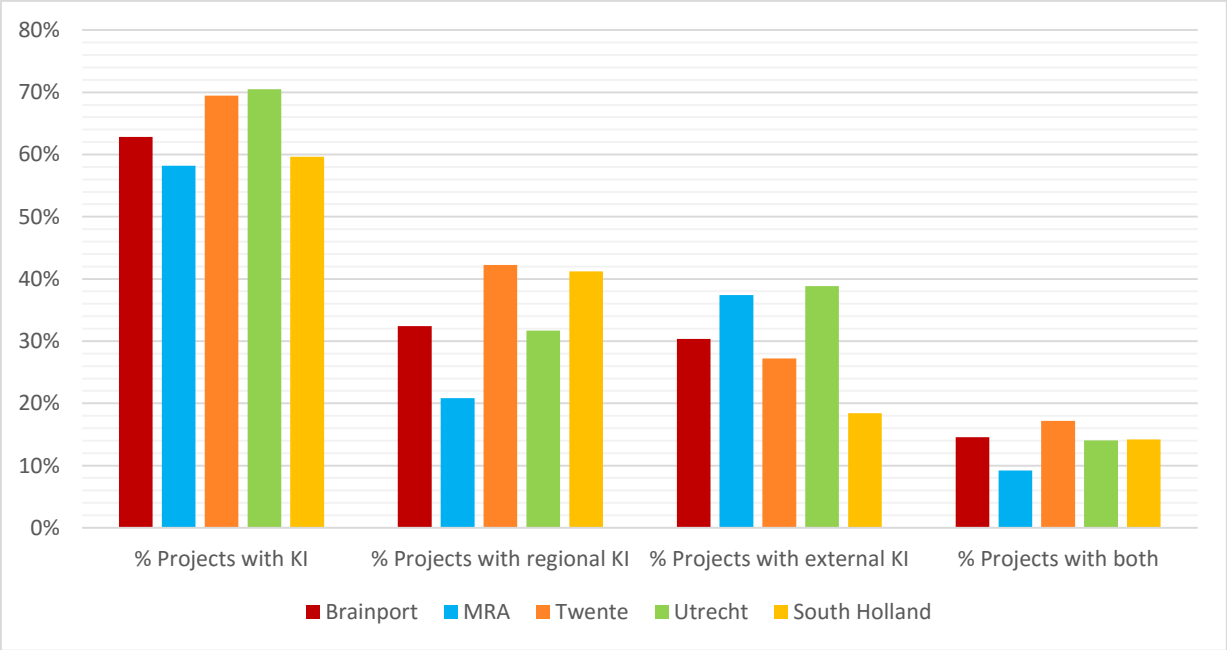


Figure 12: distribution of KI involvement in ecosystems

In Figure 12 the involvement of KIs is made relative to the number of innovation projects that contains at least one organisation from the ecosystem. All percentages are relative to the total number of innovation projects. Utrecht has a high KI involvement in its projects overall and relatively many projects feature a KI external to the ecosystem. The Twente ecosystem features the highest involvement of its local KIs, but also has the highest overlap as a large share of projects feature both a KI from the region collaborating with an external KI. Table 6 provides the overview in absolute terms.

Table 6: Overview of KI project involvement

	Brainport	MRA	Twente	Utrecht	South Holland
Number of projects	632	912	419	641	1315
Number of regional KIs	8	22	8	17	26
Projects with KI	397	531	291	452	784
Projects with regional KI	205	190	177	203	542
Projects with external KI	192	341	114	249	242
Projects with both	92	84	72	90	187

5.4.2 Involvement of HEIs

For each of the ecosystems attention is turned towards the central HEIs as described in the separate case studies. In Table 7, the bold entries indicate the highest scores of involvement relative to the total projects or organisations. The influence of an organisation is based on the betweenness centrality measure (see Annex II) and the position noted is the rank the organisation has in relation to its local peers. Organisations outside of the geographical borders of the ecosystem are not taken into account.

Table 7: Involvement of HEIs in ecosystem

	Number of projects	Number of partners	Ecosystem partners	External partners	Influence (betweenness)
Brainport					
Eindhoven University of Technology	162/26%	371/9%	**70/13%**	301/8%	4th
Fontys UAS	41/6%	642/15%	149/27%	493/13%	1st
MRA					
University of Amsterdam	70/8%	160/3%	50/6%	110/2%	2nd
VU University of Amsterdam	17/2%	100/2%	27/3%	73/2%	4th
Amsterdam UAS	23/3%	424/8%	190/21%	234/5%	1st
Twente					
University of Twente	**132/32%**	347/9%	70/15%	277/9%	2nd
Saxion UAS	**42/10%**	**794/22%**	**224/47%**	**570/18%**	1st
Utrecht					
Utrecht University	81/13%	324/6%	65/9%	259/6%	2nd
Utrecht UAS	40/6%	816/16%	288/38%	528/12%	1st
South Holland					
Delft University of Technology	273/21%	**659/10%**	**189/13%**	**470/10%**	1st
Leiden University	35/3%	164/3%	52/4%	112/2%	16th
Erasmus University Rotterdam	25/2%	189/3%	104/7%	85/2%	13th
InHolland UAS	27/2%	439/7%	117/8%	322/7%	3rd
Rotterdam UAS	19/1%	314/5%	144/10%	170/3%	6th

In general it is observed that universities are more project oriented and universities of applied science more partner oriented, often making the central UAS the most influential organisation in the ecosystem.

This effect is partially due to the fact that the UAS have access to an innovation policy instrument called SIA RAAK which is specifically designed for a UAS in partnership with a consortium of multiple local entrepreneurs. By comparison, universities often participate in several projects with no partners or only one key partner.

The tightly knit network of Twente shows relatively high involvement of its HEIs. However, Delft University of Technology, being the largest technical university in the Netherlands, takes the highest scores for involvement in projects. Together with the Brainport HEIs they are in stark contrast to the MRA, Utrecht and other HEIs of the South Holland Ecosystem, who are far less involved. Due to differences in scale and connectedness between ecosystems, most of the HEIs manage to be amongst the most influential organisations of the network. The MRA HEIs are still very central to the network even though their relative share of projects and partners is comparatively lower, because the of the larger scale and fragmentation of the network.

6 Labour Markets in Ecosystems

The knowledge triangle aims to make knowledge productive. Knowledge comes into firms in several ways:

- by students that start their career,
- by (formal) lifelong learning of those who have already an occupation, but also
- by innovations that change labour: the innovations of a few R&D professionals in a firm affects the work of a lot of other workers within the company but also influences the labour characteristics (quantitative and qualitative) at other firms, and
- by knowledge circulation when employees change occupation.

These paths are all relevant for building productive ecosystems: the higher the amount of well-educated people and mobility in terms of frequency and speed of switches in occupation of educated employees within a region, the better the conditions for entrepreneurial activity of a region.

This is a self-reinforcing effect. As more companies that require skilled and educated labour of a certain type settle in a region, they need and will attract a larger pool of employees. These employees get more opportunity to switch between firms and reach a higher level of vocation (or at least are not forced to accept a position beneath their current level). Geographical and historical conditions have given regions a particular sector distribution. When firms additionally co-locate and knowledge institutes follow, regions become more sector-specific and consequently get a more specific distribution of occupations.

Optimal specificity will attract a particular labour force and is expected to have a negative impact on unemployment. This is the explicit or implicit goal of national and regional policy makers. Not only is their aim to foster innovation and productivity, this also has to lead to more jobs and less unemployment for all categories of the labour force. In this chapter we will look at total employment: an effective knowledge triangle brings knowledge to firms that makes labour of all participants productive.

6.1 Entrepreneurial ecosystems and the labour market

From an entrepreneurial ecosystem perspective we focus on several challenges in the labour market.

1. Higher education institutes produce an enormous increase in human capital. However, large firms have shifted away from a model that relied on the availability of human capital through a life time employment plan. Large firms no longer control all their resources within their own borders. They have outsourced production and knowledge creation, and are more dependent on other firms. They also are smaller and are thus not always able to provide subsequent job opportunities to their employees.
2. This is one of the reasons firms establish themselves in ecosystems with other relevant firms. For reasons of procurement, delivery and knowledge based interaction, firms concentrate their activities in each other's proximity. This concentration also is used to safeguard the influx of enough and well educated human capital. For individual firms it can be rational to co-locate, but the question is whether the labour market can fulfil their aggregated needs.
3. Employees change jobs more frequently than twenty years ago. Individual persons have to find their way on a more dispersed labour market in which it is uncertain whether their human capital will be of value in each subsequent job.
4. This becomes more relevant when entrepreneurship results in more innovation, more new firms, more new products and processes in existing firms and more firms that are shaken out by more innovative competitors. These processes will lead to a more dynamic labour market. Changes

within the labour market can be visible in people switching employers (or becoming self-employed) but also in people changing occupation at the same employer. As such, the ability of the labour market to follow the disruptive and incremental effects of innovation and the labour market's adaptability require investigation.

Firms, employees and higher education institutes are all affected by these changes and challenges. But they don't wait silently and act separately. Firms and higher education institutes arrange place based cooperation and coordination within regions, adding to the already existing regime of sectoral coordination between each other on the labour market and with education sector on vocational education. This is elaborated in three case studies, but how the labour market partners in the knowledge triangle address this is analysed in this chapter.

6.2 Focus

In this chapter we bring in empirical data on the perspective of *specificity*. If firms settle in each other's neighbourhood, coherent ecosystems will follow. These ecosystems will build on existing sectoral focus in regions.

- Is this focus visible in job distribution?
- Can the labour market follow the dynamics of ecosystems?
- Does increased innovation and firm dynamics depreciate human capital in a region or is, alternatively, more human capital released?
- Can the existing workforce become more productive when firms co-locate and cooperate in ecosystems and can new already working employees find jobs were they can bring in their full potential?

In the next paragraph we describe sector structure and occupation distribution in each region. What are dominant sectors which consequently have high demands towards higher education? What are dominant occupations and wat are specific occupations that illuminate regional focus and specific needs of employers in the ecosystem?

In paragraph 5 we will switch to labour market mobility. Sectors fluctuate in the total amount of jobs and individual firms establish, grow, shrink or fail. New jobs are created and other jobs are phased out. But also if an occupation remains continuous does not, individual workers change occupations and switch employers. By counting job and occupation switches specific to the regional ecosystems, we analyse these labour market dynamics.

6.3 Sectors and occupations

The sector distribution is summarised, on an aggregated level in table 1. When a sector is relatively overrepresented in a region (compared to average proportion in the Netherlands), the cell is green.

Table 8: Sector distribution (part of the labour force working in a sector, 2014)

Region	Agriculture	Manufacturing	Construction	Trade & retail	Transport	Horeca	ICT & communication	Financial sector	Other services	Rental sector	Govern ment & education	Care & cure	Culture, sport & recreation
Nederland	*1,2*	*9,6*	*3,9*	*16,9*	*4,7*	*4,6*	*3,1*	*3,1*	*6,4*	*11,3*	*6,6*	*16,9*	*1,7*
Twente	0,7	14,8	5,3	17,3	3,6	4,4	2,0	1,9	4,6	9,5	4,6	19,5	1,3
Utrecht	0,3	5,5	4,2	16,0	4,1	4,0	6,3	5,0	8,2	9,0	7,9	16,3	1,6
MRA incl. Flevoland	0,5	5,7	2,4	16,8	5,7	5,6	5,3	4,8	8,5	14,1	5,3	13,8	2,1
Zuid-Holland	1,6	7,0	4,4	16,8	5,5	4,0	2,8	2,9	7,1	10,8	8,5	16,4	1,7
Zuidoost-Brabant	1,1	15,7	3,5	15,5	3,7	4,2	3,0	2,5	7,3	14,2	5,0	14,5	1,1

Twente and Zuid Oost Brabant have a comparatively large manufacturing sector. Twente also has a strong trade sector and healthcare sector. The last sector seems to follow the age distribution of a region: a younger region such as the MRA region has less people working in healthcare than an older region such as Twente (the outside part of the Netherlands has to cope with faster ageing than the Randstad region). The MRA Region and especially Utrecht have a strong focus on the services sector. The province South Holland is larger than the other regions, but also less specific, with government city The Hague providing a strong government sector.

Differences in sector composition will also have consequences for the distribution of labour. First, we look to the distribution of professions in the Netherlands. Table 2 shows the distribution on an aggregated level. The left part of the table shows the distribution according to the CBS. The second largest group, technical and industrial professions, is shrinking the most. The largest group, economic-administrative professions, appears stable, and we see growth in the medical sector and in service professions.

Table 9: Occupations in the Netherlands

Occupational group	% CBS 2004	% CBS 2014	Difference
Pedagogical professions	6,4%	7,2%	0,7%
Social-cultural professions	2,1%	2,5%	0,5%
Economic-administrative professions	36,0%	36,2%	0,2%
Social order and safety professions	3,7%	3,2%	-0,5%
Technical and industrial professions	18,0%	14,8%	-3,2%
ICT professions	3,4%	3,8%	0,4%
Agricultural professions	3,1%	2,5%	-0,7%
Medical and paramedical professions	11,8%	13,5%	1,8%
Commercial professions	8,4%	9,4%	1,0%
Transportation professions	7,1%	7,0%	-0,1%

These changes between 2004 and 2014 are the net result of a lot of changes: people change jobs and change employer. In the remaining part of this chapter we will not further analyse these CBS figures but analyse a different dataset that makes it possible to analyse individual changes in professions and

employer. CBS and SCP data provide data on an aggregate level. With the Werk.nl database we can analyse patterns and paths that people follow in more than 400 different professions. The data comes from 1,6 million people who in the period 2012-2015 were forced to search for another job or were wanting to find another job.[3] So both the less favoured persons on the labour market, fearing unemployment or already unemployed, and the persons who feel confident applying for a new job. This sample is not automatically representative for the actual composition of the labour market, but the paths that these people take are the best available indication of job-to-job changes that occur on the labour market. In table 3 we compare the distribution of CBS occupation groups with Werk.nl occupation groups.[4]

Table 10: Distribution in occupations according Werk.nl dataset

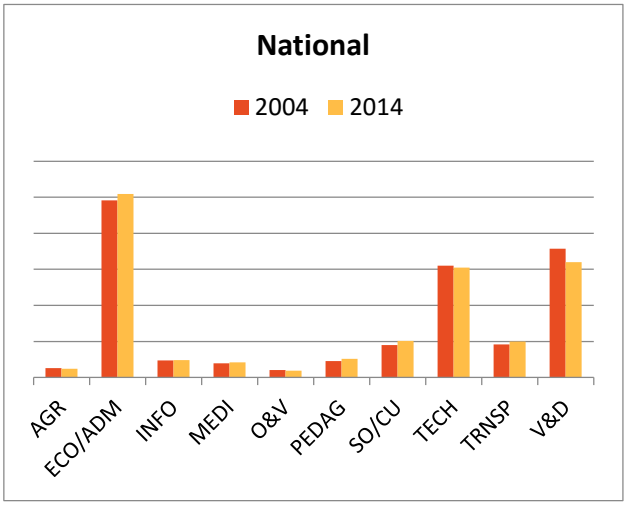
Occupational group (CBS)	%CBS 2004	% CBS 2014	Change	Occupational group (Werk.nl)	Werk.nl 2004 %	Werk.nl 2014 %	Change[5]
Pedagogical professions	6,4%	7,2%	0,7%	Pedagogical professions	3,0%	3,4%	0,4%
Social-cultural professions	2,1%	2,5%	0,5%	Social-cultural professions	5,9%	6,7%	0,8%
Economic-administrative professions	36,0%	36,2%	0,2%	Economic-administrative professions	32,3%	33,5%	1,2%
Social order and safety professions	3,7%	3,2%	-0,5%	Social order and safety professions	1,3%	1,2%	-0,1%
Technical and industrial professions	18,0%	14,8%	-3,2%	Technical and industrial professions	20,4%	20,1%	-0,3%
ICT professions	3,4%	3,8%	0,4%	ICT professions	3,1%	3,2%	-0,1%
Agricultural professions	3,1%	2,5%	-0,7%	Agricultural professions	1,7%	1,6%	-0,1%
Care and cure professions	11,8%	13,5%	1,8%	Medical and paramedical professions	2,6%	2,8%	0,2%
Service professions	8,4%	9,4%	1,0%	Care and service professions	23,5%	21,1%	-2,5%
Transportation professions	7,1%	7,0%	-0,1%	Transportation professions	6,0%	6,6%	0,5%

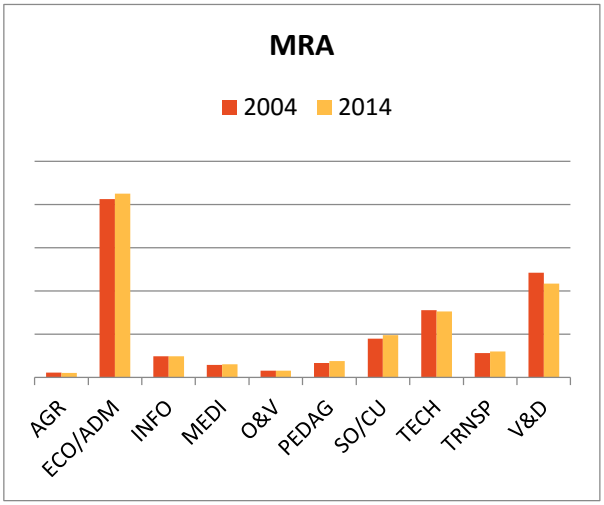
CBS give an accurate ‘still’, Werk.nl gives figures for whose or did have to change. Technical professions decline in the Netherlands, so it seems logical that the proportion of them in the Werk.nl sample stays large. Care professions grow in proportion and have a diminishing part in Werk.nl database.
So, division of jobs at Werk.nl is not representative for a complete ‘still’ of the labour market, but we can analyse what characterises different ecosystem regions. In figure 1 we compare the composition in five regions with the average distribution in the Netherlands. In the next paragraph we can use Werk.nl figures to explore changes on the labour market.

