Knowledge triangles in the Netherlands: an entrepreneurial ecosystem approach


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Knowledge Triangles in the Netherlands

AN ENTREPRENEURIAL ECOSYSTEM APPROACH

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Executive summary

This report provides a study of knowledge triangles of research-education-innovation within Dutch entrepreneurial ecosystems. These knowledge triangles do not evolve in a vacuum, but are part of a broader set of interdependent actors and factors which, if coordinated in an adequate way, enable productive entrepreneurship within a particular territory. This report focuses on the role of regional governance (i.e. networks and leadership) in the knowledge triangle and the entrepreneurial ecosystem more broadly. This is reflected in the main question of this report:

How is the interaction between research [knowledge] and education [talent] coordinated [by networks and leadership] in ways that enable or inhibit productive entrepreneurship in regional ecosystems in the Netherlands?

The performance of knowledge triangles is highly conditioned by its context, the entrepreneurial ecosystem, including culture, formal institutions, physical infrastructure, financial resources, and the available pool of talents.

The knowledge networks provide connections in such an ecosystem, whereas leadership involves a mechanism for giving direction. Knowledge networks and leadership capabilities are two critical systemic conditions for new value creation, but their role and impact cannot be isolated from the broader set of conditions.

In the Netherlands there is a strong, historically founded, preference for cooperative governance. In the 1980s and 1990s, organized cooperation on the labour market led to a – in international perspective – relatively sharp rise of employment. Since 2003, the issues of knowledge production and innovation are also addressed in a tripartite manner on a national and since 2005 on a regional level. In this report, we study and evaluate the functioning of Dutch knowledge triangles by means of three in-depth contrasting case studies: Metropolitan Region Amsterdam, Brainport Eindhoven and Twente. Empirical analysis of secondary data is also done on two additional cases: the Utrecht and South-Holland regions.

One key finding is that the entrepreneurial ecosystems of Amsterdam and Utrecht appear to perform very well in terms of gazelles (high growth enterprises), added value and employment growth, while Brainport increased its performance remarkably since the financial crisis in 2008. On all economic indicators, Twente underperforms compared with the national (average) rates.

The Amsterdam, Utrecht, Brainport and South-Holland regions do not differ substantially with respect to the structure of their knowledge networks, all having better scores than the national average. The network characteristics of the Twente region are, however, significantly different (e.g. more dense and better connected) than those in the other four regions. In Twente, two higher education institutes (HEIs) are central in the network, also due to the demise of most large corporations in this region. The knowledge networks in Amsterdam are dominated by a larger set of HEIs. In the Brainport region two large Original Equipment Manufacturers (OEMs) as well as two HEIs are central.

The Amsterdam, Brainport and Twente regions have been developing ‘triple helix‘ forms of regional governance, involving an ongoing dialogue between key stakeholders. The three regions differ significantly in how they (as an entrepreneurial ecosystem) are configured, and therefore also face fundamentally different challenges in their ecosystem. Our case studies suggest that a collective sense of urgency about the local economic situation is a critical condition for initiating a regional strategy. Each region has a unique history in shaping collective action, and has been developing a (region-specific) balance between top-down steering and bottom-up leadership. The three case studies suggest there are
substantial differences between regional boards, with regard to their ability to choose where, when and how to act. This ability largely depends on how they are funded and organized.

Moreover, the complementarities and synergies between various regions suggest the Netherlands actually constitutes a *single metropolis*. At the global level, only the entire Dutch delta can truly count as a metropolitan area (with about 17 million inhabitants). As a result, there is a strong case for reinforcing the complementarities and synergies between the regions within the larger Dutch metropolis, rather than having each region fight its own battle.

Overall, entrepreneurial ecosystems emerge and develop in highly contextual way. As such, there is unlikely to be a one-size-fits-all solution for shaping and governing (the development of) entrepreneurial ecosystems, and local governments and other agents should therefore be very careful and cautious in any attempt to copy ‘best practices’ observed in other regions, without taking into account the strengths and weaknesses of their own ecosystem.
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 is the interaction between research [knowledge] and education [talent] coordinated [by networks and leadership] in ways that enable or inhibit productive entrepreneurship in regional ecosystems in the Netherlands?

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. Chapters 5 and 6 describe and compare five ecosystems in terms of innovation networks and dynamics on the labour market. In chapters 7, 8 and 9 we present three detailed case studies, 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, we summarize the findings arising from this chapter in a conceptual framework that will inform the case studies and empirical analysis in subsequent chapters.

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. 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 occurs 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 2013). 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. 221). 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; Stam, 2013).
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 & Dodgson, 1994; Nooteboom, 1994; Moore & Davis, 2001).

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 (Eckhardt & Shane, 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 & Levinthal, 1989; Cohen & Levinthal, 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 & Delmastro, 2002; Qian & Acs, 2013). In addition, leadership experience (Stam & Wennberg, 2009), the recruitment of talented students (Mian, 1996) and experienced personnel (Audretsch & Stephan, 1996; Audretsch & Lehmann, 2006) is needed to scale up new firms and ventures.

Both talent and knowledge are therefore important resources for entrepreneurial activity in a knowledge-based economy. 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 (OECD - Directorate for Science, Technology and Innovation, 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 (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, 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 analysed 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 and 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 importance. 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 predominately determine the success of the ecosystem. Networks of entrepreneurs provide an information flow, enabling an effective distribution of knowledge, 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. 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. 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)](image)

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 questions and challenges with regard to whether and how entrepreneurial ecosystems can be governed effectively, and who needs to take up these leadership roles. In the remainder of this study, we address these questions of governance 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 active 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 (Qian & Acs, 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 align in 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.
Later in this report, we will use the conceptual framework outlined in Figure 2 as a starting point for answering our main question, regarding how the interaction between research (knowledge) and education (talent) is coordinated in ways that enable or inhibit productive entrepreneurship in regional ecosystems in the Netherlands.
3 Methodology

3.1 Case delineation

3.1.1 Ecosystem selection
The Netherlands has several regional ecosystems that encompass one or several cities that 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 selection variables reflecting 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 an established governance structure to facilitate the collaboration of education, research and innovation.
- **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 following selection of cases, which score differently on these dimensions:

<table>
<thead>
<tr>
<th>Governance</th>
<th>Performance</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>South-Holland</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>Amsterdam (MRA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utrecht</td>
</tr>
<tr>
<td>+</td>
<td></td>
<td>Twente</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eindhoven</td>
</tr>
</tbody>
</table>

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 regions have a long-standing tradition of ecosystem governance (around Kennispark Twente and the Brainport foundation respectively). South-Holland and Twente perform below the Dutch average with respect to productivity and employment.

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

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

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

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

3.1.2 Regional delineation
Regional development organisations have a somewhat fluid conception of their geographical span of control. Nevertheless, as a rule they focus on a major agglomeration together with the surrounding municipalities. Pivotal municipalities within the selected ecosystem are Amsterdam (for the MRA), Enschede (for Twente), Eindhoven (for Brainport), Utrecht (for Utrecht region) and Rotterdam-The Hague (for South-Holland). Adjacent larger municipalities are recognised as important parts of the ecosystem (for example, Helmond in Brainport, Almere in the MRA and Hengelo in Twente) and thus are included in the sphere of influence. To cover this geographical area in statistical terms we require a spatial-statistical
unit giving sufficient economic and labour market data. Based on the European standard classification this is the NUTS3-level, in The Netherlands the COROP region\(^1\). The different ecosystems have been geographically demarcated as follows:

- The Amsterdam Metropolitan Area = COROP-regions IJmond + Zaan region + Haarlem Agglomeration + Great-Amsterdam + The Gooi and Vecht region + Flevoland\(^2\).
- Kennispark Twente = COROP-region Twente.
- Brainport Eindhoven = COROP-region south-east North-Brabant.
- The Economic Board Utrecht = COROP-region Utrecht (equalling the province of Utrecht).
- The Economic Programme South Wing South Holland = COROP-regions Great-Rijnmond + Delft and Westland + The Hague Agglomeration + Leiden Agglomeration and Bollen region + East South-Holland + Southeast South-Holland (in total equalling the province of South Holland).

![Figure 3: Map of the delineated ecosystems in the Netherlands on COROP level](image)

### 3.2 Comparative background data

The different case studies are enriched with background data on various relevant indicators on labour force, business demographics, GDP growth and R&D and innovation expenditure. These indicators help to set the scene for the ecosystem and reveal the differences in size, scope and growth between them. Most recent data available is used.

\(^1\) The Dutch Central Bureau for Statistics distinguishes 40 COROP-regions in the Netherlands characterized by a large city or agglomeration and the surrounding area.

\(^2\) The Flevoland COROP (equalling the province of Flevoland) is included to cover the municipalities of Almere and Lelystad. The province of Flevoland is not officially part of the Amsterdam 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 use the Dutch average scores as a benchmark. However, in some cases this image can be skewed in favour of ecosystems in more urbanised regions. Since the Netherlands has a very urbanised and economically strong ‘Randstad’ region (including the provinces Utrecht, North Holland, South Holland and Flevoland), 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 (see Figure 34).

3.2.2 Labour force characteristics
The Central Bureau for Statistics (CBS) provides the basic labour characteristics data. The CBS publishes these data yearly for each COROP level (CBS, 2015).

3.2.2.1 Active labour force
To determine the size and growth of the labour force within an ecosystem, we use the active labour force is used as indicator. The Dutch Census Bureau (CBS) defines the active labour force as all persons receiving payment for their work. We use the COROP level data from 2004 until 2014. For this period, the growth of the labour force is based on the Compound Annual Growth Rate (CAGR) 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 be 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:

- lower education is a finished vocational high school degree (vmbo), the first three years of high school (havo/vwo), or a level 1 VET degree
- middle education is a high school degree (havo/vwo) or a finished VET degree at level 2, 3 or 4.
- higher education is a degree from a university of applied sciences or a research university.

In creating the education distributions, the figures on the active labour force were 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 CBS provides business demographic statistics. This is based on the number of establishments, defined as every separate space, terrain or complex that is used by a company for its activities. Each company consists of at least one 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 business 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, a semi-random sample from the ABR, excluding firms with less than 10 employees. The sample includes all the large corporations that spend resources on R&D in the Netherlands. Firms with multiple establishments in a single region were both accounted for in the results of a region. Firms with multiple establishments in different regions were assigned to the region were it was most likely their R&D activities were taking place based on the subsequent R&D survey³. If this gave no decisive answer, the firm was assigned to the region of its headquarters, possibly influencing the accuracy of the analysis.

Due to sample size, there was no data available for 8 out of 40 COROP regions: Leiden Agglomeration and Bollenstreek (South Holland), Alkmaar and surroundings, Gooi and Vechtstreek, IJmond (MRA), Groningen, Zeeuwsch-Vlaanderen, South East Friesland, and South West Overijssel (Remaining).

³ The R&D survey functions as follow-up to the CIS and is held each subsequent year after the CIS to survey firms on their R&D activities more in detail.
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.

In this report, we show R&D and innovation expenditures as a share of Gross Domestic Product (GDP) in 2008, 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, a business newspaper in the Netherlands compiles a list of the fastest growing firms in the Netherlands (based on data from the National Business Register). 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. For the year 2014, this results in a list of 332 firms with information on turnover and employee numbers. Of these firms:

- 175 were classified as small (turnover <2 million Euros)
- 118 were classified as medium (2 - 30 million Euros turnover)
- 39 were classified as large (>30 million Euros turnover) (Het Financieele Dagblad, 2014).

To account for the large share of smaller firms, that are likely to have a better chance of obtaining high growth rates, we compare the ecosystems on the number of gazelles, their turnover and the number of their employees. This is not a representation of the actual entrepreneurial demographics, but does give an indication of the rate of productive entrepreneurship of each ecosystem.

3.2.6 Productivity

We determine productivity by dividing the gross value added (GVA) of an ecosystem region by the volume of labour. All data for the calculation of productivity is derived from the CBS. The gross value added is defined as the value added between production (base price) and the purchase price. To obtain a comparable measure, we divide the regional value added 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, and makes no distinction between full-time and part-time labour. This yields an average amount of value added for each labour year. The data period is from 2004 to 2014. According to the CBS, the data for 2013 and 2014 are preliminary. As of 2010, the data conform to the ESR 2010 guidelines (CBS, 2015).

3.3 Network analysis

3.3.1 Data Characteristics

The database used in analysing innovation networks in the Netherlands is named NETWORKS FOR KNOWLEDGE (NfK). NfK contains all publicly funded or supported innovation projects that are carried out by companies, research institutes, governments and other organisations. This means that either the Dutch government or the European Union has in some way financed or supported the project, which thus makes turns the project’s theme and participants into public information. The database covers innovation projects that have started in the period 2006-2014. The National Business Register provides background information on most organisations, including type of organisation, sector and location. This enables creating a relevant typology (private, knowledge, public and intermediary organisations). However, 27.5% of the
organisations could not be categorised and 7.4% have no address. Table 2 depicts the scale of the database.

**Table 2: scale of NfK database**

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of projects</td>
<td>3270</td>
</tr>
<tr>
<td>Number of unique participating organisations</td>
<td>8366</td>
</tr>
<tr>
<td>Average # of participants per project</td>
<td>2.56</td>
</tr>
<tr>
<td>Companies (SMEs and large corporations)</td>
<td>4973</td>
</tr>
<tr>
<td>Knowledge Institutes</td>
<td>198</td>
</tr>
<tr>
<td>Public organisations</td>
<td>542</td>
</tr>
<tr>
<td>Intermediaries (Industry associations)</td>
<td>350</td>
</tr>
<tr>
<td>Unclassified participants</td>
<td>2303</td>
</tr>
</tbody>
</table>

More details about the dataset, the programme sources and the characteristics of projects and organisations can be found in Annex I.

The nature of the relationship between project partners and the innovativeness of the project can vary depending on the nature of the project, but all are committed through receiving a part of the public funds for the project. Since many of the programmes require the involvement of a knowledge institute, these relationships become relevant for the intensity of public-private partnerships and the role of project-based funding in the Knowledge Triangle.

Notably, this type of data only helps to scratch the surface of the nature of innovation in a regional ecosystem. The limitations of the NfK data especially arise from the following characteristics:

- Sources of public funding have specific requirements for participation. For example, the SIA RAAK funding scheme, intended to engage universities of applied science and SMEs in innovation projects, logically requires participation of these type of organizations. This skews the data to (1) public knowledge institutes and (2) intermediaries experienced in acquiring public funding.
- Most of public R&D stimuli are technological in nature. The European Framework Programme covers a wide variety of subjects, whereas most Dutch incentives are related to the Top Sector Policy, involving strongly technology-driven sectors (see section 4.3.1).
- The Dutch innovation support system relies heavily on tax incentive schemes for R&D assets and labour costs; it does not invigorate cooperation (see section 4.3.2). More than 22,000 firms made use of these incentives in 2014 (Ministry of Economic Affairs, 2015). Data on these schemes are not public and have not been taken into account.
- In terms of absolute numbers and financial size the innovation projects are skewed towards the European programmes: nearly half of the projects have a European public financial source (see also section 4.3.3).

Therefore, the data should be interpreted as a reflection of the network of cooperation incentivised by public funds.

### 3.3.2 Data Selection

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

<table>
<thead>
<tr>
<th></th>
<th>Number of innovation projects</th>
<th>Number of regional organisations</th>
<th>Number of external connected organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainport</td>
<td>632</td>
<td>550</td>
<td>3715</td>
</tr>
<tr>
<td>MRA</td>
<td>912</td>
<td>900</td>
<td>4459</td>
</tr>
<tr>
<td>Twente</td>
<td>419</td>
<td>475</td>
<td>3214</td>
</tr>
<tr>
<td>Utrecht</td>
<td>641</td>
<td>758</td>
<td>4381</td>
</tr>
<tr>
<td>South Holland</td>
<td>1315</td>
<td>1429</td>
<td>4891</td>
</tr>
</tbody>
</table>

In the visualisations in the Results section, only organisations from the ecosystem region itself will be depicted, but the various indicators have all been measured including the connected organisations outside the region.

#### 3.3.3 Method of analysis

Every organisation in the database can be connected to one or multiple projects by a tie or linkage. Some organisations are partner in multiple projects. Doing so for each organisation results in a network of organisations connected through innovation projects. These forms of networks are known as 1-mode networks. The more linkages an organization has, the more central its position in a regional network. 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.

For each organisation the following characteristics are calculated:

- The number of projects in which an organisation is partner.
- The degree of centrality: the number of partnerships an organisation has, indicating the influence an organisation has by its relationships with others (Jackson, 2010).
- The betweenness centrality of the organisation within the network, indicating the influence an organisation has in the network by its position in relation to others (Freeman, 1977).

For the entire ecosystem network, the following indicators are calculated:

- Density: 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: the level of network usage as a share of network potential, by measuring the share of organisations that can be found by another organisation through existing ties in the network (Tichy & Fombrun, 1979).
- Average distance: the amount of resources an organisation needs to find and connect with 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 their characteristics in more detail.