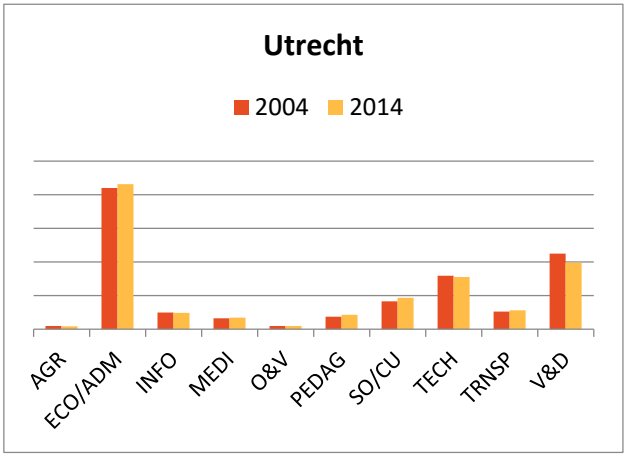
When we look at the distribution of professions according to Werk.nl sample, we see that they have a rather similar distribution of profession groups. Brainport and especially Twente differ in industry as

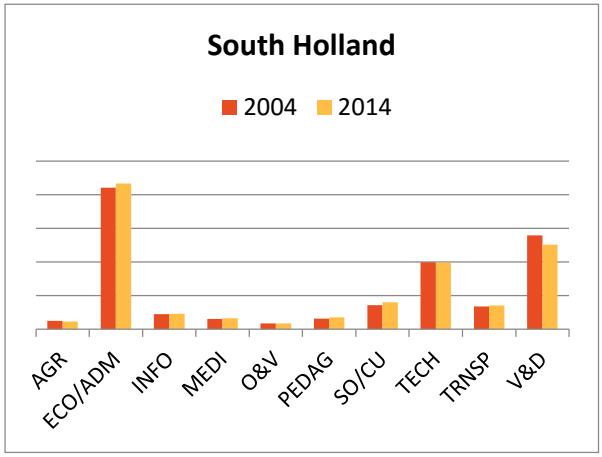
[3] Thanks to the Ockham Group who provided us the insights by translating our questions into inquiries for the Werk.nl database.
[4] Most of the occupational groups of the CBS corresponded with the classification that is used in the database from Werk.nl. The three CBS groups commercial professions, business and administrative professions, and managers were merged into the group economic-administrative professions, to compare CBS with Werk.nl. We can also see that care professions are at CBS in a different group than in Werk.nl database.
[5] All figures are rounded off, so the net change sometimes can be a slightly different number than the difference between 2004 and 2014.

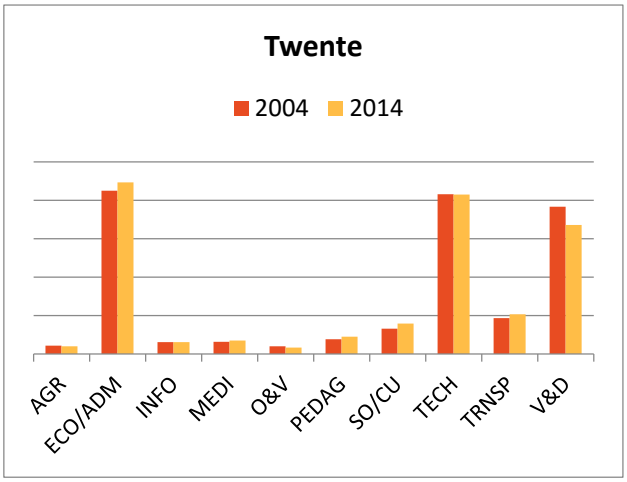
second group of professions. All regions shrink in manufacturing and service professions, but in South Holland and Twente this decrease is very small.

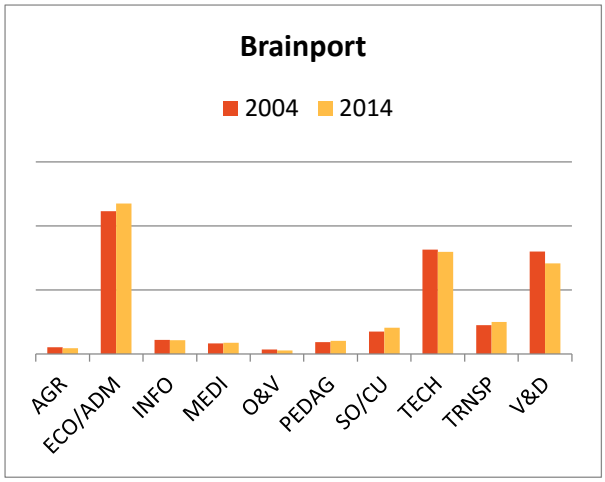












AGR = Agricultural professions
ECO/ADM = economic/administrative professions
ICT = ICT professions
MEDI = Medical/Paramedical professions
SO&S = Social Order & Safety professions
PEDAG = Pedagogical professions
SO/CU = Social cultural professions
TECH = Technical/manufacturing professions
TRNSP = Transportation professions
V&D = Service professions

6.4 Dynamics

Firms start, grow, shrink and exit. All this leads to dynamics in job creation and destruction. SCP (2015) for example, calculates that the shrink in net jobs by 1,1% in 2012 was the result of an average job creation of 5,8% and job destruction of 6.9% per year. Also, people switch employers as according to SCP companies reported in 2012 an average leave of 8,9% and an average inflow of 8,.2%. Finally, employees change jobs (within their firm) and experience changes in the content of their occupations. SCP (2015) counts that 15% of all workers state that in a period of 2 years (2010-2012) the content of their position has changed.

For this study we made use of a database with information from the UWV on resumes in the Netherlands. This database contains the resumes of persons that became unemployed since 2012. The information is categorized so that we know the different occupation changes of these persons since 2004.

From this database, information was gathered that showed changes in 10 different occupational groups: Agricultural professions, economic-administrative professions, ICT professions, Medical and paramedical professions, Social order and safety professions, Pedagogical professions, Social-cultural professions, Technical and manufacturing professions, Transportation professions, and Service professions. Over a time span of 10 years (2004 – 2014) and for each occupational group the number of employees were given that

1. Stayed in the same occupational group under the same employer
2. Stayed in the same occupational group under another employer
3. Changed to one of the other seven occupational groups

Table 11: Individual changes on the labour market

		Professional group in 2014										
	Nation-wide	AGR	ECO/ADM	ICT	MEDI	SO&S	PEDAG	SO/CU	TECH	TRNSP	SERV	NO_JOB
Professional group in 2004	AGR	12,1% 31,9%	7,8%	0,4%	0,8%	0,9%	1,3%	1,6%	12,8%	4,8%	13,4%	12,3%
	ECO/ADM	0,3%	10,3% 55,0%	1,3%	0,9%	0,4%	1,3%	3,5%	3,2%	1,8%	6,2%	15,9%
	ICT	0,1%	13,8%	9,2% 50,8%	0,5%	0,3%	1,4%	2,7%	3,6%	1,0%	1,8%	14,7%
	MEDI	0,3%	12,0%	0,5%	14,4% 39,5%	0,3%	2,5%	4,2%	2,9%	0,9%	9,2%	13,2%
	SO&S	0,9%	12,5%	1,1%	1,2%	12,4% 24,7%	1,7%	2,8%	13,4%	8,7%	9,6%	11,0%
	PEDAG	0,4%	11,0%	0,8%	1,5%	0,4%	19,2% 34,0%	7,0%	2,6%	1,2%	7,0%	15,0%
	SO/CU	0,3%	16,3%	1,3%	1,5%	0,4%	3,8%	15,0% 37,3%	2,7%	0,9%	7,5%	13,2%
	TECH	0,8%	5,8%	0,6%	0,4%	0,8%	0,6%	1,0%	13,4% 48,3%	4,2%	4,7%	19,4%
	TRNSP	1,1%	9,3%	0,5%	0,5%	1,2%	0,8%	1,4%	11,8%	12,7% 38,6%	7,6%	14,6%
	SERV	0,9%	13,5%	0,5%	1,7%	0,6%	1,4%	3,5%	5,4%	3,0%	12,6% 45,7%	11,3%

In the table the row percentages show what the destination was op people that came from a profession in 2004. It also displays which part of the employees stayed in the same occupational group at the same (blue) or at another (red) employer. The column with professions represents the occupational group in 2004, and the professions in the rows represent 2014. We conclude that people with ICT professions have the lowest job stability, while people with Pedagogical professions are most loyal to their profession group (or have less opportunities to change).

In general the transitions with the largest values can be seen within sectors. This is not strange, as it is mostly easier to switch jobs within the same organization or to another organization in the same sector. Furthermore, in all regions low values are seen in the cases of transitions from the agricultural sector to other sectors and also the other way around: low values for transitions from other sectors to the agricultural sector. The values for the agricultural sector are also relatively low when compared to the national average. In the period 2004-2014 we mostly see a shift towards economic-administrative professions and less often, to service professions and technical professions.

All five regions can be compared to the national average. When comparing the regions with the national average, it seems that the region South Holland is most representative of the country. When doing so, it is important to keep the background of this sample in mind. As most of the persons in the database uploaded their résumé due to unemployment, most of the people accounting for transitions became unemployed after their (last) transition.

The results are summarized in the table below. When changes happen more or less than could be expected a figure is printed in green or red. When looking at intra-occupational group changes, a 1 is added if it concerns changes within occupational group at the same employer (or no changes) and a 2 indicates changes within the same occupational group to a different employer. As can be seen, these five regions deviate a lot from national average when concerning changes within occupational group. Especially in the social order and security group many differences occur. Changes in the groups ICT and Service profession are mostly close to national average. Furthermore, it is noticeable that three regions have an occupational group in which relatively many people stay in the same occupational group at the same employer, and relatively little people stay in the same occupational group at a different employer. So it seems that when people leave their employer, they do not search for a job in the same occupational group. These combinations are: Eindhoven – social security & safety, Twente – social/cultural, and South-Holland – transportation.

Table 12: When ecosystems differ from national pattern

	AGR	ECO/ADM	ICT	MEDI	SO&S	PEDAG	SO/CU	TECH	TRNSP	SERV	NO-JOB
AGR		MRA						UTR		UTR	
ECO/ADM		UTR									
ICT											
MEDI				TWE							
SO&S		UTR			MRA S-H EIND1 EIND2 TWE			MRA TWE S-H	EIND		S-H EIND
PEDAG		MRA				EIND					EIND UTR
SO/CU							UTR TWE1 TWE2				
TECH								TWE MRA S-H			
TRNSP									MRA S-H1 S-H2		
SERV											

We also zoom in from profession group to unique professions. We observe the occupational distribution in more detail. Every region has on average 430 unique professions.[6]. Of these professions we isolate the 100 with the highest location coefficient. These are professions that appear relatively often in the region compared to the national average. These professions were compared with the on average 300 other professions. We can conclude that region specific occupations are often of a higher level than the other occupations and that those who have a region specific occupation have a larger chance of rising in occupational level with each consecutive job.

For each region we finally have determined what the top 20 most practiced professions are. Again this is done in absolute terms and in relative terms. The latter is done by using a location coefficient. This is done by dividing the amount of specific jobs in a region as a ratio of the total in a region, by the amount of specific jobs nationwide as a ratio of the total number of jobs nationwide. For both the top 20 absolute and the top 20 LC several dynamics are studied for each region. This is visible in Annex III.

6.5 Summary and conclusions

In Table 13 we compare five ecosystems on several key indicators:

- proportion higher educated persons as a percentage of active labour force (CBS)
- increase in higher educated persons (CBS)
- jobs requiring higher (medium) education (CBS): CBS divides jobs in 4 levels. We combine level 3: (complex tasks; medium or higher education needed) and level 4 (very complex and specialized tasks; higher or academic education needed)
- average occupation level (Werk.nl sample, 5 point scale)

[6] These professions are occupation groups: the second lowest level in labour categorisation. At the most detailed level the occupations in the résumés in the data are categorised into one of more than 3.000 occupations.

- specificity: proportion of the labour force that forms 100 most specific occupations (each region has 419 to 453 unique professions, we focus on those 100 with highest location coefficient)
- proportion of the labour force that switches towards another occupation
- proportion of the labour force that switches towards a region-specific profession
- Average Increase in occupation level as a consequence of this switch.

Table 13: Key figures of the five ecosystems

	Brainport	MRA	Twente	Utrecht	South Holland
Education and job level					
Proportion higher educated people (2014) %	35	42	30	45	36
Increase in higher educated persons (2004-2014) %	+5	+8	+6	+7	+7
Jobs requiring higher (medium) education (2014) %	43	48	37	51	45
Increase in jobs requiring higher (medium) education (2004-2014) %	+1	+5	+5	+5	+3
Average occupation level (1-5)	2,7	2,9	2,6	2,9	2,7
Specificity					
Specificity: proportion 100 most specific occupations (%)	8	21	16	20	16
Specificity: LC-level that includes top 100 LC	1,31	1,33	1,26	1,34	1,19
Mobility					
No changes in occupation or employer (2004-2014)	13%	15%	14%	11%	12%
Same occupation, other employer (2004-2014)	30%	38%	30%	29%	29%
Mobility: another occupation (2004-2014)	43%	28%	42%	43%	43%
Level specific occupations (100 of appr 430)	3,1	3,7	2,6	3,9	2,8
Change in occupation level at top 100 LC	0,19	0,22	0,08	0,27	0,07

1. There is an enormous growth in human capital especially for higher educated people. The increase varies from 6 percent in Brainport and Twente up to 8 percent in MRA. Both manufacturing regions in the intermediate zone have a lower increase than the three Randstad regions, which are known for their universities and their appeal towards younger higher educated people. The proportion of higher educated people varies in the same range, from 30 percent in Twente to 45 percent in Utrecht. These are the managers and professionals that in themselves bring productivity but also have the task to make others in their firm more productive (and adaptive to the future) by guiding or innovating the jobs of these colleagues.
2. The proportion of jobs requiring a higher medium or higher education follows this variety: most in Utrecht, least in Twente. But the rise in higher (medium) educated jobs is lower than the rise in education level. Especially in Brainport the difference in growth rate is high: it seems that growth in education level cannot be absorbed by the labour market – although still for specific professions firms experience shortages as elaborated on in the case study of Brainport. In Twente increase in job level is similar to the increase in education level.
3. Ecosystems are visible on the labour market. This is visible in sector composition and in occupation distribution. Regions have their own characteristics regarding the labour force. Especially Brainport seems to have a lot of niche-professions. The hundred most specific jobs form a relatively small proportion of the labour force: each of them is relatively infrequent. That further illustrates the specificity of the Brainport region, but also is one explanation for the

reality that employers express problems to fulfil vacancies (and also a reason for the fact that the Brainport foundation has picked up labour market policy rather early in its program as a collective goal). Twente has a second position in specificity, followed by both Randstad regions.