### 3.4 Case studies

#### 3.4.1 Respondent selection

The functioning of each of three ecosystems (MRA, Twente and Eindhoven) was further investigated by qualitative data. This qualitative research has two pillars:
desk research on relevant policy documents,

- interviews with representatives and participants of the ecosystem itself; in order to review all different perspectives on knowledge triangle interaction and governance, the aim here was to interview six respondents for each case study with the following profiles:
  - one or two representatives of an ecosystem governance organisation on both managerial and operational level;
  - a representative of local government responsible for innovation and entrepreneurship
  - representatives of educational institutes (research university, university of applied science and/or a VET school) responsible for innovation and entrepreneurship;
  - an executive of a large corporate consciously locating its offices or R&D within the ecosystem;
  - one or two ‘antitheses’: people that do not necessarily see the benefit of the ecosystem organisation and/or have an outsider’s role.

3.4.2 Approaching respondents
Respondents were approached by e-mail with a short summary of the research project and an invitation to participate. Subsequent telephone conversations then served to determine whether the respondent was positive and an appointment could be made. Most interviews were carried out face-to-face. Two interviews took place by the telephone and two interviews took place via Skype.

3.4.3 Structure of the interview
The interviews were structured using a topic list, allowing the interviewer to continue a line of inquiry and covering all the relevant topics. The average time of an interview was approximately an hour. Annex IV contains the interview protocol.
4 Overview of the Dutch Knowledge Triangle

This section gives a description of the three pillars of the knowledge triangle and the overall state of 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 research universities, 37 universities of applied sciences (UAS) and 69 regional schools for vocational education and training (VET). 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 decline 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 research universities (DUO, 2015).

As from 2011, the Dutch national policy for research universities and universities of applied sciences distinguishes three priorities:

- the quality of education and success rate of students needs to be maintained and improved;
- the differentiation within and between universities must be enhanced, with more designated profiles and more focussed research areas;
- more focus on the valorisation (useful application) of new knowledge.

4.1.1 Research universities

The 13 publicly funded research universities know three segments:

- 3 universities of technology;
- 1 agricultural university (Wageningen University and Research);
- 9 general universities.
Taken together, these universities offer 183 bachelor studies and 566 master studies (VSNU, 2012). Additionally, there are eight Academic Medical Centres (research and education hospitals), each affiliated with a university.

4.1.1.1 Position and strategy
Following national policy, there is a trend towards increasing differentiation in Dutch higher education, by implementing broader bachelor programmes, research masters and honours programmes. Simultaneously, there has been a rise in students enrolled in university college programmes, especially those focussing on liberal arts and sciences (VSNU, 2012). Universities enhance their profiles through a focus on specific research themes that match their track record; this also leads to a sharper profile in educational programmes. More recently, the Dutch government has communicated that, within a 2025 time horizon, research universities have to further reinforce their investments in the differentiation and excellence of their educational offerings and research programmes (Ministry of Education, Culture and Science, 2015).

4.1.1.2 Education funding
Research universities are funded through three main cash flows:

1. government funding: lump sum (for education, research and knowledge dissemination);
2. programme based research funding (publicly financed through organizations for scientific research);
3. project based research funding (public or public-private third parties).

The first financial source is also the largest cash flow and will be elaborated here. The second and third source are relevant for research and will be discussed later in this chapter. The Dutch Ministry of Education, culture and science provides a lump sum for all universities in the Netherlands for both education and research. The lump sum is divided in budgets for respectively education and research, but in practice research universities have some degrees of freedom on the distribution of these resources. The budget largely is based on the number of students and the allocation universities have made amongst themselves. In 2004 the education and research budget spent was 2,681 million Euros, in 2014 this has risen to 3,676 million Euros. In 2014, the average annual costs of student education on a university level amounted to € 7,327 (Panteia, 2015).

As from 2012, 7% of the funding is allocated to performance-based agreements between research universities and the government. These performance-based incentives are intended to reward better performance in (1) the quality of education, (2) student success rates, (3) knowledge dissemination, and (4) profile-enhancing research (Ministry of Education, Culture and Science, 2015).

4.1.2 Universities of Applied Sciences
There are 37 universities of applied science across the Netherlands that receive public funding (including 5 schools in the area of arts). Together, these universities offer 218 bachelor degrees and 60 master degrees. In addition, since 2013 the universities of applied science have launched 80 associate degree (two year) programmes, to bridge the gap between vocational education and higher education.

4.1.2.1 Position and strategy
From the perspective of the innovation system, the UASs have a unique position with their educational tasks on the one hand and their connections to regional business communities on the other. The UASs, like research universities, are subject to regulations and policy for higher education institutes (i.e. enhancing the quality of education and student success rates, and calling for more differentiation in
educational programmes) (Ministry of Education, Culture and Science, 2011). In the research area, UASs are required to:

- specialise in research themes;
- strengthen their research infrastructure;
- ally with other HEIs and the private sector; and
- develop a stronger connection between research and education (Ministry of Education, Culture and Science, 2015).

4.1.2.2 Education funding
The universities of applied sciences are funded through three main cash flows:

1. government funding (for education, applied research and knowledge dissemination);
2. programme based research funding (publicly financed through organizations like Taskforce Applied Research (SIA));
3. project based research funding (public or public-private third parties)

Funding is almost entirely provided by the Ministry of Education, culture and science. The budget for education in 2004 was 1.657 million Euros; in 2014 it had increased to 2.688 million Euros. The budget of an UAS is largely based on the number of students. On average a UAS received € 6.226 for each student in 2014 (Panteia, 2015).

Of the funding of UASs, 7% is performance based. Since 2012, 5% of the funding relates to quality of education (student success rates, increase of excellence of both students and teachers, efficiency) and enhanced profile. Additionally, 2% of the budget is earmarked for the establishment of so-called Centres of Expertise that develop and deliver high-level knowledge in public-private partnerships (Ministry of Education, Culture and Science, 2011).

4.1.3 Vocational Education and Training
The institutes of vocational education are organised regionally, with each region having one ‘regional education centre’ (ROC). Additionally, there are several schools that have a more sectoral focus, e.g. the 4 agricultural centres and 10 schools for specific professions (such as silversmiths and seafarers). In total, there are 69 publicly funded VET schools in the Netherlands. They offer 1380 different education programmes at different levels (with level 1 being the lowest level and 4 being the most advanced) and in different forms. Most important 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. About 80% of VET-students is enrolled in theory based programmes (CBS, 2016). The education programmes follow sector based qualification requirements.

4.1.3.1 Position and strategy
As from 2012, Dutch government has been urging VET institutes

- to improve quality of education (more lessons, better qualified teachers, stricter examination)
- to improve governance, and
- to better cater for the regional labour force demands (Ministry of Education, Culture and Science, 2011).

Rapid changes in economy and business in general and in sectors increase the need for flexible education programmes. Innovation and e.g. digitization ask for structural cooperation between VET institutes and
businesses to adapt education swiftly. The education programmes must be aligned better to prior and following education possibilities and contain the possibility for an excellence track (Ministry of Education, Culture and Science, 2014). Additionally, more attention is paid to learning and training of active workforce (lifelong learning).

4.1.3.2 Education funding
The VET schools are primarily funded by the Ministry of Education and receive some additional funding from the Ministry of Economic affairs. This budget totalled 2.858 million Euros in 2007, increasing to 3.355 million Euros in 2014. The Ministry of Education on average spent € 6.855 on each student in 2014 (Panteia, 2015).

Part of the funding, approximately 400 million Euros, is based on performance in (1) reducing the number of dropouts, (2) increasing the success rates, (3) enhancing the quality of teachers and (4) enhancing the quality of internships. Furthermore, this funding encourages excellence programmes in VET that focus on craftsmanship and skills (Ministry of Education, Culture and Science, 2014).

To stimulate linkages with private partners, the VET schools establish the so-called Centres for Innovative Craftsmanship. These public-private centres aim at improving the quality of technical education in the region in close collaboration with regional private partners. Their profiles are aligned with top sector specialization of their respective regions (Van der Meer, et al., 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 the 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
- stimulating innovation in economically important areas, and
- reducing fragmentation by creating sufficient focus and scale in the separate institutes.

In the nearby future the focus is on creating a profile within an international context, guided by the national Top Sector policy and the European research- and innovation programme Horizon 2020. This has its implications for the characteristics of research and funding for HEIs. The innovation strategy includes establishing public private consortia for knowledge and innovation that require the participation of HEIs (VSNU, 2012). Overall, in 2012 The Netherlands spent 1.85% of its GDP on research and development; 0.75% is publicly financed (OECD, 2012). In 2013 The Netherlands spent 1.98% of its GDP on R&D. According to the Dutch government, The Netherlands is on track to reach its target of 2.5% in 2020 (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 share of the lump sum dedicated to research is transferred from the non-performance based budget to the performance-based budget. From 2000 to 2010 the non-performance based research budget declined from 2 billion to slightly above 1.7 billion Euros (VSNU, 2012).

The second cash flow is being distributed by independent public organisations, especially the Netherlands Organisation for Scientific Research (NWO) that is responsible for grants for research programmes and individual scientists. On average, NWO 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). Additionally, NWO oversees
several specialized research agencies which receive part of this funding. 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 are influential in setting the research agenda of the Netherlands.

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

The national strategy has resulted in a relative decline of the first cash flow and an increase in the second and third cash flows. As a consequence, the research funding agencies have gained influence. The universities responded by creating stronger focus in research programmes, choosing long-term investments in infrastructure and human capital and matching with the Top Sector strategy (VSNU, 2012).

4.2.1.1 Third mission

The research universities have adopted several strategies to cope with the growing importance of their third mission. The establishment of incubators and centres of technology transfer and entrepreneurship have led to an increase in new companies founded by (former) university students and employees. Also the relevance of entrepreneurship education has increased substantially over the past decade. Furthermore, collaboration with private partners has intensified and each university now has made valorisation (the useful application of scientific knowledge) a part of its research structure and human resources policy (VSNU, 2012).

4.2.2 Universities of applied sciences

As of 2001, the Dutch UASs are officially acknowledged as research institutes with a focus on applied research. This is done through the so-called lectorates, branches of the UAS with a specific research task in which lecturers fulfil both a teaching and a research role. The relationship with education is paramount, as insights from the research must be applied in the educational programme.

The strategy of UASs for research primarily focuses on the useful application of (scientific) knowledge. UASs prevent fragmentation by regionally or thematically aligning their investments in infrastructure, bundling of activities and alliances with knowledge institutes, public partners such as healthcare and private partners. Valorisation efforts are required to turn applied research into new products, services, processes and economic activity (Ministry of Education, Culture and Science, 2011).

Since applied research and education in the UAS model are entwined, the first cash flow used for applied research is the lump sum of the ministries, which is described in the Education section. The second cash flow 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 cash flow is project based funding from public and private third parties. A part of this project based research is done within Centres of Expertise which have been launched since 2010. UASs are enabled to establish Centres of Expertise if this adds to developing the discipline and enhancing the profile of the UAS. In Centres of Expertise high quality education is connected with applied research in collaboration with (regional) businesses and public organisations. The centre’s aim is to intensify knowledge spill-overs and valorisation (Ministry of Education, Culture and Science, 2011). Currently there are 28 government funded public-private initiatives (some based on the 2% performance based funding).
in various stages of development throughout the Netherlands of which almost all (26) are affiliated to a Dutch top sector (Van den Toren & Lie, 2014). Additionally, the UASs have been able to establish Centres of Expertise without government funding, using only UAS and business sector funding.

4.3 Innovation policy
As from 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 pivotal point for information concerning innovation and financing, networking and regulatory matters. RVO is the executive organisation for the national innovation subsidy schemes.

4.3.1 Enterprise Policy and Top Sector approach
The Dutch enterprise policy is based on stimulating demand-driven innovation through access to capital, better utilisation of knowledge infrastructure, and use of fiscal incentives (OECD, 2012). In 2011, the Netherlands have reformed their science and technology policies to focus on nine Top Sectors (agro-food, horticulture and propagating stock, high-technology materials and systems, energy, logistics, creative industries, life sciences, chemicals, and water). The selection of these sectors is based on a combination of the intensity of R&D and export success.

The linkages, ambitions and sectoral roadmaps have been 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). For 2014, the TKIs have invested around 814 million Euros in public-private collaborations between businesses and science. From this, 454.7 million Euros was from public investments and 359.2 million Euros was contributed by private partners in cash or in kind (Ministry of Economic Affairs, 2015).

The Top Sector policy focuses at existing sectors and does not automatically provide the exploration of new niches in business and science, making it less dynamic. To address this, three cross-cutting themes have been introduced (ICT, bio-based economy and nanotechnology). Also, some Top Sector committees explore new cross-sectoral opportunities and perspectives. 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 multiple indicators (OECD, 2014).

4.3.2 Human capital agendas and Public Private Partnerships in education
In these designated Top Sectors a sectoral human capital agenda has been defined, highlighting the expected and preferred skill profiles in each of the nine sectors (Van der Meer, et al., 2016). These HCAs include objectives on the quality and quantity of higher and vocational education, stressing the importance of skill development and lifelong learning. In some sectors, the targets have become more tangible and are already being implemented. In other sectors, there is still a long way to go in supporting the open, ambiguous and experimental character of the approach (Jager, et al., 2016). Human capital and education subsequently became a key element of the national Technology Pact of May 2013, realised between government, employers’ associations, trade unions, the education sector and separate regions.

As of 2015, SMEs are increasingly represented in the Top Sectors through projects with TKI financing (between 75% and 90% of the private partners were SMEs in 2014). The MIT-arrangement (see 4.3.3) is one of the instruments that helps foster this participation (Ministry of Economic Affairs, 2015).
In November 2015 a similar pact has been negotiated to increase cooperation between hospitals, healthcare institutions, insurance organisations, universities and vocational education in the healthcare sector.

Already in 2010, the Science and Technology Platform (Platform Bèta Techniek) was given the task to set up top centres for technology and education: Centres for Innovative Craftsmanship (CIV in VET) and Centres of Expertise (CoE in UASs). With a government investment of 250 million Euros, knowledge development and knowledge dissemination can take place. Leading examples are the Centres of Expertise in water technology, automotive, genomics, biobased economy and the Chemelot innovation and learning labs in higher professional education; and the Centres for Innovative Craftsmanship in VET-areas such as logistics; coatings; instrument building; agriculture and food and process technology. These centres promote and stimulate innovation in vocational education and support innovation within firms: students, teachers and UAS-researchers solve real-world challenges or questions and work at innovative solutions to strengthen economic competitiveness. Some centres offer labs and other shared facilities to support SMEs in particular to organize their own R&D. In 2014 the government continued to enhance the collaboration of companies and schools with establishment of the Regional Investment Fund Vocational Education (RIF) in 2014, that can be used by public private partnerships within and outside top sectors.

4.3.3 Entrepreneurship and innovation stimuli

The main package for stimulating R&D within companies is the R&D tax credit facility (WBSO), providing tax reductions on R&D labour costs and other R&D expenditures. Next to this, the innovation fund offers loans and risk capital for SMEs (OECD, 2012). In 2014 nearly 23,000 companies successfully applied for WBSO facilities, of which 97% were SMEs (Ministry of Economic Affairs, 2015; 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, the MiT-arrangement (an instrument aimed at SMEs) provides funding for feasibility studies, innovation vouchers and collaborative opportunities if there is affiliation with a Top Sector. In 2014, 28.7 million Euros was granted to SMEs affiliated to a Top Sector. Overall, in terms of budget the system heavily depends on tax incentives, which have been evaluated as well-designed but may be less suited for more long-term and high-risk innovation activities (OECD, 2014).

4.3.4 Valorisation programme

In 2010, a valorisation programme was started by the ministries of Education, Culture and Science and Economic Affairs. Its aim is to improve the knowledge transfer process in the Netherlands in general. The budget of 63 million Euros is used to finance 13 projects with regional consortia grouped around a higher education institute. Funding was meant to stimulate entrepreneurial education, screening and scouting knowledge transfer opportunities, IP applications, pre-seed funding, proof-of-concept funding, network creation and other activities that contribute to knowledge transfer. For all these activities the programme has quantified goals for the first four years. The objective is that these programmes can continue without government funding in the long term, as the programme is active until 2018 (Panteia, 2015).

A midterm review of the programme from 2010 to 2014 finds that entrepreneurial education and screening activities are well under way in becoming more embedded within higher education. In terms of IP, the technical universities produce the expected number of patent applications, but for general universities this is relatively new terrain, which is a possible reason for their poorer performance. Of the expected 609 patents, only 234 have been realised. Pre-seed funding activities within these programmes have yielded 100 loans with an average size of 35,000 Euros. Additionally, 63 proof-of-concept loans have been distributed by the consortia. Some of the consortia also invest heavily in the formation of knowledge
transfer networks, organising 668 network events for stakeholders in knowledge transfer since 2010 (Panteia, 2015).

4.3.5 European programmes
Dutch knowledge institutes together with private partners have attracted significant levels of funding from the European Horizon 2020 programme, the successor of FP7. In 2014, a budget of 537 million Euros was attracted for R&D projects; 31% of the awarded projects were public private partnerships (Ministry of Economic Affairs, 2015).