4. Figures of distributions in 2004 and 2014 suggest moderate changes. But we have to manage with a lot of fluctuation. National figures make it possible to estimate that, in a period of five years 70% of the number of companies has been renewed, 30% of the jobs has been updated and (partially as a result of this job destruction and creation) 50 percent of the employed persons have changed occupation and/or employer. This fits to our analysis were we see that in a period of 10 years 85% of the workforce has changed occupation and/or employer. This forms an enormous potential to bring human capital to the most productive places.
5. Ecosystems have a certain specificity in firms and professions. This seems helpful for firms but also for workers. Turning in to a specific job on average brings in a higher occupation level and, as we may suppose, more productivity to firms. In this respect labour market dynamics is supportive to catch productivity potential of human capital. Specific jobs are also helpful for individual workers in their pathway on the labour market: it simplifies your navigation through a more fluctuating labour market. We can expect that guidance from ecosystem coordinators helps both firms and employees to make maximally use of this potential of increase in occupation level and additional productivity.
6. There are interesting differences between ecosystems. Brainport seems to have the biggest gap between average education level and occupation level, this may even be a bottleneck and explanation for the comparatively low growth in jobs that require above average education level in Brainport. Twente has the lowest proportion of higher educated people above average jobs, and different from else also specific jobs do not have a higher level than other jobs in the region. When leaders in the ecosystem aim at more knowledge transformation from education sector towards business sector, the absorption capacity of the workforce is a challenge. MRA and Utrecht seem to earn most of ecosystem specific firms and jobs. People that change jobs realise on average an increase in occupation level. Still the increase in human capital (visible in level and increase of higher educated people) cannot yet fully be absorbed in actual jobs. Entrepreneurship can be an alternative way to make this increase in human capital productive.

7 The Brainport case study

7.1 Overview

Table 14: overview of Brainport ecosystem economic indicators

Indicator	Unit	Figure
Total area	Hectares	145.783 ha
Active labour force 2014	Number of persons and percentage of total Dutch active labour force	370.000 (4,50%)
Labour force growth 2004-2014	Compound annual growth rate	0,59%
Gross added value 2014	Gross added value (× €1.000,-) controlled for full time equivalent years	88,5
Unemployment rate 2014	Percentage of total labour force	7,30%
Higher educated active labour force 2004	Percentage of total active labour force	30,1%
Higher educated active labour force 2014	Percentage of total active labour force	35,2%
Business demographic 2015	Number of businesses and percentage of total Dutch businesses	64.685 (4,56%)
Business demographic growth 2011-2015	Compound annual growth rate	2,40%
GDP growth 2011-2014	Compound annual growth rate	1,224%
R&D expenditure as share of GDP based on CIS 2008	Percentage of GDP	7,86%
Innovation expenditure as share of GDP based on CIS 2008	Percentage of GDP	8,94%

7.2 The knowledge triangle in the ecosystem

The Brainport ecosystem includes several institutes of higher education. The largest university in the region is the Eindhoven University of Technology (TU/e), which has its own campus located in the heart of the city of Eindhoven. Fontys University of Applied Sciences is the other large higher education institute in the region. Some departments of Fontys are located on the campus of TU/e, but most departments are located elsewhere in the city. Vocational education is provided by three schools in Eindhoven and Helmond: Summa College, Sint Lucas, and Ter AA schools.

7.2.1 Eindhoven University of Technology

The TU/e is a research university with a focus on science and engineering. It was established in 1956 as a technical university of applied sciences, primarily to support the education of Philips employees. It has grown into a full-fledged university since the 1980s and now has 9 different academic departments in the area of science and engineering, including for example electrical engineering, built environment, applied physics, biomedical engineering, chemical engineering, industrial design, and industrial engineering and innovation sciences. In total, these departments offer 11 different bachelor degrees and 22 master degrees. The campus of the TU/e, named TU/e Science Park, provides the infrastructure for education and research but also for new business creation and technology entrepreneurship.

The university has around 5.000 enrolled bachelor students and 3.200 master students. Additionally it has about 1.500 doctoral (PhD and PDeng) students on its campus[7]. These students are almost all active in the science and engineering domain. The TU/e has over 2.000 academic staff-members.

All the activities in knowledge transfer and new business creation have been situated in a separate entity named TU/e Innovation Lab. This Innovation Lab aims to facilitate and support collaborative work with corporates, develop innovation projects and new business together with SMEs, and stimulate entrepreneurship for technology-driven start-ups.

7.2.2 Fontys University of Applied Sciences

The scope of Fontys University of Applied Sciences is broad, compared to the TU/e. Fontys has 28 institutes with a wide variety of disciplines. It offers 85 different bachelor degrees and 40 master degrees. The engineering institutes of Fontys work together with the TU/e and are located at the TU/e Science Park. Fontys currently has around 44.000 students and about 4.400 employees.

The activities around knowledge transfer are organized around 39 lectureships that focus on practice-based scientific research for the development and innovation of the various professions and vocations that the bachelor and master programs of Fontys are linked to. Next to this, Fontys has established two Centres of Expertise, one in the area of high tech systems and materials, and another in the area of healthcare and technology, and is partner in Centres of Expertise in Automotive (on Automotive Campus Helmond) and Logistics.

7.2.3 Vocational education

The Brainport region also has three vocational schools – Summa College, SintLucas and Ter AA – which together have a volume of almost 21.000 enrolled students. The largest school of these three is Summa, which is organized into 22 faculties and offers around 250 vocational degrees.

Summa is also the leading partner in two centres for innovative craftsmanship. These are the Teclab, which provides advanced vocational education in technology for both students and employees of companies, and the Automotive Centre that aims at teaching the latest innovations to technicians in the automotive sector.

7.3 History of regional ecosystem

One of the primary economic drivers of the region in the 20th century dates back to 1892 when a company named Philips established a small lightbulb factory in the municipality of Eindhoven. Over the course of a century, this company would grow into the multinational corporation Royal Philips and provide employment for many people in the region and elsewhere in the Netherlands. In the 1980s, lithographic technology developed at Philips led to the foundation of ASML. In the beginning of the 21st century, the company scaled down and divested parts of its electronic divisions. These divestments in turn provided the foundation for many new companies in the high tech systems sector, including NXP semiconductors. Other early economic drivers of the Eindhoven economy were companies like DAF and Brabantia.

Eindhoven and the surrounding municipalities have been dubbed the 'Brainport' region as a juxtaposition to the airport region (Amsterdam Schiphol) and the seaport region (Rotterdam) elsewhere in the Netherlands. To develop the local knowledge economy of the Eindhoven region, in 2006 the local government, industry and TU/e established the *Brainport Foundation*. The board of Brainport Foundation

[7] Based on the annual report of TU/e and census data from 2013 and 2014 (source: DUO)

currently contains members representing all the major higher education institutes and vocational schools in the region, as well as several municipalities, the provincial government, and several representatives of large firms and industry associations. The mayor of Eindhoven chairs this board. The Brainport Foundation has an executive organisation named *Brainport Development*, which is responsible for the international communication strategy of the economic interests of the region, the international human capital agenda, the technology portfolio, and the creation of a favourable investment climate. The organisation is funded by each of the stakeholders represented in the board, either in cash or in kind. The executive organisation currently consists of 18 people, many of which are responsible for one of the themes of Brainport Development.

The Brainport region has a rich history of location-based policies for knowledge development. The TU/e Science Park is centrally positioned in the knowledge infrastructure of the region, and more recently established campuses have substantially reinforced this infrastructure. The High Tech Campus Eindhoven (HTCE) was established by Philips in 1998 (on the premises of its NatLab) to focus its Dutch R&D activities. The HTCE was opened to other companies in 2003 and became an independent organization in 2012, when the HTCE property was sold to a group of external investors. Strijp S, another former Philips industrial location, functions as a creative hub in the city since 2006. The Automotive Campus in the nearby municipality of Helmond has been established to develop and test high tech knowledge and systems in the area of mobility. Finally, ASML has established a research campus in Veldhoven that extend its research facilities at the HTCE.

These leading companies and their relationships with HEIs can be traced back to the network analyses. Here we see that ASML, NXP and Philips all have strong positions in terms of the number of innovation projects they have in their portfolio. Both the TU/e and Fontys have placed themselves in a central position in the network and collaborate with both the large firms and SME's.

7.4 Functioning of the ecosystem

7.4.1 Governance structure

The Brainport Foundation is responsible for bringing public and private organisations together and building a reputation for the region. The Brainport Strategy is focusing on being and promoting to be 'the world's smartest region'. Brainport Foundation recently has formulated a so-called 'adaptive strategy', which does not contain any quantitative long-term objectives but rather aims at continually identifying opportunities to increase the competitive advantage of the region and being flexible enough to exploit them.

The projects of Brainport Development arise from those problems and challenges the stakeholders of Brainport are facing that require extensive collaborative efforts to explore and implement solutions. Brainport Development has organized these initiatives into several societal challenges such as solar energy, smart mobility, health and food, and safety. This thematic focus on societal challenges builds on what the region excels at within the HEIs and corporations that populate the region (Brainport, 2015). These projects are required to fit the strategic agenda of Brainport.

The funding scheme of a project depends on its nature and scope, and will be publicly or privately funded, or in a combination of both, depending on what is necessary. The interviewees emphasize that Brainport Development is considered a neutral party, and therefore Brainport managers are often called upon to bring different public and private organizations together. In this respect, Brainport Development acts as a project-based organization that initiates and runs projects, resulting in deliverables that either

established or newly created organisations implement and apply. The only continuous activity of Brainport Development is the international positioning and branding of the region.

One method to tackle these challenges involves Brainport Development working together with stakeholders to create 'living labs'. Together with HEIs, government and a consortium of private sector parties, a project is created in which a street, district or municipality is subjected to testing new technology, with the aim of getting user feedback as early as possible. For example, Living Lab eHealth provides elderly people the opportunity to try out new medical and healthcare services and a Smart Energy Grids project provides new energy solutions for social housing.

The board of Brainport Foundation and Brainport Development has 14 members. The mayor of Eindhoven chairs the board, and besides of him, four mayors represent the other 20 municipalities in the region. Five persons represent individual or organised firms and four represent knowledge institutions: TU/e, Tilburg University (an alpha gamma university just outside Brainport region) Summa and TNO. The general committee of Brainport Foundation comes together 6 times a year and the executive committee meets every six week. The agenda is prepared by the executive organisation Brainport Development. Brainport Development has a staff of 17 members.

The 21 municipalities in the region are organised in MRE (metropolitan Region Eindhoven). Eindhoven is by far the largest municipality in the region and the other municipalities appear to accept its leadership role and central agency in strengthening the entire region. Initially visualised as the Brainport 2020 agenda but recently rebranded as the Brainport Network, the region seeks to reinforce its collaborative efforts and ambitions with eight other regional development boards elsewhere in the provinces of Noord-Brabant and Limburg.

Next to the Brainport Foundation there is also *Brainport Industries*, which unites around 300 1st, 2nd and 3rd tier (suppliers of) original equipment manufacturers in the region, to provide its members with one strong voice as well as promote collaboration in order to improve the innovativeness of the companies.

A major funding organization for the region is the Brabant Development Agency (BOM), which provides funds for long term investment schemes. The BOM attempts to support regional economic clusters and the crossovers these clusters create by investing in collaborative programs and ventures, attracting foreign companies, and investing in starting and growing companies in the province of Noord-Brabant. Since the vast majority of high tech firms in the Brainport region is extremely capital intensive, the BOM is an important source of additional funding.

7.4.2 Commitment of firms, knowledge institutions, and government

In the Brainport Foundation, the major regional stakeholders are all represented within the board, which creates an inherent commitment for new initiatives from Brainport Development that align with the strengths and challenges of the region. Simultaneously, the education institutes and the private sector actively search for ways to use their combined strengths in productive partnerships. Governments attempt to facilitate these partnerships where possible.

Increasingly, higher education institutes seek focus and mass in education and research through collaboration. The Fontys UAS has co-located its engineering schools on the campus of the TU/e to improve knowledge transfer between the students and teachers and to strengthen the (critical mass of the) research infrastructure. Similarly, vocational schools like Summa have agreements with both TU/e and Fontys for sharing facilities. Additionally, Summa offers tracks within its vocational education programs to facilitate the flow of students to higher education institutes such as Fontys.

All of the HEIs also have solid ties with technology-driven companies in- and outside the region. The TU/e has long-term innovation contracts with eight large firms (amongst them ASML, NXP, Philips and Shell), which enables TU/e researchers to collaborate with companies on a regular basis. The Innovation Lab of the TU/e ensures that patentable knowledge generated by the TU/e is either patented by private companies (around 80% of all IP developed by TU/e) or turned into spinoff companies. The Fontys UAS ensures close ties with both international firms and specialised suppliers in the region and makes agreements on the specifications for the education of engineering students. Such agreements typically last for four years (i.e. the time it takes to educate an engineering student) and often firms contribute in kind by making machinery and other facilities available. At the level of VET, companies help revise the qualifications for their field and provide internships and lecturers for the school.

In addition there are several societal themes that have inspired public-private partnerships between the UAS, the VET and the private sector. The Fontys UAS manages two Centres of Expertise, one around the top sector high tech systems and materials with a focus on robotics, mechatronics in agriculture and 3D printing, the other around healthcare and technology. These centres gather multidisciplinary applied research for solving societal problems and collaborate with companies to put their developments to the test. Similarly, the VET schools in the region have joined forces in two centres for innovative craftsmanship, the Teclab and the Automotive Centre. Both are aimed at giving the highest level of VET students extra qualifications for the high tech and automotive industries respectively.

The international companies based at the HTCE and other locations in the Brainport region are committed to the functioning of the ecosystem and all have the capacity for a long term strategy agenda. They need a continual influx of new knowledge and high level suppliers. The international OEMs in the region are all HTSM firms, but mostly not direct competitors, which in turn facilitates cooperation. Although they have high standards in terms of business climate, almost all have a long history with the region which makes it easier for government and HEIs to come to long term agreements with the private sector. One interviewee noted that “there seems to be a common goal to keep labour and knowledge beneficial for the region”.

Additionally, the corporate culture of the large specialised suppliers in the region is very cooperative. Several interviewees noted a revival of this cooperative stance that has cropped during the recent financial crises, which has resulted in the region weathering the recession with minimal losses. This culture fosters many informal meeting moments between the leadership of the private sector in the region, which adds to the quality of the network. Brainport Development is another factor in maintaining this network.

7.4.3 Functioning of governance

The Brainport ecosystem appears to be almost exclusively focused on regional competitiveness. The global High Tech Systems sector is crucial for the economic power of the region, but this sector has relatively short economic cycles, which forces companies like ASML, NXP, FEI and VDL to improve and renew their products on a continual basis. One interviewee noted that “speed is the determinant for success in this sector and since most firms are specialists, collaboration is essential for survival”.

The campuses of the region are central to this imperative to innovate. The design of the HTCE is for instance informed by the open innovation approach, which implies that high tech companies require each other and the proximity of research institutes to develop innovative solutions that cannot rely on solely their own expertise and talents (Chesbrough, 2003). The HTCE thus provides two benefits to its residents (140 firms, 10 thousand employees): first, it facilitates and supports the R&D and product

development processes of individual companies at the campus by providing access to shared resources (e.g. cleanrooms), and second, it creates a community of innovation that enhances knowledge sharing and transfer among companies and the research institutes located at the campus (Van der Borgh, et al., 2012)

Of the HEIs, the TU/e increasingly takes on the role of orchestrator of the ecosystem, thereby filling the vacuum arising from the transformation and downsizing of Philips as the former orchestrator of the regional ecosystem. In addition to its incubator and knowledge transfer role, the TU/e is responsible for initiating some of the living labs in the region such as the lab for smart mobility that has made infrastructural changes to the science park. As Brainport Development's capacity is somewhat limited due to its small scale, the TU/e and its Innovation Lab have access to a much more substantial pool of human and other resources to take new and sustain new initiatives.

However, there is some scepticism amongst the interviewed educational institutes whether public-private partnerships can maintain themselves in the long run. At this point, the Centres of Expertise, Centres for Innovative Craftsmanship and other initiatives hinge partially on government funding and a sustaining model for when this source of funding stops has not yet been found.