4.3.6 Place based policies
To be eligible for innovation funding from the EDRF (European Regional Development Fund), the Netherlands has adopted the research and innovation strategies for smart specialisation (RIS3) of the European Union. Separate regional agendas have been designed for the regions North, East, South and West. These agendas mostly focus on strengthening regional sectoral specializations, 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. Other national strategies aiming at the development of regions are also sectoral in focus. Since each Top Sector is concentrated in a few regions, regional development agencies are involved in the execution of Top Sector policy (AWTI, 2014). As of 2015 new funding for EDRF is part of the new EU program period; the Netherlands is expected to receive 500 million Euros funding until 2020.

Some provinces in the Netherlands have own funds to stimulate R&D, innovation and regional economic development. These funds have been managed by long established regional development agencies. Multiple triple helix (industry-university-government) economic boards have emerged recently in the Netherlands. Several regions were early adopters of this now quickly expanding concept (the cases of Amsterdam region, Brainport and Twente are elaborated in chapter 7, 8 and 9 in this report). These regional organizations are not stimulated nor funded by the national government, but national government strongly cooperates with these boards in regions where they exist. These triple helix economic boards have been arising in response to the regional needs for closer triple helix cooperation that enhances the economic resilience of the region. The Economic Board Groningen is an exceptional example: here, the province of Groningen and the Nederlandse Aardolie Maatschappij (the leading Dutch natural gas producer) collectively invest in regional development to counter the economic consequences of earthquakes caused by gas production.

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
The OECD (2014) observed the following strengths of the Dutch innovation system:

- The presence of multinationals with a global scope, including R&D and innovation.
- Strong technological capabilities and performance of Dutch firms.
- A strong science base with strong research universities and public research institutes, excellent output in terms of the number and quality of scientific publications, and high productivity.
- A strong participation in European Framework Programmes and other international co-operative efforts and networks.
- Innovative approaches, design, and delivery of innovation policy.
• A strong culture of evaluation.

4.4.2 Weaknesses
The OECD (2014) assessed the Dutch innovation system to be relatively weak in the following areas:

• Several aspects of the framework conditions for innovation, for example in the area of financing (new) enterprises.
• The 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, shortage of students in science, technology and engineering.
• Several weaknesses in the culture of entrepreneurship.
• Low graduation success rates in tertiary education.

In the remainder of this report, we will more deeply study several dimensions of knowledge triangles in the Netherlands and interpret these with the Entrepreneurial Ecosystems approach.
5 Knowledge Networks in Ecosystems

As stated in chapter 2, networks of entrepreneurs provide an information flow, enabling an effective distribution of knowledge, labour and capital. Especially in times of technological discontinuity, inter-firm networks are a stabilising factor (De Vaan, 2010). Firms cooperating with public (knowledge) organisations provide a flow of new knowledge, ideas and talent into the private sector. The hypothesis driving the network analysis approach in this chapter is that the more knowledge institutes in an ecosystem are connected to other public and private partners, the more opportunities occur for the generation of knowledge and talent that is relevant for productive entrepreneurship.

5.1 Project intensity

To illustrate the difference between ecosystems we look at project intensity first. Based on the number 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. Table 4 shows the average number of projects per 1000 firms in a region, and compares this with the Dutch average.

Table 4: Project intensity across ecosystems

<table>
<thead>
<tr>
<th></th>
<th>Number of companies in 2014</th>
<th>Number of projects</th>
<th>Projects/1.000 companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>1,363,265</td>
<td>3,270</td>
<td>2,40</td>
</tr>
<tr>
<td>Brainport</td>
<td>62,500</td>
<td>632</td>
<td>10,11</td>
</tr>
<tr>
<td>MRA</td>
<td>247,655</td>
<td>912</td>
<td>3,68</td>
</tr>
<tr>
<td>Twente</td>
<td>44,585</td>
<td>419</td>
<td>9,40</td>
</tr>
<tr>
<td>Utrecht</td>
<td>110,850</td>
<td>641</td>
<td>5,78</td>
</tr>
<tr>
<td>South Holland</td>
<td>274,810</td>
<td>1,315</td>
<td>4,79</td>
</tr>
</tbody>
</table>

Overall, all ecosystems studied have a project intensity beyond the national average, but the Brainport and Twente ecosystems far exceed expectations in number of innovation projects compared to the number of companies residing 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 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 (see figure 6).
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.

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 number 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

The Brainport network has 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 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 as a hub node for different companies. The companies that participate the most, are the high-tech giants NXP Semiconductors, ASML and Royal Philips. Royal Philips is best 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 103 organisations that are not connected to any of the other regional organisations.

<table>
<thead>
<tr>
<th>Projects</th>
<th>632</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisations connected to these projects</td>
<td>4259</td>
</tr>
<tr>
<td>Organisations in regional ecosystem</td>
<td>550 (12.9%)</td>
</tr>
<tr>
<td>Average number of organisations per project</td>
<td>6.74</td>
</tr>
</tbody>
</table>
5.2.2 Amsterdam Metropolitan Area Network

The Amsterdam Network is somewhat fragmented, with only approximately half of the organisations in the main network component. The three HEIs have 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 corporation to appear is Akzo Nobel, also taking a fringe position. In total, 194 organisations are not connected to other regional organisations in the network.

<table>
<thead>
<tr>
<th>Projects</th>
<th>912</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisations connected to these projects</td>
<td>5353</td>
</tr>
<tr>
<td>Organisations in regional ecosystem</td>
<td>899 (16.8%)</td>
</tr>
<tr>
<td>Average number of organisations per project</td>
<td>5.87</td>
</tr>
</tbody>
</table>
5.2.3 The Twente Network

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 corporation that is best 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.

<table>
<thead>
<tr>
<th>Projects</th>
<th>419</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisations connected to these projects</td>
<td>3686</td>
</tr>
<tr>
<td>Organisations in regional ecosystem</td>
<td>476 (12.9%)</td>
</tr>
<tr>
<td>Average number of organisations per project</td>
<td>8.80</td>
</tr>
</tbody>
</table>
5.2.4 The Utrecht Network

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 regional projects. Both the university and the 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.

<table>
<thead>
<tr>
<th>Projects</th>
<th>641</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisations connected to these projects</td>
<td>5131</td>
</tr>
<tr>
<td>Organisations in regional ecosystem</td>
<td>758 (14.8%)</td>
</tr>
<tr>
<td>Average number of organisations per project</td>
<td>8.00</td>
</tr>
</tbody>
</table>
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 largest number of 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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Brainport</th>
<th>MRA</th>
<th>Twente</th>
<th>Utrecht</th>
<th>South Holland</th>
<th>The Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of organisations</td>
<td>4259</td>
<td>5353</td>
<td>3686</td>
<td>5131</td>
<td>6312</td>
<td>8366</td>
</tr>
<tr>
<td>Average partnerships</td>
<td>46.2</td>
<td>42.9</td>
<td>52.5</td>
<td>44.9</td>
<td>40.6</td>
<td>35.5</td>
</tr>
<tr>
<td>Components</td>
<td>44</td>
<td>87</td>
<td>25</td>
<td>63</td>
<td>148</td>
<td>463</td>
</tr>
<tr>
<td>Density</td>
<td>0.0108</td>
<td>0.0079</td>
<td>0.0143</td>
<td>0.0087</td>
<td>0.0064</td>
<td>0.0042</td>
</tr>
<tr>
<td>Connectedness</td>
<td>0.89</td>
<td>0.90</td>
<td>0.96</td>
<td>0.92</td>
<td>0.88</td>
<td>0.84</td>
</tr>
<tr>
<td>Average distance</td>
<td>3.10</td>
<td>3.16</td>
<td>3.02</td>
<td>3.04</td>
<td>3.11</td>
<td>3.18</td>
</tr>
<tr>
<td>Standard deviation of distance</td>
<td>0.765</td>
<td>0.733</td>
<td>0.759</td>
<td>0.688</td>
<td>0.693</td>
<td>0.72</td>
</tr>
</tbody>
</table>

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 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 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 contain 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

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

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

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

In general, it is observed that research 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 UASs 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, research 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 HEIs in MRA are still very central to the network even though their relative share of projects and partners is comparatively lower, because of the larger scale and fragmentation of the network.
The analysis in this chapter provides a snapshot of cooperation incentivised by project-based public funding. This snapshot suggests that ecosystems focussed on high-tech systems, such as Brainport and Twente, are on average more connected and that universities of technology are more connected in terms of projects. This is probably a result of the larger volume of technology-focussed public funding instruments in the Netherlands and the EU and more articulated demand for this type of funding from technology-oriented firms (relative to their non-tech counterparts). Furthermore, UASs have taken up their role of applied research in collaboration with SMEs, reflected in their high levels of connectedness in terms of partnerships with firms.
6 Labour Markets in Ecosystems

In the Knowledge Triangle, new knowledge continually enters the labour market. The focus of a Knowledge Triangle tends to be on higher educated people, because they develop most of the innovative ideas, products and systems. Innovations are likely to change the nature of labour: the innovations of a few R&D professionals in a single firm tend to affect the work of a lot of other workers within the company, but also influence the labour characteristics (quantitative and qualitative) at many other firms (Osterman & Weaver, 2014). This new knowledge is only translated into positive outputs and outcomes for the ecosystem when employees at all levels are available and are able to apply new knowledge. This happens via four paths:

1. Existing employees learn from the changes in their work; they stay in the same position, but the content of their job changes (mostly gradually).
2. In the case of more profound changes in production, some types of jobs will be terminated, and new ones will be created. People that cannot stay in their current position at their current employer can find a similar job at another firm, or switch to another job at the same or another firm.
3. Employees not only switch jobs or employer when their current job is terminated. They may change jobs voluntarily when they think they can realize a better fit between work and their competences and interests. Knowledge and experience that have become obsolete in firm A can become productive in firm B (Parello, 2011). This is an important element of ‘knowledge circulation’ (WRR, 2013).

In all these three routes, post initial training and courses (‘lifelong learning’) are helpful to make these changes happen.

4. Finally, young people come into the workforce with a different education than those who leave the workforce by retirement. So, gradually the skills of the workforce adapt to new requirements.

These paths are all relevant for building productive ecosystems: a large share of well-educated employees and a sufficiently high job mobility enable entrepreneurship in a region. This is a self-reinforcing effect. As more companies requiring skilled and educated labour of a certain type settle in a region, their demand for this type of labour rises 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 below 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 (Neffke & Nedelkoska, 2012; Kok & Ter Weel, 2014).

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 relies 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 (Langlois, 2003). They also are smaller and are thus not always able to provide subsequent job opportunities for 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 (Porter, 2000). This concentration is also used to safeguard the influx of sufficient volumes of well-educated human capital (Leydesdorff, et al., 2006). 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 (SCP, 2015). 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.

In the other chapters of this report we focus on HEIs and consequently on higher educated people entering the labour market. In this chapter we analyse to what extent all members of the workforce are able to adapt to changing circumstances, especially by labour market mobility. In the next section, we will describe sector structure and occupation distribution in each region. What are dominant sectors that consequently have high demands towards higher education? What are dominant occupations and what are specific occupations that illuminate regional focus and specific needs of employers in the ecosystem?
In section 6.4 we will switch to labour market mobility. Sectors fluctuate in the total number of jobs and individual firms establish, grow, shrink or fail. New jobs are created and other jobs are phased out. But also if his or her position is continued, individual workers change occupation and switch employer. By analysing 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 8. When a sector is 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)

<table>
<thead>
<tr>
<th>Region</th>
<th>Agriculture</th>
<th>Manufacturing</th>
<th>Construction</th>
<th>Trade &amp; retail</th>
<th>Transport</th>
<th>Accommodation &amp; food service</th>
<th>ICT &amp; communication</th>
<th>Financial sector</th>
<th>Other services</th>
<th>Rental sector</th>
<th>Government &amp; education</th>
<th>Care &amp; cure</th>
<th>Culture, sport &amp; recreation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>1,2</td>
<td>9,6</td>
<td>3,9</td>
<td>16,9</td>
<td>4,7</td>
<td>4,6</td>
<td>3,1</td>
<td>3,1</td>
<td>6,4</td>
<td>11,3</td>
<td>6,6</td>
<td>16,9</td>
<td>1,7</td>
</tr>
<tr>
<td>Twente</td>
<td>0,7</td>
<td>14,8</td>
<td>5,3</td>
<td>17,3</td>
<td>3,6</td>
<td>4,4</td>
<td>2,0</td>
<td>1,9</td>
<td>4,6</td>
<td>9,5</td>
<td>4,6</td>
<td>19,5</td>
<td>1,3</td>
</tr>
<tr>
<td>Utrecht</td>
<td>0,3</td>
<td>5,5</td>
<td>4,2</td>
<td>16,0</td>
<td>4,1</td>
<td>4,0</td>
<td>6,3</td>
<td>5,0</td>
<td>8,2</td>
<td>9,0</td>
<td>7,9</td>
<td>16,3</td>
<td>1,6</td>
</tr>
<tr>
<td>MRA</td>
<td>0,5</td>
<td>5,7</td>
<td>2,4</td>
<td>16,8</td>
<td>5,7</td>
<td>5,6</td>
<td>5,3</td>
<td>4,8</td>
<td>8,5</td>
<td>14,1</td>
<td>5,3</td>
<td>13,8</td>
<td>2,1</td>
</tr>
<tr>
<td>South Holland</td>
<td>1,6</td>
<td>7,0</td>
<td>4,4</td>
<td>16,8</td>
<td>5,5</td>
<td>4,0</td>
<td>2,8</td>
<td>2,9</td>
<td>7,1</td>
<td>10,8</td>
<td>8,5</td>
<td>16,4</td>
<td>1,7</td>
</tr>
<tr>
<td>Brainport</td>
<td>1,1</td>
<td>15,7</td>
<td>3,5</td>
<td>15,5</td>
<td>3,7</td>
<td>4,2</td>
<td>3,0</td>
<td>2,5</td>
<td>7,3</td>
<td>14,2</td>
<td>5,0</td>
<td>14,5</td>
<td>1,1</td>
</tr>
</tbody>
</table>

Twente and Brainport have a comparatively large manufacturing sector. Twente also has a strong trade sector and healthcare sector. The latter 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; notably, some of the outer parts of the Netherlands have to cope with faster ageing than the Randstad region because of the attractiveness of the Randstad and its big cities for younger people. The MRA and especially Utrecht have a strong focus on the services sector. The province South-Holland is larger than the other regions, and consequently is less specific. The government city The Hague obviously entails 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 9 shows the distribution on an aggregated level, according to 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

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

These changes between 2004 and 2014 are the net result of many changes: people change jobs and change employer. In the remaining part of this chapter we will add information to these CBS figures by using a different dataset that makes it possible to analyse individual changes in professions and employer. CBS provides data on an aggregate level. With the Werk.nl database we can analyse the 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, alternatively, took the initiative to find another 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 10 we display both the distribution of CBS occupation groups and Werk.nl occupation groups.

---

5 Thanks to the Ockham Group who provided us the insights by translating our questions into inquiries for the Werk.nl database, and Maria Derks and Pieter van Os for research support.

6 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.
## Table 10: Distribution in occupations according Werk.nl dataset

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

The CBS figures give an accurate snapshot, while Werk.nl provides detailed figures for those who wanted or did have to change. The number of technical jobs is declining in the Netherlands, implying that the proportion of them in 2014 in the Werk.nl sample is large (because of the higher number of people that have to change occupation). Alternatively, the pedagogical professions have grown, so less people feel forced to apply for another job, which can explain a relatively low proportion in the Werk.nl database. So, the division of jobs at Werk.nl is not representative for a ‘still’ of the labour market, but gives us the opportunity to illustrate to what extent ecosystems differ. We can also compare the shifts between profession groups in five regions with the average shifts in the Netherlands. In the next section we will use Werk.nl figures to explore changes on the labour market in detail.

The following figures reveal the composition of professional groups of those who worked in both 2004 and 2014. First we can look at differences in job composition in five regions ultimo 2014. We see that the ecosystems have a rather similar distribution of profession groups. The biggest differences are visible in technical and manufacturing professions, as this ranges from 13.9 percent in the MRA to 27.2 percent in Twente. Brainport and especially Twente contrast in technological professions as the second biggest group of professions. For the population that had a job in 2014, we also know what their profession was in 2004. For this population, we see in all regions that on balance people have left technological and service professions and entered economic/administrative professions. All regions have similar patterns, but in South Holland and Twente the decrease in technological professions is relatively small.

So, the selected ecosystems differ in job composition especially regarding technological professions. Changes over the boundaries of professional groups seem relatively small when we look at the consolidated effect in ten years. In the next section we will decompose these aggregated figures and we will look at all changes, also within professional groups. We will see that actual changes are much larger.

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7 All figures are rounded off, so the net change sometimes can be a slightly different number than the difference between 2004 and 2014.
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 net decline in jobs of 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 even in a period of 2 years (in this case 2010-2012), 15% of all workers state that the content of their job has changed (SCP, 2015).