Brainport Development functions more as a network organisation and is praised for its ability to bring together public and private parties as partners. However, the organisation is funded by its stakeholders regardless of performance, which does not make it dependent on the results of its activities. This sometimes leads to the effect that the organisation is often perceived as being present at new initiatives but rarely realising a project. As such, it has designed an effective marketing and broker organisation but nowadays it has to change its role being a successful project organisation.

The imperative of innovation also has consequences for the qualifications offered in education, in which VET and the UAS become increasingly outpaced by technological developments. There is a mismatch on the labour market, now and in the near future. The demand for engineers is ever growing and both the Fontys UAS and TU/e cannot keep up in terms of supply. Simultaneously there is a massive shortage of IT skills in the labour force, especially now that almost 40% of the region's jobs are IT related. One interviewee stated that there would be a shortage of 10.000 engineers a year for the next 10 years, a gap which the TU/e cannot possibly fulfil. Most of its graduates find their first position within one of the eight large corporates recruiting in the region, leaving relatively little graduates for the SME's.'

The local government attempts to facilitate and foster the ecosystem by improving the quality of life, reachability and infrastructure of the region. However, several interviewees predict that on the long term, the region will become ill equipped for the demands of the international enterprises in terms of highway and airport access. This would require significant government investments on both regional and national level.

According to interviewees, the national government does not invest enough in the maintenance of the research infrastructure. There are more requirements to be fulfilled for receiving research grants whilst the total budget diminishes for HEIs and is insufficient to match the amount of private R&D capital that is invested in the ecosystem. Simultaneously there is too little regional focus for applied research funding with not enough regional spending. The multinational firms in the region already capitalize on the knowledge produced in other regions in the Netherlands and abroad. ASML for example has initiated the Advanced Research Center for Nanolithography (ARCNL) in Amsterdam in cooperation with Amsterdam-based HEI's.

Overall, the governance of the Brainport ecosystem and knowledge triangle entails

- An orchestrating university that through its students, resources and research provides regional organisations actively transfers knowledge to the regionally established firms.
- An active network organisation that facilitates the collaboration between public and private parties and aligns initiatives with the strengths of the region but focuses to spin out these activities to new or existing organisations.
- A tightly knit high tech community of large firms and specialised SMEs that are willing to collaborate with competitors and partners in the value chain.

The organisations within the Brainport region see several constraints in the further development of the ecosystem.

- The development speed in the high tech sector far outpaces the renewal of education qualifications, creating a larger gap between education and professional requirements.
- International enterprises in the region place higher demands on infrastructure, which is currently unequipped for the future.
- The ecosystem is very dependent on several large manufacturers, making it less resilient should one of these firms exit the region.
- Research and innovation funding becomes increasingly complex and tight for HEIs and companies alike.
- The public private partnerships that have been established by HEIs such as Centres of Expertise have yet to find a sustainable business model and meanwhile continue to lean on government funding.

8 The Amsterdam Metropolitan Area case study

8.1 Overview

Table 15: overview of Amsterdam Metropolitan Area ecosystem economic indicators

Indicator	Unit	Figure
Total area	Hectares	406.054 ha
Active labour force 2014	Number of persons and percentage of total Dutch active labour force	1.265.000 (15,40%)
Labour force growth 2004-2014	Compound annual growth rate	1,05%
Gross added value 2014	Gross added value (× €1.000,-) controlled for full time equivalent years	93,4
Unemployment rate 2014	Percentage of total labour force	7,45%
Higher educated active labour force 2004	Percentage of total active labour force	34,2%
Higher educated active labour force 2014	Percentage of total active labour force	41,6%
Business demographic 2015	Number of businesses and percentage of total Dutch businesses	259.905 (18,33%)
Business demographic growth 2011-2015	Compound annual growth rate	3,42%
GDP growth 2011-2014	Compound annual growth rate	1,730%
R&D expenditure as share of GDP based on CIS 2008	Percentage of GDP	1,14%
Innovation expenditure as share of GDP based on CIS 2008	Percentage of GDP	1,67%

8.2 The knowledge triangle in the ecosystem

The ecosystem in the Amsterdam Metropolitan Area includes a large number of institutes for higher education. The most important institutes are the University of Amsterdam, the Free University and the Amsterdam University of Applied Science. The second University of Applied Science is InHolland, with four locations in the Amsterdam Metropolitan Area (15,000 students). The largest institute for vocational education and training is the ROC van Amsterdam.

8.2.1 University of Amsterdam (UvA)

The history of the University of Amsterdam dates back to 1632. Today, the university counts 30,000 students. The UvA has seven faculties: Humanities, Social and Behavioural Sciences, Economics and Business, Law, Science, Medicine and Dentistry. It is housed on four city campuses; the Amsterdam Science Park is one of them, dedicated to science, engineering and informatics.

8.2.2 Free University (VU)

The Free University was founded in 1880 as a protestant initiative. The philosophy of the VU is expressed in three core values: responsible, open, personally engaged. The university focuses on four profile themes: Governance for Society, Human Health & Life Sciences, Connected World, Science for Sustainability. The VU counts 23,000 students, and ten faculties. Its buildings are concentrated on the VU Campus on the southaxis of the city of Amsterdam.

8.2.3 Amsterdam University of Applied Sciences (HvA)

The HvA counts seven faculties with nearly 50,000 students. The Faculty of Economics and Business is the largest, with more than 25% of the HvA-students, followed by the Faculty of Digital Media and Creative Industries and Faculty of Social Sciences and Law. Linked to its seven faculties are seven Centres for Applied Research. In addition, four interdisciplinary priorities and two HvA-wide themes bring together research capacity: Amsterdam creative industries, Urban Management, Urban Vitality, Urban Technology, Entrepreneurship (theme), and Urban Education (theme). The HvA has 40 lectorates.

As the capital of the Netherlands, the Amsterdam HEIs count more than 100,000 students (which is 12% of all Dutch students at universites for applied science, and 22% of all Dutch university students). Both UvA and VU have their own academic medical centres.

In 1997 the University of Amsterdam (UvA) and the Amsterdam University of Applied Science (HvA) prepared for a close cooperation. Main purposes were a better match between students and HEIs, innovation of education and a better match between HEIs and industry/society, and more operational efficiency.

In 2012 the UvA-HvA together with the VU joined forces in the Amsterdam Academic Alliance. Its aim is "to make Amsterdam a hub for international competitiveness and academic excellence". Among its targets are strengthening the regional innovative potential and providing better-qualified regional workforce.

The UvA-HvA and VU already cooperate in a joint Faculty of Dentistry and in the Amsterdam University College. Further cooperation of the two academic medical centres is being negotiated, as is a stronger cooperation of both faculties of Science to strengthen the position of Amsterdam.

8.2.4 ROC van Amsterdam

The largest institute for vocational education and training is the ROC van Amsterdam, with 36,000 students, of which 27,000 follow VET. The ROC Amsterdam has locations in Amsterdam, Hoofddorp, Hilversum and Amstelveen. ROC van Amsterdam and ROC-institutes in surrounding provinces cooperate to provide an efficient distribution of vocational education in the Amsterdam Metropolitan Area. An example of strong relationship between the regional economic profile and VET is the Airport College. ROC van Amsterdam also cooperates with two Universities of Applied Science (HvA and InHolland) to provide associate degree courses, as an instrument to upgrade the level of education of the labour force. The second largest institute for VET is ROC TOP, with nearly 5,000 students.

8.3 History of the regional economy

The city of Amsterdam lies in the province of North-Holland. The Amsterdam Metropolitan Area (MRA) stretches beyond the provincial borders, because Almere (province of Flevoland) is also part of it.

The economic strength and diversity of the Greater Amsterdam Area goes back to the 16th century. During the Dutch revolt of the Netherlands against Spain, Amsterdam switched sides from catholic to protestant. The city became a safe haven for wealthy (Portuguese-Jewish) merchants fleeing the fall of Antwerp. In 1602 the start of the Dutch East Indies Company marked the beginning of the Golden Era: this multinational trading company, first ever to issue stock, provided its shareholders and suppliers with large profits.

The city of Amsterdam enjoyed strong economic growth during the last twenty years, which was preceded by a decline in inhabitants and economic prosperity during the '60s and '70s. In this period

Amsterdam lost a large number of manufacturing industries like printing and apparel. The economic structure of the city of Amsterdam is now largely dependent on professional services (including financial services, marketing agencies, IT-services), transport and wholesale. Amsterdam is the centre of creative and cultural industries in the Netherlands.

The larger MRA has a different and more diverse structure, including an important food processing industry, steel manufacturing, manufacturing of metal products and machinery, large logistic areas (Port of Amsterdam, Schiphol Airport) and high tech agriculture and horticulture (flowers, vegetables, green biotechnology (Seed Valley)). The city of Hilversum, 35 km away and part of MRA, is the national broadcasting centre.

The MRA has several business clusters with a strong signature, including the South Axis (professional and financial services), creative campuses (like the Kauwgomballenfabriek, NDSM-area), and start up campuses (like B.Amsterdam). Educational facilities are scattered around the city. Some university locations, like the VU Campus in Amsterdam South, are developing into so-called 'hotspots'. In 1996 the City of Amsterdam designated Amsterdam Science Park, on the east side of the city, as a major project. Developed out of the Institute for Nuclear Physics Research (1946) this campus is now hosting nearly 20 research institutions (partly affiliated with University of Amsterdam) focusing on life sciences, mathematics, informatics, physics and chemistry. It is also home of the Faculty of Science (UvA) and 130 companies. In 2015 the Knowledge Mile was launched, a cooperation of two Universities of Applied Science, the Amsterdam University of Arts, the City of Amsterdam, KPN, Bell Labs and private investors. This applied science park should become both a living lab for creative services and a central hub for creative companies.

8.4 Functioning of the ecosystem

8.4.1 Governance structure

The Amsterdam Metropolitan Area has 36 municipalities on board, alongside two provinces (North Holland, Flevoland) and the regional authority (Stadsregio Amsterdam). It is an all-government cooperation, coordinating policy in the fields of spatial planning, transport and regional economic policy. The coordination of regional economic policy is in the hands of the Platform Regional Economic Structure (PRES), chaired by the alderman of Economic Affairs of the City of Amsterdam. PRES oversees several organisations dealing with separate tasks: IAmsterdam (international marketing), Amsterdam in Business (foreign direct investment), Plabeka (Platform for the planning of business and office locations), and the Amsterdam Economic Board (triple helix cooperation for innovation).

The Amsterdam Economic Board was established only in 2010, but has not appeared out of the blue. As a regional outcome of the national technology policy position paper "Concurreren met kennis" (1993) the Kenniskring Amsterdam was launched in 1994. This knowledge partnership provided meet-ups between captains of industry, researchers and public bodies on a regular basis. The main goal was the strengthening of the local knowledge infrastructure through the exchange of trends and ideas. Cooperative projects between firms and HEIs were a side effect, but no main purpose. Therefore, the OECD in 2010 concluded that "the Kenniskring (Knowledge Circle) Amsterdam is a key mechanism to future success" but "its potential to take on the role of giving more strategic advice should be considered". According to the OECD the Amsterdam region lacked a shared strategic vision on economic development and innovation, as well as a good match between educational supply and demand on a regional level.

In 2013 the Kenniskring Amsterdam merged into the Amsterdam Economic Board, together with its spinoff the Amsterdam Innovation Motor (launched in 2004 and focusing at stimulating entrepreneurship and innovation in four industries/themes - creative industries, life sciences, ICT, sustainability).

The Amsterdam Economic Board was established in 2010, and its first main strategic document was the Kennis & Innovatie Agenda (Knowledge & Innovation Agenda), with a thorough analysis of the regional innovation system in the Amsterdam area. Triple helix cooperation should strengthen the position of seven (and later eight) important industries in the metropolitan area (creative industries, knowledge intensive business services, logistics, ICT, life sciences, food & flowers, tourism, manufucturing) and guarantee future competitive advantages for the Amsterdam region. Relevant deliverables have been scenario studies for the Amsterdam area and the human capital agenda (2013). The latter focuses on international talent and the provision of high qualified workforce especially in the fields of ICT and technology.

The Amsterdam Economic Board has 22 members, and is chaired by the mayor of the City of Amsterdam (Eberhard van der Laan, himself a founder (1992) of a successful law firm, and previous member of the Amsterdam city council (1990-1998), and minister of “Living, Neighborhoods and Integration” in the period 2008-2010). Most interviewees praise the mayor’s role as an energetic pace-maker as well as the function of the AmEcBoard as a platform for collective action. The AmEcBoard has been able to build upon existing networks and social capital, although these predecessors have been informal and non-committal.

8.4.2 Commitment of firms, HEIs, and government

There are different perspectives on the level of commitment from *leader firms*: key actors from corporates like FloraHolland, Schiphol, IBM, Shell, Randstad and EY are active members of the AmEcBoard. However, influential stakeholders in the Amsterdam region like ING and ABN Amro (financial services) do not participate directly. This is quite odd, given the dominance of the financial sector in the regional economy.

Interviewees broadly share the observation that startups are barely connected with the AmEcBoard. AmEcBoard has a branch called Young on Board, focusing on young professionals - not necessarily startups. One interviewee observed that "for startups there appear to be other focal points like [the accelerators] Rockstart and StartupBootcamp." One of the consequences of this poor connectivity between the startup community and the AmEcBoard is that it is quite difficult for the flourishing fintech startup community to work itself into the financial corporate world and its educational system. The same counts for the connection with and commitment of SMEs, in all sectors stretching from creative industries to manufacturing.

There are different levels of commitment from HEIs as well, also within HEIs themselves.

- The staff of the Faculty of Science of University of Amsterdam is active in valorization, connecting with corporates, and the constitution of regional Knowledge & Innovation Agenda.
- The Free University on the executive board level shows clear dedication to solving societal challenges and embedding in the region, both in strategy and actions.
- The Amsterdam University of Applied Science has 7 local knowledge centers (e.g. health, education, social innovation, engineering, digital media) and 54 lectorates, dedicated to and embedded in the urban system. It participates in the Knowledge Mile, a cooperation to turn the Wibautstraat area into a living lab for creative services. The AUAS is willing to swiftly adapt educational programmes or launch new master programmes when there is a broadly supported

demand from Amsterdam industries. One example is the launch of a master programme in Digital Design, following a joint request from 10 digital marketing agencies based in the Amsterdam Area. They are typified as a flock. Enterprises are frank in their expectations that they might drop out of the flock within a few years due to bankruptcy but their positions will be filled by new members. Cooperation between HEIs and new industries has to cope with these uncertainties and flexible memberships. The start of the Jean School, following a lobby from several Amsterdam based jeans labels (Hilfiger, Levi's, Denham), is another example of industry-initiated (vocational) educational programmes. The MBO College Airport caters to specific skills in the airport industry, and cooperates with KLM and the Luchtvaartcollege (initiated by KLM, Schiphol Group and ROC).

However, more knowledge-intensive new industries, like fintech, identify large gaps between HEIs and their community in terms of quality of education, the development of new, interdisciplinary knowledge and in understanding the needs of new industries. The presence of two universities enhances the competition where cooperation to set up new programmes would be more efficient. HEIs and SMEs share the opinion that research universities and universities of applied science should bridge their different views on education to provide better programmes for both students and industries.

One AmEcBoard initiative that is broadly supported, is the Human Capital Agenda. This instrument aims at a better balance between (local) industry needs and educational propositions. At the same time it tackles the increasing youth unemployment. It is funded by both the Ministry of Social Affairs and the Amsterdam Metropolitan Area. The agenda is quite directive on the regional educational system. This must reduce the lack of efficiency in vocational education and turn competition between institutes into more tailor-made education in Amsterdam and surroundings. One of the projects is the retraining of 180 academic alumni to ICT-professionals.

There is a strong commitment from local and regional governments to the AmEcBoard. At the start, the AmEcBoard could build upon the fundament of the all-government platform PRES. This platform has been able to provide finance and staffing of the AmEcBoard. Also PRES could be considered a living lab for regional cooperation between local governments. The AmEcBoard extended this cooperation to HEIs and enterprises.

However, there are signals that local councils sometimes prefer to launch a policy initiative under their own signature, like Startup Amsterdam and Amsterdam Institute for Advanced Metropolitan Solutions (AMS). The latter has been an outcome of the local policy programme Amsterdam Topstad (2006-2010). One of the ambitions was to create "Harvard on the Amstel", by means of excellent university tracks. As results may count the Duisenberg School of Finance, Amsterdam University College, THNK (creative leadership) and Amsterdam Institute for Advanced Metropolitan Studies (AMS, cooperation between Delft University of Technology, MIT, and Wageningen University & Research).

8.4.3 Functioning of governance

There are different views on whether the AmEcBoard is able to unite relevant (public, private and public-private) initiatives. The human capital agenda is a successful example of a broadly supported and collective policy agenda for a better match of supply (vocational education, HEIs) and demand (business community) on the labour market. On the other hand there are several programmes that have been initiated by the City of Amsterdam but are not part of the agenda of the AmEcBoard, like the local start up policy programme Startup Amsterdam. However, there is consensus on the importance of the City of

Amsterdam: "Without the City of Amsterdam, the AmEcBoard would not have existed." Also the energy and commitment of individual members of the Amsterdam city council is widely praised.

The AmEcBoard has recently seen a major change in strategy, organization and approach.

- The cluster approach has been abandoned; instead, five societal challenges have been formulated to mobilize SMEs, corporates, HEIs and governments into joint action. These challenges are:
    - health
    - mobility
    - digital connectivity
    - circular economy
    - jobs of the future.
- As a consequence, also the ambition to remove institutional obstacles for cluster development and business development more broadly (one of the goals at the start of AmEcBoard) has been left behind. This role is thought to suit industry organizations better.
- Cluster managers have been replaced by business managers: supporting initiatives by giving lip service is not enough, partners have to show their commitment by participating actively in projects and programmes (also in cash), and preferably by taking the lead in execution.
- Joint initiatives will be judged on 'semi-commercial' criteria: is it feasible, is it scalable, does it depend upon a local/regional competitive advantage that will be enhanced?

Major achievements of the AmEcBoard are the collective actions and shared goals, like the Human Capital Agenda. A relevant barrier to overcome, is the lack of commitment of partners, within and close to the Board, to actively take the lead in projects and programmes. The new strategy should address this problem.

However, when looking at the dominant sectors in the Amsterdam Metropolitan Area, the question might be to what extent HEIs add to innovation in these sectors beyond the (one-way) delivery of human capital.

BiGGAR Economics found that the Amsterdam Universities have less staff engaged business interaction and knowledge transfer than other European universities that have excelled in these areas. The ambitious fintech community experiences a lack of interdisciplinary educational programmes on the highest level. The academic medical centres appear to be stand-alone actors, hardly embedded in the local, regional, social and economic structure and governance.

Overall, the governance system of MRA appears to have become increasingly adapted to the diverse structure of the regional economy, moving its focus from sectors to societal challenges. However, the ecosystem seems to be largely driven by self-organization, without a firm guidance or steering by the AmEcBoard. The board has especially been successful in making sense of a shared vision on the ecosystem, and providing a platform for collective action in particular niches.

The most binding constraints of this governance system seem to be the lack of connections of startup communities with the AmEcBoard and the ensuing limited entrepreneurial leadership in the entrepreneurial ecosystem. In addition the wide variety of governmental actors (municipalities, regional authorities, two provinces) seems to slow down effective governance. However, there seems to be so much bottom-up self-organization (especially in the densely populated, diverse Amsterdam metropolitan area) that these constraints are not very binding.

9 The Twente case study

9.1 Overview

Table 16: overview of Twente ecosystem economic indicators

Indicator	Unit	Figure
Total area	Hectares	150,371 ha
Active labour force 2014	Number of persons and percentage of total Dutch active labour force	298,000 (3.63%)
Labour force growth 2004-2014	Compound annual growth rate	0.41%
Gross added value 2014	Gross added value (× €1.000,-) controlled for full time equivalent years	75.9
Unemployment rate 2014	Percentage of total labour force	7.60%
Higher educated active labour force 2004	Percentage of total active labour force	24.0%
Higher educated active labour force 2014	Percentage of total active labour force	30.1%
Business demographic 2015	Number of businesses and percentage of total Dutch businesses	46,205 (3.26%)
Business demographic growth 2011-2015	Compound annual growth rate	2.20%
GDP growth 2011-2014	Compound annual growth rate	-0.003%
R&D expenditure as share of GDP based on CIS 2008	Percentage of GDP	1.05%
Innovation expenditure as share of GDP based on CIS 2008	Percentage of GDP	1.73%

9.2 The knowledge triangle in the ecosystem

The Twente ecosystem includes two institutes of higher education: the *University of Twente* and *Saxion University of Applied Sciences*. All intermediate vocational education is offered by the *ROC Twente*.

9.2.1 University of Twente

The University of Twente (UT) was founded in 1961, mainly to boost the local economy that suffered from a dwindling textile industry. The UT offers research and degree programmes in the social and behavioral sciences as well as in engineering. It currently has 10,000 enrolled students and about 3,000 staff members. In keeping with its historical mission and entrepreneurial spirit, the UT is committed to making an economic and social contribution to the Twente region. The UT is located in Drienerlo, situated between the municipalities of Hengelo and Enschede, as a campus university where many students and staff live, work and recreate. More recently, the UT location has become embedded in the so-called Kennispark Twente.

9.2.2 Saxion University of Applied Sciences

Saxion was established in 1998, as a merger of two schools. Saxion now is a vocational university with four campuses in the Overijssel region that provide more than 100 degree programs in fields such as engineering, economics, finance, law, hospitality and art. It currently has over 26,000 students enrolled

and around 2,800 staff members. Saxion has six research centres, in areas such as design and technology, hospitality, and innovation and entrepreneurship. Notably, two of Saxion's main locations (campuses) are elsewhere in the province of Overijssel, that is, outside the Twente region.

9.2.3 ROC Twente

ROC Twente offers Vocational Education and Training (VET) as well as adult education. It currently has more than 18,000 enrolled students and has about 2,000 employees on its payroll. ROC Twente is organized into 11 Colleges for VET programs and 1 College for Second-Opportunity-Education and Adult Education. In the VET programs, students are trained in professional practice via internships and work placements. The work placement is a compulsory component of every course of secondary vocational education. Therefore, each of the 11 Colleges maintains close relations with over 8,000 companies and other organizations in the regional labour market, to ensure a close match between the education offered and the skills needed in companies.

9.3 History of regional ecosystem

The Twente region is part of the Dutch province of Overijssel, and is the most urbanized part of this province. The region of Twente is located on the eastern border with Germany, and as such is also part of the so-called Euregio (transregional collaboration between German and Dutch regions at the border between the two countries).

Historically, the economic structure of the Twente region has long centered around agriculture and services, and to a lesser degree on the tourism and transportation sectors. Until the 19th centure, the Twente region was a largely rural area, with mainly farmers and traders. However, the quality of the soil was too poor for farmers to build economically strong farms. Therefore, farmers and their family members took up spinning and weaving, especially in the winters, which created the weaving industry in the region from which several large textile companies such as TenCate arose (Sijgers, et al., 2005). Also with governmental support, this led to a highly modern textile industry in Twente, which in turn also spurred the development of several related industries in the area of metals, machinery and electronics (Sijgers, et al., 2005). Twente has also given birth to many construction companies, some of which have grown into globally operating companies.

Until the first half of the 20th century, the textile and related industries constituted the primary economic pillar of the region. As of the 1950s, however, the textile industry in Twente suffered from a structural decline, as a result of increasing competition from low-wage countries, the independence of (former) Dutch colonies that produced cotton, and other factors. This led to a decrease of 80% in employment in the textile industry in the period 1955-1980, a loss of about 40,000 jobs (Sijgers, et al., 2005).

In the same period, therefore, key agents from industry and local government started lobbying for academic education, which resulted in the establishment of the new University of Twente in 1964. The new university started with offering degrees in math and applied physics as well as mechanical, electronic and chemical engineering – in line with the industrial heritage of the region (Sijgers, et al., 2005). Later, the UT diversified its research and educational portfolio to the social sciences. In the 1960s and 1970s, several other institutes for higher education (now part of Saxion) also expanded.

As of the 1980s, these investments in higher education as well as substantial support from European funds helped the Twente region to somewhat recover from its decline in the preceding decades. But overall, the economic structure of Twente is still relatively weak in terms of the educational level of its population as well as R&D and innovation expenditures (see the overview in 9.1 earlier). In this respect,

the industrial infrastructure of Twente continues to suffer from the demise of several large corporations in the region, whereas those multinational companies still located in the region have either moved their R&D activities to locations in other countries (e.g. Urenco) or have distributed their R&D across multiple locations including several sites outside Twente (e.g. Thales Netherlands and Vredestein). Notably, the main location of Thales in Hengelo has recently been redeveloped into the so-called High Tech Systems Park Hengelo that now is also open for other firms.

As a result, the knowledge networks in the Twente region are now heavily centered around Saxion and UT, as is also evident from the network analysis conducted in chapter 5. This is evident from the collaboration between the UT and Saxion, supported by the various local governments, in Kennispark Twente.

9.4 Functioning of the ecosystem

9.4.1 Governance structure

The region has two higher education institutes: the *University of Twente* and *Saxion University of Applied Sciences*. All intermediate vocational education is offered by the *ROC van Twente*. Other important agents and bodies in Twente's ecosystem are the City of Enschede; Region of Twente (collaborative body in which all 14 municipalities, including Enschede, participate); Province of Overijssel; Technologie Kring Twente; Twente Board; and Kennispark Twente. The "Technologie Kring Twente" is an informal network of about 150 knowledge- and technology-intensive companies in the Twente region. In the remainder of this section, we will outline the role of Twente Board and Kennispark Twente, in view of their (intended) governance roles in the regional knowledge triangle and infrastructure.

A key orchestrator of Twente's knowledge triangle is *Kennispark Twente,* that is legally shaped as a foundation. Kennispark Twente's mission is to further "develop an innovative entrepreneur's climate in the region of Twente." This is done by investing in and offering three kinds of facilities and conditions:

- support and support systems for innovative startups: from coaching programs and events, to financing;
- industrial innovation: joint innovation projects between SMEs, local industries and universities;
- attractive business climate: create the right environment for innovative businesses and attract new businesses for Twente.

The foundation Kennispark Twente is a joint initiative of the University of Twente, the City of Enschede, the Region of Twente, the Province of Overijssel and the Saxion University of Applied Sciences. By means of Kennispark Twente, they have committed to the economic development goal of creating 10.000 new jobs for the region. The foundation has a board of three directors, supported by a small team of support staff. This board meets twice per month, to discuss and decide on both operational and strategic issues; when engaging with particular strategic challenges, the board may meets more frequently.

The board of the foundation Kennispark Twente relates to the five founders, as to external investors. The annual plan and budget is authorized by the founders, and the board accounts for its activities by means of an annual report to the founders. In addition, each quarter the board meets the five founders in a so-called "state of the union" session, in which the progress of the Kennispark activities in terms of the metrices in the annual plan are monitored and discussed. Kennispark Twente also has a formal Supervisory Board that primarily has a control and auditing function, which in turn enables the (dialogue between the) founders and board of Kennispark to focus on the mission and strategy of Kennispark.

In the last fifteen years the Twente region has set up various regional bodies, such as a Regional Innovation Platform and later a Strategy Board. The latter board was transformed in 2014 in the Twente Board. At the regional level, the *Twente Board* operates as a collaborative body, set up to stimulate Twente's economic development, with a focus on the top sector High Tech Systems & Materials (HTSM). The Twente Board consists of 10 representatives from all sides of the triple helix: the business sector, higher education institutions, and several layers of government. The Board is led by an independent chairman, and meets 8 to 10 times per year.

The first action undertaken by the Twente Board in 2014 was to invite a visitation committee (chaired by Wiebe Draaijer) to assess the state and strategy of the Twente region. This committee wrote a report that confirmed that Twente needs to maintain its focus on the HTSM sector, because HTSM in combination with technology-driven entrepreneurship constitute the unique profile of the region, and are also likely to spur economic growth and internationalization. But, the committee led by Draaijer also signalled that the Twente region cannot exclusively focus on HTSM and entrepreneurship.

The report of the visitation committee led the Twente Board to develop an activity agenda "Twente Works" ("Twente Werkt") in 2015. In addition to efforts to enhance the HTSM profile and stimulate entrepreneurship, this activity agenda contains three other programs such as creating a sustainable labor market for the entire region and setting up a single acquisition team. The chair of the Twente Board thus observed that *"we have moved towards one shared agenda, with clear targets such as 5000 new jobs in Twente and 500 new jobs at the German side of the border (…) and objectives such as increasing the participation rate and the regional gross domestic product. These are very specific objectives that we will also measure every year. For this purpose, we publish the so-called Twente Index."* Another key initiative taken by the Twente Board is to visit 100 enterprises in the region, of which 75 visits have been completed in the Board's first year. By means of these visits, the Twente Board expects to connect a substantially larger number of companies to the HTSM agenda.

The Twente Board has adopted a rather lean operational structure. It draws on a limited annual budget of 150K Euro for initiating and supporting projects, with additional secretarial services from the province and region. The members of the Twente Board therefore turn to their own staff (e.g. at UT, Saxion, Twente region, or province Overijssel) to actually run the projects. In this respect, the chairman of the Twente Board believes *"it is important in Twente to avoid further institutionalization, and instead focus on making connections with the key actors and their initiatives"*.

9.4.2 Commitment of firms, knowledge institutions, and government

The Twente region has a rather unique history and profile, and its knowledge triangle is also orchestrated in a distinct manner. One interviewee argued that the Twente ecosystem *"is organized in a radically different manner than in other regions, because the university is the driving force behind the system. There are hardly any large firms that can fill in this role, but instead many startups and SME's. We have had a few fast-growing companies, but they often relocate outside the region when they become too big for the local labour market"*. The classic example here is Booking.com, the online booking website that started as a small start-up in Enschede in 1996, but later moved to Amsterdam.

This key role of the University of Twente is also evident in Kennispark Twente, of which the UT is the key occupant and (majority) owner. The other founders of Kennispark are all public organizations (Saxion and the three local governmental levels) which serves to create a robust, stable configuration around Kennispark – evident from the ongoing strategic dialogue between the five founders and the Board of Kennispark. As such, the stable governance system of Kennispark Twente appears to have contributed to

its successful performance as an incubator of new firms; its historical track record in terms of spinoff creation is still unmatched in the Netherlands and has also long been a benchmark in Europe (Benneworth & Charles, 2005; Benneworth, et al., 2010).

The public ownership and control of Kennispark Twente obviously implies that local industry is not represented in its management and governance. Several interviewees also observe this governance approach helps the board of Kennispark to steer away from any conflicts of interest, for example in case of a startup that develops a technology that is highly disruptive for the business of an established company in the region. The other side of the same coin is that there are no private investors in the knowledge infrastructure; that is, corporations in the region only invest/participate in specific projects. Kennispark Twente is thus under-financed, also as a result of the budgetary constraints of the UT and Saxion. Compared to Delft and Eindhoven, Kennispark Twente has also missed a large TNO (type of) institute on its premises. This has caused the UT to search for other applied research institutes that can fill this gap. A first success of this search effort is the recent decision by the Fraunhofer Institute to establish a project center in precision engineering and nanotechnology at Kennispark; this new resident may also give researchers of UT and Saxion better access to the German knowledge valorisation system.

Overall, we observe a strong commitment of the two leading educational organizations and three local government levels (cities, region, and province) to the knowledge triangle, in terms of both investment and governance. There are hardly any large industrial companies that have their primary base (incl. head office) in Twente, which makes the regional ecosystem largely dependent on startups and SMEs. The large population of small and medium-sized firms mainly contributes to developing and sustaining the regional ecosystem via representatives in formal bodies (such as Twente Board) as well as via informal settings and meetings (such as in Technologiekring Twente).

9.4.3 Functioning of governance

The Twente ecosystem has gradually evolved into a “startup region” par excellence, with a well-developed governance system around Kennispark Twente at its core. The Kennispark serves as a portal to many organizations in the region as well as the primary orchestrator of new business creation. Kennispark is governed by five founders (UT, Saxion, city, region, and province), who shape the strategy and future of Kennispark in an ongoing dialogue with the board of directors.

The recently established Twente Board can potentially offer an orchestrator capability that complements the public ownership and governance of Kennispark Twente. However, as several interviewees observed, the Twente Board still operates rather loosely and in the next few years will have to demonstrate that it can effectuate this capability.