For this study we make use of a database with information from the UWV on résumés in the Netherlands. This database contains the résumés 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 ten 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 proportion of employees were given that

1. Stayed in the same occupational group at the same employer
2. Stayed in the same occupational group at another employer
3. Changed to one of the other seven occupational groups or became unemployed

Table 11: Individual changes on the labour market

<table>
<thead>
<tr>
<th>Professional group in 2014</th>
<th>Nation-wide</th>
<th>AGR</th>
<th>ECO/ADM</th>
<th>ICT</th>
<th>MEDI</th>
<th>SO&amp;S</th>
<th>PEDAG</th>
<th>SO/CU</th>
<th>TECH</th>
<th>TRNSP</th>
<th>SERV</th>
<th>NO_JOB</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>AGR</td>
<td>12.1%</td>
<td>11.2%</td>
<td>7.8%</td>
<td>0.4%</td>
<td>0.8%</td>
<td>0.9%</td>
<td>1.3%</td>
<td>1.6%</td>
<td>12.8%</td>
<td>4.8%</td>
<td>13.4%</td>
<td>12.3%</td>
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<tr>
<td>ECO/ADM</td>
<td>0.3%</td>
<td>10.3%</td>
<td>1.3%</td>
<td>0.9%</td>
<td>0.4%</td>
<td>1.3%</td>
<td>3.5%</td>
<td>3.2%</td>
<td>1.8%</td>
<td>6.2%</td>
<td>15.9%</td>
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<tr>
<td>ICT</td>
<td>0.1%</td>
<td>13.8%</td>
<td>9.2%</td>
<td>0.5%</td>
<td>0.3%</td>
<td>1.4%</td>
<td>2.7%</td>
<td>3.6%</td>
<td>1.0%</td>
<td>1.8%</td>
<td>14.7%</td>
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<tr>
<td>MEDI</td>
<td>0.3%</td>
<td>12.0%</td>
<td>0.5%</td>
<td>14.4%</td>
<td>0.3%</td>
<td>2.5%</td>
<td>4.2%</td>
<td>2.9%</td>
<td>0.9%</td>
<td>9.2%</td>
<td>13.2%</td>
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<tr>
<td>SO&amp;S</td>
<td>0.9%</td>
<td>12.5%</td>
<td>1.1%</td>
<td>1.2%</td>
<td>12.4%</td>
<td>1.7%</td>
<td>2.8%</td>
<td>13.4%</td>
<td>8.7%</td>
<td>9.6%</td>
<td>11.0%</td>
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<tr>
<td>PEDAG</td>
<td>0.4%</td>
<td>11.0%</td>
<td>0.8%</td>
<td>1.5%</td>
<td>0.4%</td>
<td>19.2%</td>
<td>7.0%</td>
<td>2.6%</td>
<td>1.2%</td>
<td>7.0%</td>
<td>15.0%</td>
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<tr>
<td>SO/CU</td>
<td>0.3%</td>
<td>16.3%</td>
<td>1.3%</td>
<td>1.5%</td>
<td>0.4%</td>
<td>3.8%</td>
<td>15.0%</td>
<td>37.3%</td>
<td>2.7%</td>
<td>0.9%</td>
<td>7.5%</td>
<td>13.2%</td>
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</tr>
<tr>
<td>TECH</td>
<td>0.8%</td>
<td>5.8%</td>
<td>0.6%</td>
<td>0.4%</td>
<td>0.8%</td>
<td>0.6%</td>
<td>1.0%</td>
<td>13.4%</td>
<td>4.2%</td>
<td>4.7%</td>
<td>19.4%</td>
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</tr>
<tr>
<td>TRNSP</td>
<td>1.1%</td>
<td>9.3%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>1.2%</td>
<td>0.8%</td>
<td>1.4%</td>
<td>11.8%</td>
<td>12.7%</td>
<td>7.6%</td>
<td>14.6%</td>
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<td></td>
</tr>
<tr>
<td>SERV</td>
<td>0.9%</td>
<td>13.5%</td>
<td>0.5%</td>
<td>1.7%</td>
<td>0.6%</td>
<td>1.4%</td>
<td>3.5%</td>
<td>5.4%</td>
<td>3.0%</td>
<td>12.6%</td>
<td>45.7%</td>
<td>11.3%</td>
</tr>
</tbody>
</table>
In Table 11 the row percentages show what the destination was of people that came from a profession in 2004. It also displays which part of the employees stayed in the same occupation at the same employer (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 employer (or have less opportunities to change).

The number of transitions is larger than the aggregated outcomes in the previous section suggest. In all professional groups just 37% (social order & safety professions) up to 65% (economic/administrative professions) stay in their professional group, and the others have changed over the boundaries of their professional group (or are unemployed). The minority of the ‘stays’ fit to their original job, a three to five times bigger proportion changes employer (but is still in the same group of professions). In the period 2004-2014 we mostly see a change towards economic-administrative professions and less often, to service professions and technical professions. However, this group also loses people to other professions.

All five regions can be compared to the national average. 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 Table 12. 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. When comparing the regions with the national average, it seems that the region South Holland is most representative of the country.

Changes in the groups Agricultural, ICT, Medical and Service professions are mostly close to national averages. Nevertheless, all regions show deviations from national averages when concerning changes within occupational groups. Especially in the Technical/manufacturing professions group, many differences from national averages occur. Twente is doing well in job changes within and towards technological professions, MRA and Brainport region have a less than average change of jobs within this group of professions.
We have presented our results on the level of professional groups. We can also zoom in to unique professions. Every region has on average 419 to 453 unique professions. Of these professions we focus on the 100 professions with the highest location coefficient. These are professions that appear relatively often in the region compared to the national average. This is calculated by dividing the number of specific jobs in a region as a ratio of the total in a region, by the number of specific jobs nationwide as a ratio of the total number of jobs nationwide. These professions were compared with the on average 319 to 353 other professions in the region. 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. The results of this analysis are summarised in the next section.

For each region we have determined what the top 20 most practiced professions are and what the 20 most region specific professions are. 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 Consolidation and comparison with education levels

To assess the functioning of the labour market, we have to compare the labour market performance with at least one other element of the knowledge triangle: education. In Table 13 we compare five ecosystems on several key indicators:

- Proportion of higher educated persons as a percentage of active labour force (CBS)
- Increase in higher educated persons (CBS)

---

8 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.
• 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)
• 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

<table>
<thead>
<tr>
<th></th>
<th>Brainport</th>
<th>MRA</th>
<th>Twente</th>
<th>Utrecht</th>
<th>South Holland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Education and job level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion higher educated people (2014) %</td>
<td>35</td>
<td>42</td>
<td>30</td>
<td>45</td>
<td>36</td>
</tr>
<tr>
<td>Increase in higher educated persons (2004-2014) %</td>
<td>+5</td>
<td>+8</td>
<td>+6</td>
<td>+7</td>
<td>+7</td>
</tr>
<tr>
<td>Jobs requiring higher (medium) education (2014) %</td>
<td>43</td>
<td>48</td>
<td>37</td>
<td>51</td>
<td>45</td>
</tr>
<tr>
<td>Increase in jobs requiring higher (medium) education (2004-2014) %</td>
<td>+1</td>
<td>+5</td>
<td>+5</td>
<td>+5</td>
<td>+3</td>
</tr>
<tr>
<td>Average occupation level (1-5)</td>
<td>2.7</td>
<td>2.9</td>
<td>2.6</td>
<td>2.9</td>
<td>2.7</td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specificity: proportion 100 most specific occupations (%)</td>
<td>8</td>
<td>21</td>
<td>16</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Specificity: LC-level that includes top 100 LC</td>
<td>1.31</td>
<td>1.33</td>
<td>1.26</td>
<td>1.34</td>
<td>1.19</td>
</tr>
<tr>
<td><strong>Mobility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No changes in occupation or employer (2004-2014)</td>
<td>13%</td>
<td>15%</td>
<td>14%</td>
<td>11%</td>
<td>12%</td>
</tr>
<tr>
<td>Same occupation, other employer (2004-2014)</td>
<td>30%</td>
<td>38%</td>
<td>30%</td>
<td>29%</td>
<td>29%</td>
</tr>
<tr>
<td>Mobility: another occupation (2004-2014)</td>
<td>43%</td>
<td>28%</td>
<td>42%</td>
<td>43%</td>
<td>43%</td>
</tr>
<tr>
<td>Level specific occupations (100 of approximately 430)</td>
<td>3.1</td>
<td>3.7</td>
<td>2.6</td>
<td>3.9</td>
<td>2.8</td>
</tr>
<tr>
<td>Change in occupation level at top 100 LC</td>
<td>0.19</td>
<td>0.22</td>
<td>0.08</td>
<td>0.27</td>
<td>0.07</td>
</tr>
</tbody>
</table>

We see that there is an enormous growth in human capital especially for higher educated people. The increase varies from 6% in Brainport and Twente up to 8% in the 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 to younger higher educated people. The proportion of higher educated people varies in the same range, from 30% in Twente to 45% 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.