The overview of the ecosystem given earlier, in combination with the interview data, also suggests that the Twente region continually adds new bodies and initiatives to an already dense network of taskforces, clusters, and agencies. In this respect, one interviewee observed “this region has a strong tendency to add new initiatives to existing ones, often by neglecting already existing activities. I often get invited to join a new initiative, and you then go from one club and project group to another. This is typical Twente: if something is not functioning properly, you do not shut it down, but start a new initiative that then exists in parallel.” A recent example is the creation of a ‘top team’ led by Aad Veenman, set up to reinforce the business and knowledge activities in the area of advanced materials and manufacturing in Twente, especially around the Twente airport territory (Province of Overijssel, 2015). For outsiders, it is difficult to understand what this team adds to the functionality of the Twente Board, and in particular

why the Twente Board was not asked to develop a vision on and strategy for the economic development of the territory around Twente airport.

This tendency to grow the institutional complexity also arises from the region being composed of 14 municipalities. Several interviewees observed that (representatives of) most municipalities tend to prioritize the interests of their own municipality above those of the region. In its continual effort to support and connect these municipalities in a regional entity (Twente Region), the province of Overijssel tends to increase this complexity—especially if it acts in response to specific challenges, as illustrated in the airport case.

A recurrent theme in the interviews with representatives from the Twente ecosystem is the shared perception of Twente being (geographically) rather distant from the heart of the Netherlands, which would reduce access to national funds and programs. For example, in the context of the top sector program High Tech Systems & Materials (HTSM), most interviewees observe Twente to be "second best" compared to the Eindhoven region that has a large number of OEMs in the HTSM domain. In this respect, the region's current focus on HTSM may not be sufficiently distinctive to attract large numbers of new investors, companies and knowledge institutes. On a related note, external observers have recently argued that the Twente region is in need of a new connector, or group of connectors, that would reduce its current dependence on the UT (incl. Kennispark) as the main connector (Van Agtmael & Bakker, 2016).

Overall, the governance system of the Twente knowledge triangle appears to entail:

- a well-functioning Kennispark system, with a stable configuration of public owners and investors;
- a relatively new Twente Board that still has to establish itself and demonstrate its complementary capability (especially relative to Kennispark Twente) to orchestrate and facilitate economic growth of the region;
- a tendency to further increase the institutional complexity of the region, by continually adding new initiatives, teams and taskforces to the existing landscape of collaborative bodies.

The most binding constraints of this governance system are:

- its (perceived) distant location relative to more densely populated regions in both the Netherlands (e.g. Randstad) and Germany (e.g. Ruhr region);
- the historical demise of most (home-grown) large industrial firms, which has made the region almost entirely dependent on the UT and Saxion as primary orchestrators of the knowledge infrastructure (supported by several layers of local government);
- the relatively low stock of human and financial resources that new startups as well as SMEs and large corporations have access to, given limitations arising from the local labour market, local sources of risk capital, and so forth;
- a current regional profile around "High Tech Systems and Materials" that in the long term may not be sufficiently distinctive to attract new investors, companies and knowledge institutes.

10 Evaluation

The main question of this report is

> How can the interaction between research [knowledge] and education [talent] be coordinated [by networks and leadership] in such a way that it enables productive entrepreneurship in regional ecosystems?

We first have described and explored the nature and dynamics of the entrepreneurial ecosystems in the three case study regions, with an explicit focus on the nature of innovation networks, the functioning of labour markets and of leadership in the form of regional economic boards.

10.1 Overall state of the knowledge triangle

Education and public research in the Netherlands are strongly government regulated, with various procedures and systems for holding HEI and other institutes accountable. At the same time, research and innovation policy of the Dutch government and other agencies gives a lot of freedom to individual organizations: if HEIs reach an agreement or establish a consortium, they obtain funding; but if they do not, or are not sufficiently organised, funding stays absent, even if it would be economically rational. Long established partners appear to be better equipped to realise funding than newcomers.

This is reflected in the top sector policy, in which the directives of policy directly target the cooperation of large corporations with the higher education institutes. Here the funding is channelled through sectoral and cross-sectoral themes to those firms and universities that are specialised in this area of expertise. To further stimulate entrepreneurship, a broad range of financial instruments and incentives available, designed to let SMEs, universities and UAS and in some instances VET school collaborate. However, this requires organisation on the part of SMEs to connect with the right HEIs and form the needed coalitions.

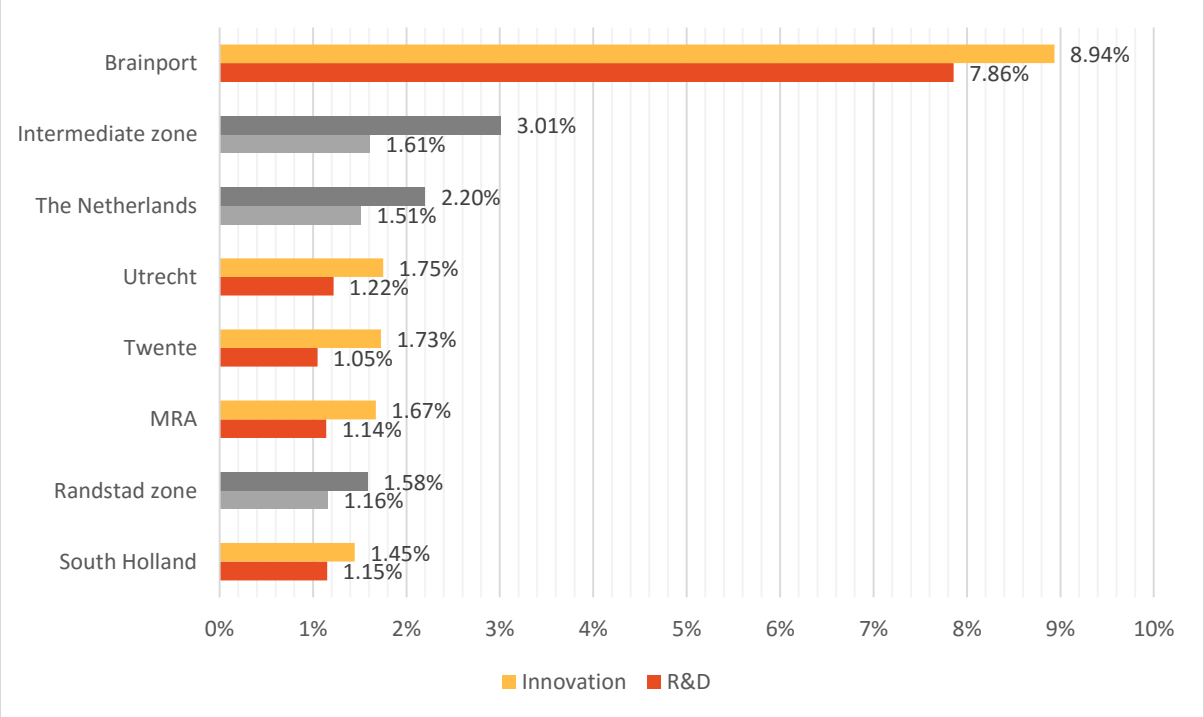


Figure 13: Innovation and R&D Intensity in ecosystems (expenditure as share of GDP), 2008

The actual manifestations of the KT in the Netherlands appear to be largely conditioned by national and regional incentives. The latter give rise to a lot of variety, but also make the regional KTs highly dependent on historical and local circumstances and coalitions as can be seen by the differences in R&D expenditure. For example, the Twente region has a rich industrial history, but never truly recovered from the demise of the textile (and related) industries, making its KT almost entirely dependent on the three educational institutes in the region. Due to the Philips' legacy, the Brainport region now includes a strong cluster of OEMs aligned to HEIs and other educational institutes that have a similar (perhaps too narrow) focus. Due to its long history of attracting talent and resources, MRA has the most diverse KT in the Netherlands and also includes the largest pool of (e.g. HEI) students and academics in the country.

10.2 Knowledge triangle orchestration

The stimulation of network formation in regional ecosystems provides two major benefits. First, it strengthens the ecosystem's position in areas of knowledge and industry in which it already had a strong competence base. Second, it attempts to fill the gaps within an innovation system by trying to connect those parties that are able to address the challenge. In the network analyses this was visible by looking at the most central organisations that influenced the network. Twente has typically a more central role for the HEIs due to the absence of large regional OEMs. Amsterdam has a more fragmented network but a large mass of HEIs at different positions whereas Brainport features several dominating large corporations.

The three regions we studied have chosen a rather similar KT strategy and governance approach, aiming to make universities and other educational institutes more relevant for their regional ecosystem. But regions appear to differ substantially in their capacity to absorb this increase in knowledge and make it relevant for their own labour force. Whereas all these Dutch regions share an overall collaborative approach based on stakeholder consultation and shared meeting spaces, they have also developed unique, region-specific governance systems. For example, the Twente region has a well-established Kennispark (entirely governed by public agents) with an excellent track record in new business incubation and creation, but has not yet developed a productive discourse on the future of the region. The Brainport region has developed a relatively coherent community of corporations and HEIs that, together with representatives from local governments, shapes the future of the region – while it faces the huge challenge to make the "Brainport" recipe more future-proof. Finally, the diversity and the strong economic development of the MRA region appear to constrain the ability for any regional board to steer it in new directions.

We witness forms of isomorphism between these forms of regional governance. First, all choose to focus their governance on the sectors that are thought to reinforce regional competitiveness. Second, all initiatives gradually move towards a tripartite mode of collaboration to stimulate the strengths of the region. Even the Twente region, that has long chosen to exclude the involvement of businesses in their ecosystem approach have now established a tripartite Twente Board.

However, the sectoral focus is also a remnant of older forms of economic policy and some of the boards are now moving away from this model in favour of an approach aimed at societal challenges. The AEB is moving towards addressing societal challenges frequently using the government as launching customer to support the firms that propose solutions. The Brainport region has done the same by formulating the main themes to which according to them the region has the capabilities of solving.

10.3 Added value of regional governance

The differences in employment growth between regions appear larger than differences in net growth rate in firms as can be seen in Figure 14 and Figure 15 below. The ability to start a firm looks rather similar in each region, but the ability to absorb new knowledge and higher educate people in existing firms seems to differ. Although inter-professional and intra-professional labour mobility is rather comparable in regions, especially in Twente, there still is a gap between produced new knowledge (on a higher level) an needs of firms. Additional actions seem necessary to make the HEIs of the ecosystem relevant for a broader part of the workforce.

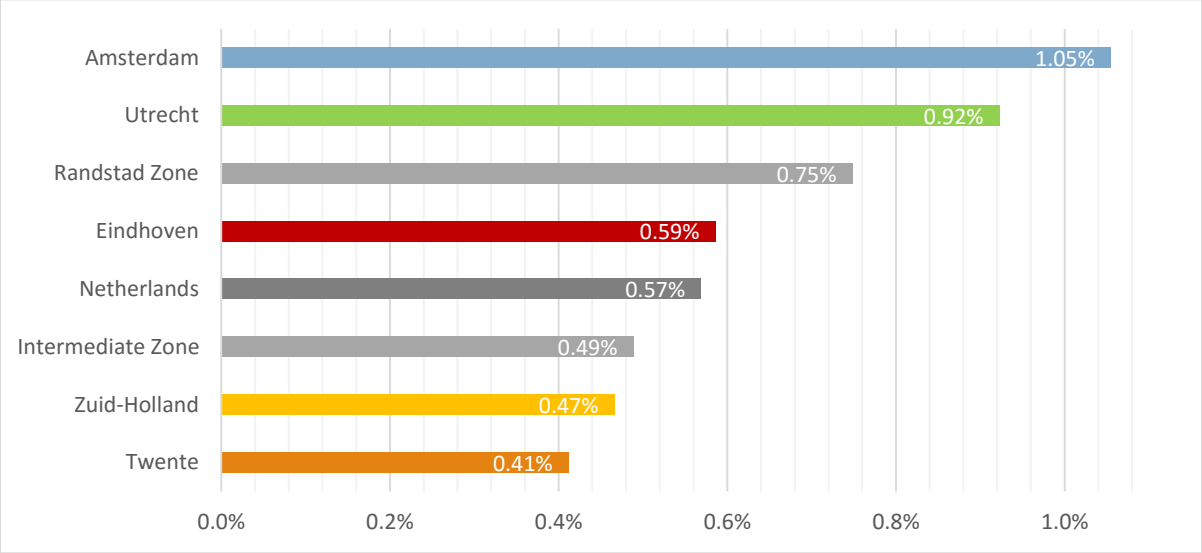


Figure 14: CAGR of ecosystems, based on employed persons, 2004-2014

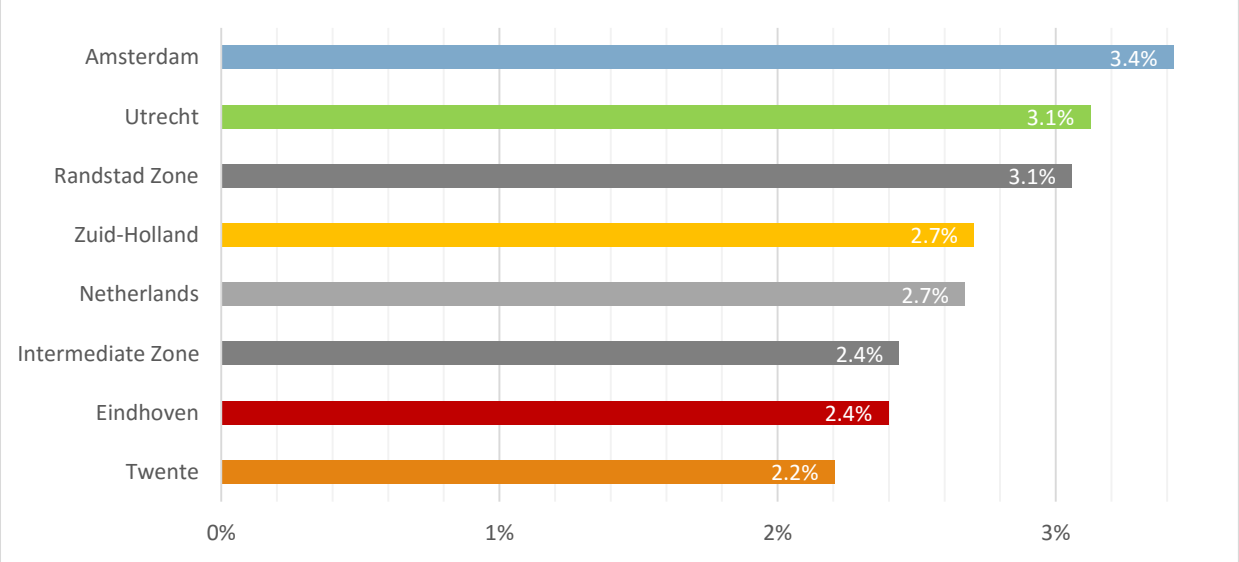


Figure 15: Compound Annual Growth Rate of businesses in ecosystems from 2011-2015

Additionally, the output of each ecosystem in terms of fast growing firms shows an image that may very well relate to sector specificity. The 'gazelles' in each ecosystem provide a different ratio of turnover per employee, where it is immediately visible that Brainport with its High Tech focus generates more turnover than expected from their share of fast growing companies. The Twente region does not display

this ratio, which correlates with the findings of the case study that fast growing companies often relocate to other regions with a more favourable human capital climate.

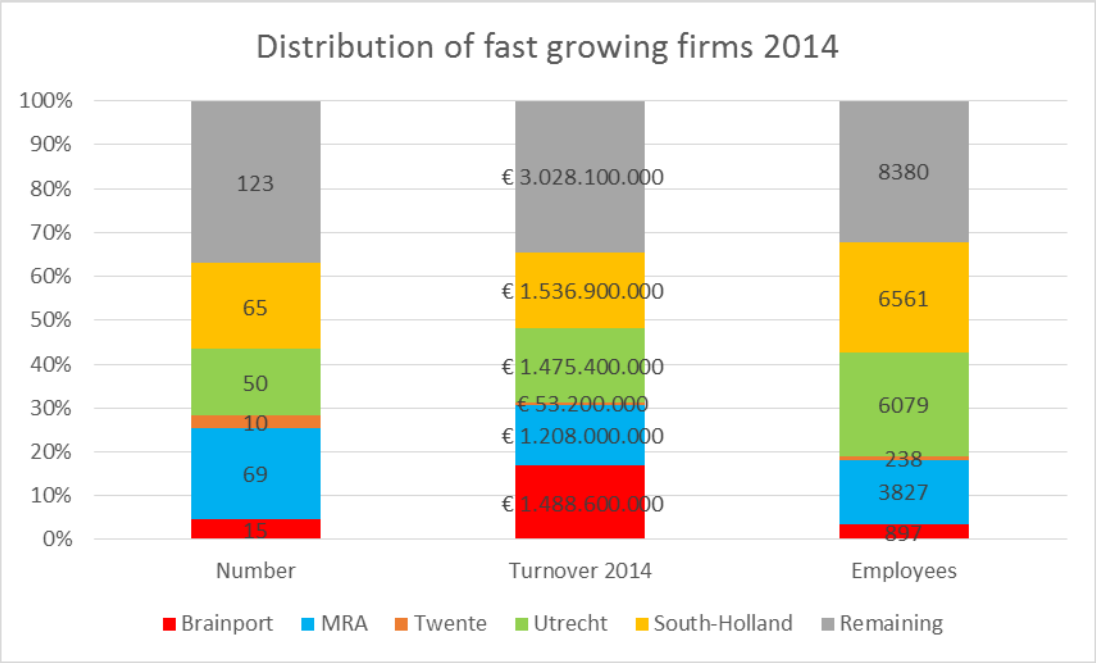


Figure 16: Gazelles distributed over ecosystems

We studied entrepreneurial ecosystems that already perform very well, both in entrepreneurial ecosystem inputs (such as Brainport and Utrecht), and in outputs (Figure 16), outcomes (Figure 17) and performance (MRA and Utrecht). The question rises to what extent a regional governance organisation contributes to this success. With this study we can only hint at potential causalities involved (creating a shared vision on the future of the region, leading to more effective use and creation of regional resources; monitoring bottlenecks in the region, guiding public(-private) investments to projects with the highest public return). In order to test the impact of these forms of regional governance, we need to take a longer term perspective to trace the (relative) effect of regional governance on entrepreneurial activity and ultimately aggregate value creation in these regions.

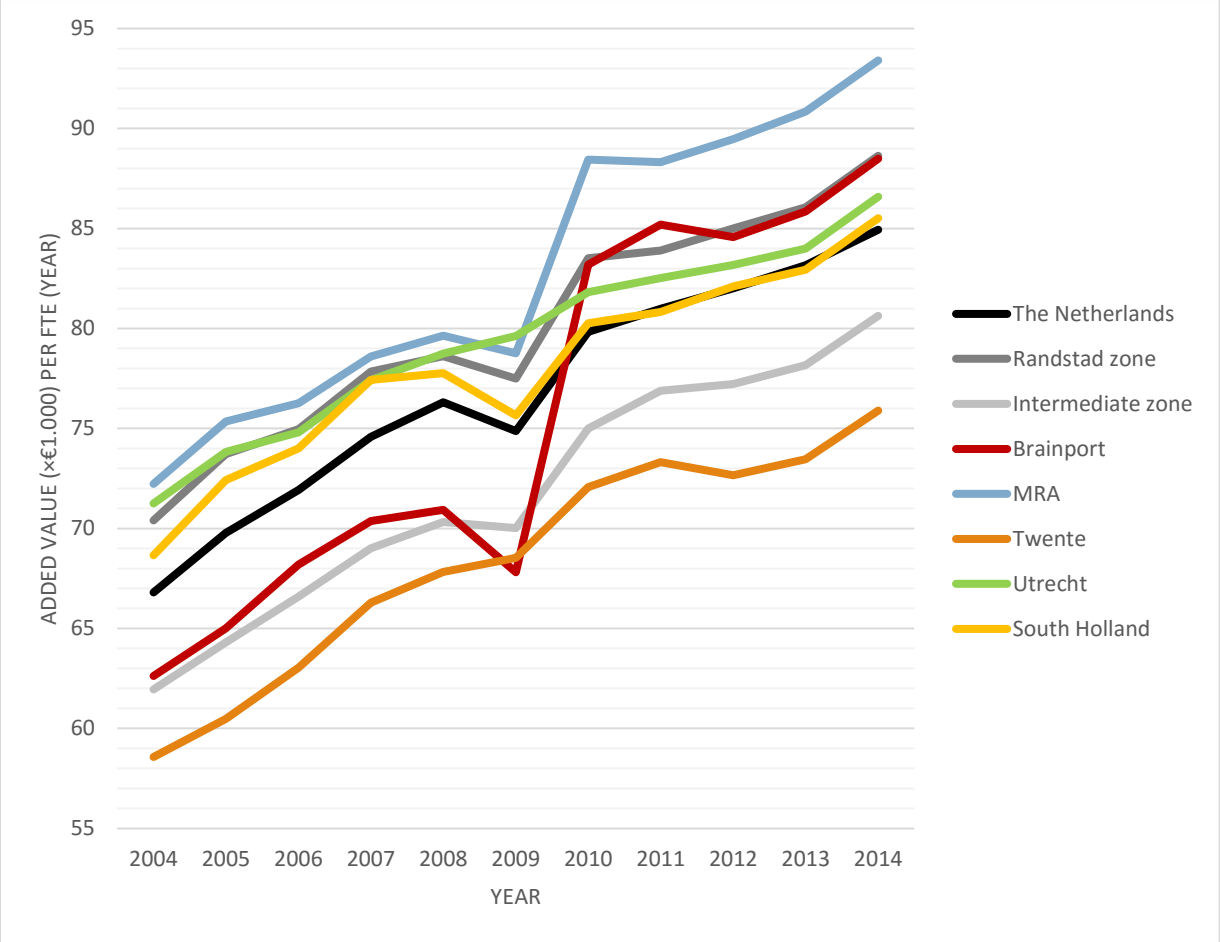


Figure 17: Added value in ecosystems compared

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Annexes

11 Annex I: Characteristics NETWORKS FOR KNOWLEDGE

The NfK database contains 3.270 innovation projects from 93 different public innovation programmes in the Netherlands. These can be supported by either local, regional, national or European government grants. Figure 18 shows the 14 largest programmes that together account for over 80% of all innovation projects. Of special note is the European Framework Programme category, which contains all FP7 projects and accounts for almost half of all projects.

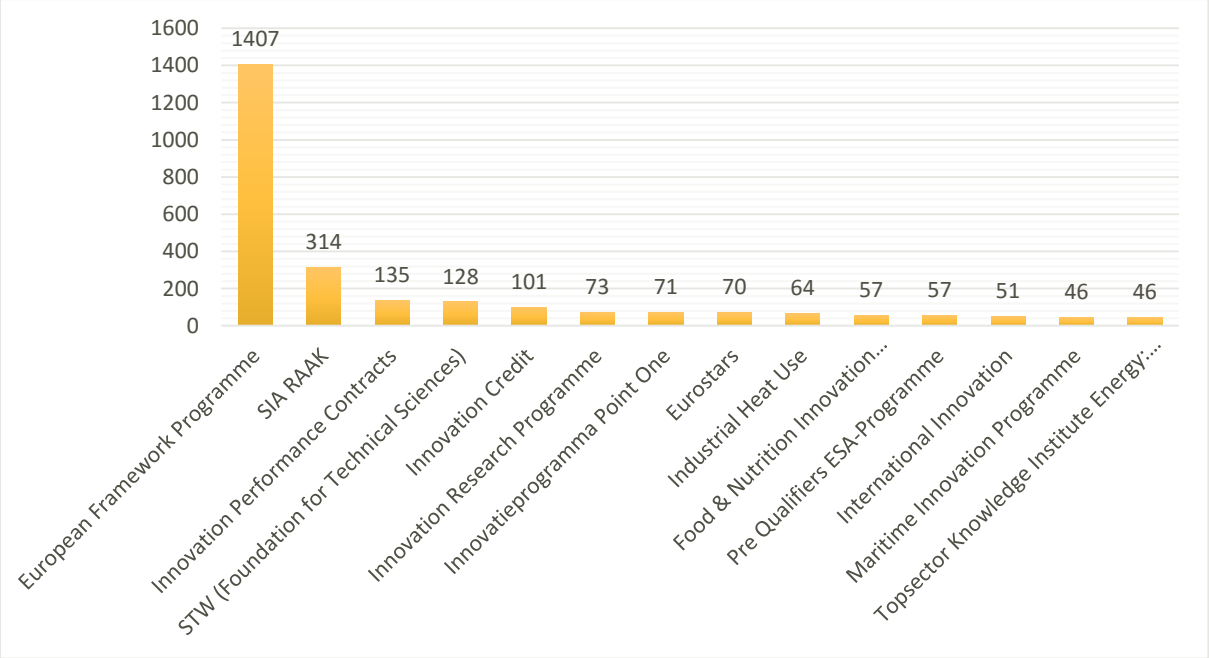

Figure 18: Distribution of innovation projects over innovation programmes

The participating organisations are divided in four categories: companies (SME's and large corporations), knowledge Institutes (Higher Education and Public research), public organisations (Healthcare, education and government) and intermediaries (Industry associations). These organisation's distribution over the provinces of the Netherlands is visualised in Figure 19.

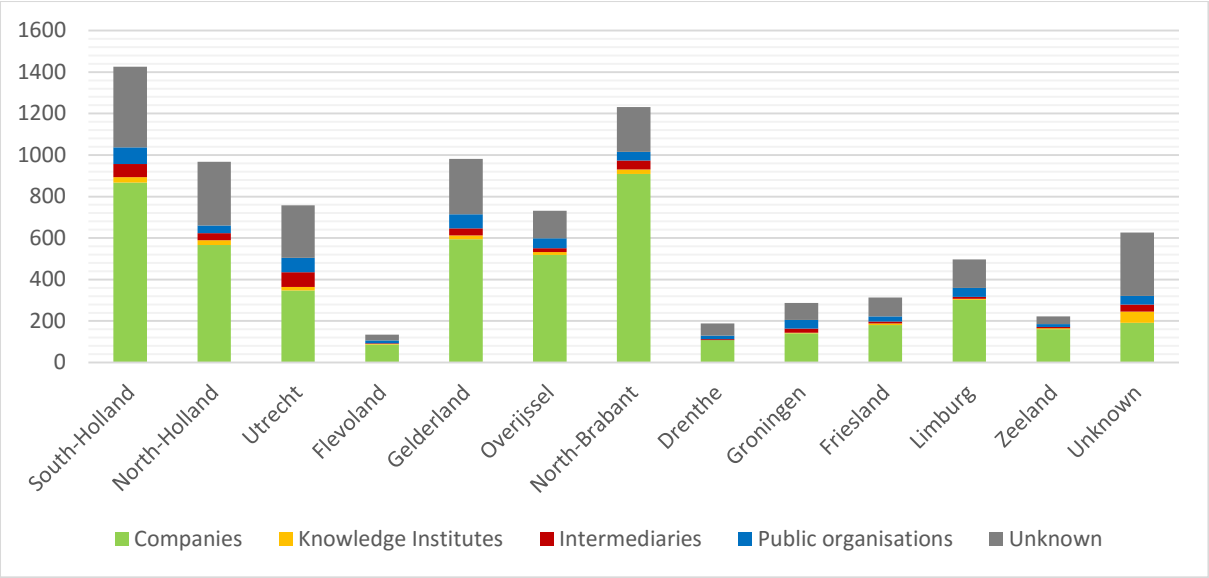

Figure 19: Distribution of organisation types across provinces

12 Annex II: Methodology of network indicators

12.1 Centrality of organisations

12.1.1 Degree

The primary centrality indicator is degree centrality, which counts an organisation's every interaction on a project with another organisation as a partnership (Jackson, 2010). The sum of these partnerships gives an indication of how influential the organisation is in a network in terms of the relationships it maintains.

12.1.2 Betweenness

The secondary centrality indicator is betweenness centrality, which quantifies the number of times an organisation acts as a bridge along the shortest path between two other organisations. For every organisation there is a shortest path through the network (measured in steps required to reach another organisation using the existing links) which will often pass through other organisations. Betweenness centrality consists of the sum of all the shortest paths that pass through a single organisation as a fraction of the total of shortest paths (Freeman, 1977). Thus, those organisations with the highest betweenness centrality can be considered more influential in terms of their position in the network.

12.2 Network characteristics

12.2.1 Density

An indicator for the intensity of interaction within the network is the Density of the network itself. It represents the share of linkages between organisations that is actually used as a fraction of the total amount of possible linkages. It is calculated by dividing the sum of linkages by the total sum of potential linkages between every organisation (Friedkin, 1981).

12.2.2 Connectedness

The connectedness of a network is measured through the share of organisations that are connected with other organisations in the network. This is measured by looking at all the possible pairs of organisations

in a network and dividing the sum of possible pairs that are connected with each other by the total of possible pairs. This results in a share of organisations that are connected to each other represented by a number between 0 and 1. The higher the score, the more organisations are able to reach each other using the existing ties of the network (Tichy & Fombrun, 1979).

12.2.3 Distance

Average distance within a network is measured by averaging all the shortest paths between all possible pairs. This shortest path is expressed in the minimum number of linkages required for an organisation to reach a random other organisation in the network (Newman, 2001). Thus, the distance represents whether on average other organisations are reachable from any point in the network. The standard deviation of distance gives an indication of the variety of distances within the network.

13 Annex III: Most seen and most specific jobs in ecosystems

Meest voorkomende beroepen
in de twee meest uiteenlopende regios

MRA

BEROEP	Aandeel	Niveau	Hiaat dgn
Schoonmakers huishouding	6,5%	1,1	219
Productiemedewerkers	4,3%	1,0	434
Secretaresses	3,9%	3,3	142
Medewerkers kinderopvang	3,6%	2,9	238
Klantenservice- en callcentermedewerkers	3,6%	3,0	477
Magazijnmedewerkers	3,4%	2,1	170
Managers sales, marketing en reclame	2,5%	4,0	125
Groepswerkers zorg en welzijn	2,3%	3,1	161
Assistenten secretariaat	2,2%	2,0	165
Specialisten personeel en arbeid	2,1%	3,8	155
Accountmanagers	2,0%	4,0	119
Beveiligers	1,9%	3,0	152
Reclame en marketingspecialisten	1,7%	4,0	118
Topmanagers & bestuurders	1,6%	5,0	112
Journalisten-redacteuren	1,4%	4,0	238
Kassamedewerkers	1,3%	2,1	135
Chauffeurs individueel personenvervoer	1,2%	2,0	275
Docenten beroepsonderwijs	1,2%	4,4	101
Beheerders (technisch-hardware)	1,2%	3,3	182
Keukenmedewerkers	1,2%	1,7	160

Twente

BEROEP	Aandeel	Niveau	Hiaat dgn
Schoonmakers huishouding	2,7%	1,1	238
Productiemedewerkers	2,2%	1,0	358
Magazijnmedewerkers	1,1%	2,1	130
Groepswerkers zorg en welzijn	1,1%	3,0	276
Klantenservice- en callcentermedewerkers	0,9%	3,0	163
Timmerlieden	0,8%	2,1	70
Medewerkers kinderopvang	0,8%	2,9	194
Docenten primair onderwijs	0,7%	4,0	62
Secretaresses	0,7%	3,2	163
Specialisten personeel en arbeid	0,5%	3,7	115
Assistenten secretariaat	0,5%	2,0	149
Tegelzetters en metselaars	0,5%	2,0	72
Operators procesindustrie	0,5%	2,2	95
Chauffeurs individueel personenvervoer	0,5%	2,0	217
Schilders	0,4%	2,0	82
Managers sales, marketing en reclame	0,4%	3,9	113
Kassamedewerkers	0,3%	2,1	101
Logistiek medewerkers	0,3%	3,0	147
Accountmanagers	0,3%	4,0	121
Wegenwerkers	0,3%	2,0	116

Vetgedrukt: beroepsgroepen die, van beide regio's, alleen in deze regio in top 20 staan.
Aandeel: aandeel van dit beroep in de regio
Niveau: gemiddeld (gewogen) niveau van de onderliggende registerberoepen (1-5)
Hiaat: gemiddelde periode (kalenderdagen) tussen dit en voorgaande beroep (indien hiaat tussen 2004-2014)

Top 20 locatiecoëfficiënt
voor beroepen ≥ 10 pp per regio

MRA

BEROEP	Niveau	N=	LC	Hiaat dgn
Dansers	3,5	79	3,2	101
Programmamakers en productieleiders	3,7	359	3,1	104
Visbewerkers	2,0	60	3,1	131
Acteurs	3,9	529	3,0	79
Afdelingshoofden textiel	3,0	22	3,0	122
Regisseurs	3,9	240	2,9	138
Servicemedewerkers personenvervoer	2,8	289	2,9	107
Ontwerpers mode-kleding	4,0	202	2,7	137
Kunst & cultuur onderzoekers	5,0	17	2,7	74
Producenten muziek, theater, film, rtv bedrijf	4,0	118	2,7	123
Artistiek leiders dans	4,0	13	2,6	29
Specialisten effectenhandel	4,0	95	2,6	122
Stewards	3,0	121	2,5	61
Piloten	4,0	40	2,3	101
Medewerkers banqueting en zaalinrichting	2,6	10	2,3	198
Managers muziek, theater, film, rtv bedrijf	4,0	35	2,2	188
Artiestenmakelaars	4,0	15	2,2	204
Journalisten-redacteuren	4,0	1014	2,1	238
Artistiek vormgevers film en podiumkunst	3,3	129	2,1	102
Modellen	2,0	43	2,1	72

Totaal 3.430 personen; 4,8% van het totaal in de regio MRA

Twente

BEROEP	Niveau	N=	LC	Hiaat dgn
Operators textiel	2,0	18	5,9	43
Werkplaatstimmerlieden	2,1	117	3,1	118
Monteurs elektropanelen	3,0	43	3,1	123
Tegelzetters en metselaars	2,0	365	3,0	72
Industrieelwetenschappers	5,0	37	2,2	126
Machinaal houtbewerkers	2,0	54	2,2	155
Confectie- en textielmedewerkers	2,0	21	2,2	174
Managers toeristische dienstverlening	4,0	10	2,2	67
Stukadoors en vloerenafwerkers	2,0	76	2,1	70
Medewerkers dier- en veehouderij	1,9	50	2,0	108
Verspaners	2,4	124	2,0	97
Bouwkundig tekenaars en werkvoorbereiders	3,0	181	1,9	115
Landbouwers	3,0	12	1,9	5
Werkvoorbereiders hout en meubileringsindustrie	3,0	10	1,9	12
Tekenaars elektrotechniek	3,0	11	1,9	126
Bedrijfsleiders metaalindustrie	3,0	19	1,9	58
Brandweerspecialisten	3,8	12	1,8	109
Montagemedewerkers hout/metaal	2,0	104	1,8	124
Timmerlieden	2,1	595	1,7	70
Operators procesindustrie	2,2	365	1,7	95

Totaal 2.224 personen; 11,2% van het totaal in de regio Twente

Niveauverandering in MRA

Top 20 aantal en Top 20 LC

MRA Top 20 aantal Huidig beroep	Gem niv eerder beroep	Gem niveau huidig beroep	Niveau veran-dering
Productiemedewerkers	1,4	1,0	-0,44
Schoonmakers huishouding	1,5	1,1	-0,43
Keukenmedewerkers	1,5	1,7	0,25
Assistenten secretariaat	2,1	2,0	-0,09
Chauffeurs individueel personenvervoer	1,9	2,0	0,10
Magazijnmedewerkers	1,9	2,1	0,16
Kassamedewerkers	1,6	2,1	0,52
Medewerkers kinderopvang	2,6	2,9	0,36
Beveiligers	2,4	3,0	0,61
Klantenservice- en callcentermedewerkers	2,7	3,0	0,32
Groepswerkers zorg en welzijn	2,6	3,1	0,49
Beheerders (technisch-hardware)	2,9	3,3	0,36
Secretaresses	3,1	3,3	0,21
Specialisten personeel en arbeid	3,4	3,8	0,37
Journalisten-redacteuren	3,4	4,0	0,53
Accountmanagers	3,3	4,0	0,71
Reclame en marketingspecialisten	3,2	4,0	0,84
Managers sales, marketing en reclame	3,3	4,0	0,76
Docenten beroepsonderwijs	3,6	4,4	0,73
Topmanagers & bestuurders	3,5	5,0	1,50

MRA Top 20 LC Huidig beroep	Gem niv eerder beroep	Gem niveau huidig beroep	Niveau veran dering
Visbewerkers	1,5	2,0	0,47
Modellen	2,0	2,0	0,05
Medewerkers banqueting en zaalinrichting	2,6	2,6	0,00
Servicemedewerkers personenvervoer	2,2	2,8	0,57
Stewards	2,2	3,0	0,78
Afdelingshoofden textiel	2,8	3,0	0,18
Artistiek vormgevers film en podiumkunst	2,5	3,3	0,81
Dansers	2,7	3,5	0,84
Programmamakers en productieleiders	2,8	3,7	0,86
Acteurs	2,8	3,9	1,08
Regisseurs	2,9	3,9	1,02
Journalisten-redacteuren	3,4	4,0	0,53
Ontwerpers mode-kleding	2,8	4,0	1,23
Producenten muziek, theater, film, rtv bedrijf	3,0	4,0	0,97
Artistiek leiders dans	2,5	4,0	1,54
Specialisten effectenhandel	3,3	4,0	0,71
Piloten	2,1	4,0	1,95
Managers muziek, theater, film, rtv bedrijf	3,2	4,0	0,77
Artiestenmakelaars	3,0	4,0	1,00
Kunst & cultuur onderzoekers	3,8	5,0	1,18

Niveauverandering in Twente

Top 20 aantal en Top 20 LC

Twente Top 20 Aantal Huidig beroep	Gem niv eerder beroep	Gem niveau huidig beroep	Niveau veran-dering
Productiemedewerkers	1,4	1,0	-0,38
Schoonmakers huishouding	1,6	1,1	-0,52
Assistenten secretariaat	2,1	2,0	-0,10
Tegelzetters en metselaars	1,4	2,0	0,58
Chauffeurs individueel personenvervoer	2,0	2,0	0,03
Schilders	1,3	2,0	0,71
Wegenwerkers	1,5	2,0	0,51
Magazijnmedewerkers	1,7	2,1	0,32
Timmerlieden	1,5	2,1	0,53
Kassamedewerkers	2,2	2,1	-0,12
Operators procesindustrie	2,1	2,2	0,08
Medewerkers kinderopvang	2,6	2,9	0,27
Klantenservice- en callcentermedewerkers	2,4	3,0	0,60
Logistiek medewerkers	2,2	3,0	0,81
Groepswerkers zorg en welzijn	2,7	3,0	0,39
Secretaresses	2,6	3,2	0,55
Specialisten personeel en arbeid	3,0	3,7	0,69
Managers sales, marketing en reclame	3,3	3,9	0,66
Docenten primair onderwijs	2,9	4,0	1,10
Accountmanagers	3,3	4,0	0,73

Twente Top 20 LC Huidig beroep	Gem niv eerder beroep	Gem niveau huidig beroep	Niveau veran dering
Medewerkers dier- en veehouderij	1,6	1,9	0,30
Montagemedewerkers hout/metaal	1,7	2,0	0,31
Operators textiel	1,3	2,0	0,67
Tegelzetters en metselaars	1,4	2,0	0,58
Confectie- en textielmedewerkers	1,3	2,0	0,67
Stukadoors en vloerenafwerkers	1,4	2,0	0,57
Machinaal houtbewerkers	1,6	2,0	0,41
Timmerlieden	1,5	2,1	0,53
Werkplaatstimmerlieden	1,6	2,1	0,53
Operators procesindustrie	2,1	2,2	0,08
Verspaners	1,8	2,4	0,67
Monteurs elektropanelen	2,6	3,0	0,42
Bouwkundig tekenaars en werkvoorbereiders	2,5	3,0	0,49
Landbouwers	1,5	3,0	1,50
Werkvoorbereiders hout en meubileringsindustrie	2,9	3,0	0,10
Tekenaars elektrotechniek	2,5	3,0	0,45
Bedrijfsleiders metaalindustrie	2,8	3,0	0,16
Brandweerspecialisten	2,6	3,8	1,25
Managers toeristische dienstverlening	3,3	4,0	0,70
Industrieel wetenschappers	2,7	5,0	2,32

14 Annex IV: Interview protocol

14.1 Hoofdvragen

1. Hoe krijgt in regionale ecosystemen de wisselwerking tussen onderzoek, onderwijs en innovatie vorm en hoe wordt deze beïnvloed door andere elementen van het ecosysteem?
2. Op welke wijze spelen (regionale) overheden daarin een rol en welke vormen van governance zijn ontstaan?
3. Wat zijn de effecten die diverse ecosystemen bereiken en hoe zijn deze te verklaren uit de kenmerken van het ecosysteem en de gekozen interventies?
4. Welke lessen zijn te trekken over het functioneren van de kennisdriehoek in ecosystemen en hoe deze te besturen?

14.1.1 Algemene vragen

1. Wie zijn de spelers die in deze regio een rol hebben gepakt om van de regio een goed functionerend ecosysteem te maken? Wie zijn de leidende partijen (vanuit bedrijfsleven, lokale overheid en kennisinstellingen)? Is er voldoende massa?
2. Hoe verloopt de verbinding tussen landelijk beleid en nationaal ecosysteem? Via welke personen en organisaties? Hoe is de wisselwerking tussen het regionaal ecosysteem en het nationaal systeem (specificeer naar soort beleid en specifieke effecten daarvan)? Is er sprake van internationale samenwerking?
3. Wat zijn de effecten van het landelijk beleid op het ecosysteem? Waar heeft de regio specifieke afhankelijkheden? In welke mate is de regio economisch verbonden met het nationale ecosysteem? Op wat voor manier?
4. Wat is de invloed van de ligging van de regio op het ecosysteem? Wat is de invloed van regio specifieke historische en culturele factoren op het ecosysteem? Specifieker: hoe is de houding en de manier van zaken doen van mensen van invloed op de werking van het ecosysteem? Hoe internationaal en multicultureel georiënteerd is het ecosysteem?
5. Wat is de vorm of wat zijn de vormen van gezamenlijk bestuur in het ecosysteem? Wat zijn de geldende formele en/of informele spelregels die samenwerking via/in dit bestuur bepalen? Welke rechtsvormen zijn gekozen en waarom?
   Zijn er formele bijeenkomsten voor de ecosysteem spelers en in welke mate wordt hier gebruik van gemaakt? Aan wie legt het bestuur (extern en/of intern) verantwoording af? Is er een gezamenlijke agenda? Door wie wordt die bepaald en op basis van wat voor soort (externe of interne) informatiestromen/signalen? Wordt deze agenda ondersteund door financiering? Is er een directie/directeur (verantwoordelijk voor een uitvoerend orgaan, met gecommitteerde mensen & middelen) die de visie en strategie van het bestuur in acties en programma's kan omzetten? Wat is de invloed van historisch gegroeide machtsverhoudingen en polderorganisaties (brancheverenigingen & werkgevers-/werknemersorganisaties)?
6. Wat zijn de belangrijkste veranderingen van de afgelopen vijf jaar? Zijn er nieuwe publiek-private samenwerkingen en arrangementen tussen onderwijs, onderzoek en innovatieve bedrijven? Zijn er nieuwe private samenwerkingen (clusterorganisaties) die kennis en middelen proberen effectiever in te zetten? Wat zijn de grootste issues die zijn opgepakt?
7. Hoe heeft de organisatie van het ecosysteem bijgedragen aan de veerkracht van de regio? Wat zijn de resultaten op het gebied van innovatie, ondernemerschap en groei? Wat betekent dit voor werkgelegenheid, maatschappelijke oplossingen en productiviteit?
8. Hoe verloopt het effect van organisatie via interventie naar resultaat? Welke interventies door het ecosysteem hebben de afgelopen tijd geholpen in het organiseren van het ecosysteem en hebben zichtbaar resultaat geboekt?

9. Wat zijn op dit moment knelpunten in het functioneren van het ecosysteem? Welke knelpunten waren er in het verleden en hoe zijn in het verleden knelpunten opgelost door het ecosysteem? Wat is de rol van de (lokale) overheid in het wegnemen van deze knelpunten geweest? Hoe wordt die nu gezien?
10. Wat zijn de “best practices” en de grootste “trauma’s” van dit ecosysteem?

14.1.2 Specifieke vragen afhankelijk van rol

14.1.2.1 Beleidsmaker/ecosysteem ondersteuning

1. Wat is het doel van de triple helix zoals deze in dit ecosysteem is ingericht?
2. Is er een sectorale focus binnen het ecosysteem en zo ja, wat is die? Wat is de verbinding met de topsectoren? Zijn er maatregelen die bepaalde sectoren specifiek ondersteunen? Is er daarnaast generieke ondersteuning?
3. Wat is de rol en wat is het effect van landelijk beleid in het ondersteunen of juist tegenwerken van het ecosysteem?
4. Zijn er voldoende kenniswerkers, vakmensen, en andere competenties in de regio om bedrijvigheid aan te trekken? Zijn er voldoende kenniswerkers en vakmensen om eigen kweek aan bedrijven te laten groeien?
5. Is de rol van de lokale overheden ter ondersteuning van het ecosysteem de afgelopen 5 jaar veranderd? Hoe is de verhouding tussen lokale overheden in de regio? En tussen lokale overheden en provincie? Hoe is de wisselwerking tussen lokaal, regionaal en provinciaal beleid en innovatiebeleid (fiscaal en topsectorenbeleid) en ondernemerschapsbeleid? Kunnen politieke verwachtingen ten opzichte van resultaten van het ecosysteem worden waargemaakt?
6. Welke issues moeten nu opgelost worden?

14.1.2.2 Ondernemer/groot bedrijf

1. Welke regiokenmerken zijn belangrijk voor de locatiekeuze van de onderneming? Hoe waardeert de ondernemer de SWOT van de regio?
2. Werkt het bedrijf samen met andere bedrijven in de regio? Op wat voor manier? Gezamenlijk onderzoek, ontwikkeling of ketenbeheer?
3. Wat voor effect heeft "het landelijk beleid" op dit ecosysteem? Specifieker: wat is de invloed van bijvoorbeeld fiscaal beleid, topsectorenbeleid, ondernemerschapsbeleid?
4. Gaat het bedrijf op zoek naar kennis bij publieke instellingen? Werkt het bedrijf samen met studenten of onderzoekers van kennisinstellingen? Op wat voor manier en in welke mate?
5. Werkt het bedrijf samen met onderwijsinstellingen in de regio? Hoe - bijvoorbeeld door vorming curricula, innovatieprojecten, onderzoek, stageplaatsen, centra voor innovatief vakmanschap (CIV), centres of expertise (CoE), publiek-private samenwerking in het kader van het regionaal investeringsfonds (RIF)? Werkt het bedrijf juist samen met onderwijs- of onderzoeksinstellingen buiten de regio omdat de regio onvoldoende voorziet in specialistische kennis?
6. In welke mate stromen studenten door naar de regionale bedrijven?
7. In welke mate zijn bedrijven afhankelijk van in de regio aanwezige kenniswerkers en vakspecialisten?

14.1.2.3 Kennis- of onderwijsinstelling

1. Wat is jullie rol in het ecosysteem? Welke onderwijs- en onderzoeksinstellingen vervullen nog meer een rol? Hoe zijn die rollen verdeeld, op welke manier zijn de instellingen complementair aan elkaar? Of op welke manier zijn ze juist elkaars concurrent?
2. Welke keuzen zijn de afgelopen periode gemaakt in portfolio en curricula? Waarom zijn deze keuzen gemaakt? Wat is de rol van regionale besturen?

3. Werkt de onderwijsinstellingen samen met bedrijven (of instellingen)in de regio? Hoe - bijvoorbeeld door vorming curricula, innovatieprojecten, onderzoek, stageplaatsen, centra voor innovatief vakmanschap (CIV), centres of expertise (CoE), publiek-private samenwerking in het kader van het regionaal investeringsfonds (RIF)?
4. Op wat voor manier werken studenten en onderzoekers samen met bedrijven gevestigd in de regio? In welke mate gebeurt dit? Zijn hier aparte regelingen of programma's voor?
5. In welke mate stromen studenten door naar de regionale bedrijvigheid?
6. Welke issues moeten nu opgelost worden?

14.2 Afsluitende vragen

1. Wie moeten wij nog spreken binnen dit ecosysteem? Wie heeft een unieke kijk of juist een kritische blik op het functioneren van dit ecosysteem?
2. Wij sturen een interviewverslag op ter verificatie. Wilt u uw naam vermeld hebben in de respondentenlijst? Bij letterlijke citaten leggen wij u altijd eerst de formulering voor.