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 (chapter 7). In Twente the increase in job level is similar to the increase in education level.
Amsterdam region and especially Utrecht region have a high proportion of higher educated people, but also a high proportion of jobs that require a higher (or medium higher) education. The rise in education level is absorbed by the regional labour market. Brainport and especially Twente have had a similar rise in higher educated people but still are on lower level, thus constraining the growth in higher level jobs. Rise in job level will lead to productivity rise and especially in region specific jobs people can reach a higher job level with the same education level. Brainport has a small and specific labour market, and Twente profits less from job rise towards specific jobs (although this is the only region where mobility leads towards technical professions).

Figures of distributions in 2004 and 2014 suggest moderate changes. But we have to account for a lot of fluctuation. National figures make it possible to estimate that, in a period of five years 70% of companies has been renewed, 30% of the jobs have been updated and (partly as a result of this job destruction and creation) 50% of the employed persons have changed occupation and/or employer. This fits to our analysis where we see that in a period of 10 years 85% of the workforce has changed occupation and/or employer. This constitutes an enormous potential to bring human capital to the most productive places.

6.6 Conclusions

Ecosystems have a certain specificity in firms and professions. This seems helpful for firms but also for workers. Having a region-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 are 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 use of this potential of increase in occupation level and additional productivity.

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. Also, different from other ecosystems, specific jobs in Twente do not have a higher level than other jobs in the region. When leaders in the ecosystem aim at more knowledge transfer from the education sector towards the labour market, the absorption capacity of the workforce is a challenge. MRA and Utrecht seem to retain most earnings of ecosystem specific firms and jobs. People that change jobs achieve on average an increase in occupation level. Still the increase in human capital (visible in level and increase of the proportion 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.

Labour market policy has only recently come to the agenda of regional boards in the Netherlands. But there appears to be a high potential for guiding knowledge more towards the existing firms and existing workforce by cooperation with vocational education/training and lifelong learning, but also by guiding labour market mobility. Job mobility is high in the Dutch context, but not always as productive for the outcomes of the ecosystem as it can be.
7 The Brainport case study

7.1 Overview

Table 14: overview of Brainport ecosystem economic indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area</td>
<td>Hectares</td>
<td>145.783 ha</td>
</tr>
<tr>
<td>Active labour force 2014</td>
<td>Number of persons and percentage of total Dutch active labour force</td>
<td>370,000 (4.50%)</td>
</tr>
<tr>
<td>Labour force growth 2004-2014</td>
<td>Compound annual growth rate</td>
<td>0.59%</td>
</tr>
<tr>
<td>Gross added value 2014</td>
<td>Gross added value (× €1000) controlled for full time equivalent years</td>
<td>€ 88.5</td>
</tr>
<tr>
<td>Unemployment rate 2014</td>
<td>Percentage of total labour force</td>
<td>7.30%</td>
</tr>
<tr>
<td>Higher educated active labour force 2004</td>
<td>Percentage of total active labour force</td>
<td>30.1%</td>
</tr>
<tr>
<td>Higher educated active labour force 2014</td>
<td>Percentage of total active labour force</td>
<td>35.2%</td>
</tr>
<tr>
<td>Business demographic 2015</td>
<td>Number of businesses and percentage of total Dutch businesses</td>
<td>64,685 (4.56%)</td>
</tr>
<tr>
<td>Business demographic growth 2011-2015</td>
<td>Compound annual growth rate</td>
<td>2.40%</td>
</tr>
<tr>
<td>GDP growth 2011-2014</td>
<td>Compound annual growth rate</td>
<td>1.224%</td>
</tr>
<tr>
<td>R&amp;D expenditure as share of GDP based on CIS 2008</td>
<td>Percentage of GDP</td>
<td>7.86%</td>
</tr>
<tr>
<td>Innovation expenditure as share of GDP based on CIS 2008</td>
<td>Percentage of GDP</td>
<td>8.94%</td>
</tr>
</tbody>
</table>

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 (stylised TU/e), which has its own campus located in the heart of the city of Eindhoven. The Fontys University of Applied Sciences is the other large higher education institute in the region. Most departments of Fontys are located on or near the campus of TU/e, whilst other departments are located elsewhere in the city. Vocational education is provided by three schools: Summa College in Eindhoven, and the Sint Lucas and Ter AA schools in the municipality of Helmond.

7.2.1 Eindhoven University of Technology

The TU/e is a 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 research university since the 1980s and now has 9 different academic departments in the area of science and engineering including architecture, physics, innovation sciences, industrial design and electrical, biomedical, chemical and industrial engineering. In total, these departments offer 11 different bachelor and 22 master degree programmes. The campus of the TU/e, titled TU/e Science Park, provides the infrastructure for education and research but also for new business creation and technology entrepreneurship.
The university has around 5000 enrolled bachelor students and 3200 master students. Additionally it has about 1500 doctoral (PhD and PDeng) students on its campus\textsuperscript{9}. These students are almost all active in the science and engineering domain. The TU/e has over 2000 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. The Innovation Lab aims to (1) facilitate and support collaborative work with corporates and SMEs, (2) develop innovation projects and new business, and (3) stimulate entrepreneurship for technology-driven start-ups. Bright Move, the executive organisation of the Valorisation Programme in the region, manages a pre-seed and proof-of-concept fund that finances knowledge transfer spin-offs in early stages (Panteia, 2015).

7.2.2 Fontys University of Applied Sciences

The scope of Fontys University of Applied Sciences is broader compared to the TU/e, both disciplinary and geographically, as it also has establishments outside of the Brainport region. It encompasses 28 institutes with a wide variety of disciplines and offers 85 different bachelor and 40 master degree programmes. The engineering institutes of Fontys collaborate with the TU/e and are located at the TU/e Science Park. Fontys currently has around 44000 students of which 15000 study in the Brainport region and about 4400 employees.

The activities regarding 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 (located at the Automotive Campus Helmond) and Logistics.

7.2.3 Vocational education

The three vocational schools in the Brainport ecosystem – Summa College, SintLucas and Ter AA – 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 to teach 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 20\textsuperscript{th} 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, currently the world’s largest supplier of lithography machines for the semiconductor industry. In the beginning of the 21\textsuperscript{st} century, Philips scaled down and divested parts of its electronic divisions such as semiconductors, optics and x-ray systems. These divestments in turn provided the foundation for many new companies in the high-tech systems sector, including NXP semiconductors, FEI and PANalytical. Other early economic drivers of the Eindhoven economy were companies like truck manufacturer DAF and household products manufacturer Brabantia.

\textsuperscript{9} Based on the annual report of TU/e and census data from 2013 and 2014 (source: DUO)
The high-tech expertise of Eindhoven and the surrounding municipalities have led to the region being dubbed ‘Brainport’, as a juxtaposition to the other key assets of the Dutch economy: the airport region (Amsterdam Schiphol) and the seaport region (Rotterdam). 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 currently includes representatives of (1) all the major higher education institutes and vocational schools in the region, (2) several municipalities, (3) the provincial government, and (4) large firms and industry associations. The board is chaired by the mayor of Eindhoven.

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 counts 18 employees, many of which are responsible for one of the themes of Brainport Development.

The Brainport region has a rich history of place-based policies for knowledge development and innovation. 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 and is used for 80% of the company’s worldwide R&D.

These leading companies and their relationships with HEIs can be traced back to the findings from the network analyses in chapter 5. In that chapter, we observed that ASML, NXP and Philips all have strong positions in terms of the number of innovation projects in their portfolio. Both the TU/e and Fontys have also placed themselves in a central position in the network and collaborate with both the large firms and SMEs.

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 and strengthening the economy. Its marketing strategy brands the region as an international high-tech hotspot. Brainport Foundation has formulated a so-called ‘adaptive strategy’ in 2015, 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. At the heart of this adaptive strategy is the need to match and develop the key competences of the region with the grand societal challenges.

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, agriculture 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 projects will be publicly or privately funded, or by 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 three mayors with campuses in their municipalities (Helmond, Veldhoven and Best) also serve as board members. In this board, five persons represent the industry and four represent knowledge institutions: TU/e, Tilburg University (an alpha and gamma university just outside the Brainport region) Summa and TNO. The board gathers bimonthly and the executive committee meets every six weeks. The agenda is prepared by the executive organisation Brainport Development.

The 21 municipalities in the region are organised in Metropolitan Region Eindhoven (MRE). Eindhoven is by far the largest municipality in the region (30% of total inhabitants) 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 and 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.

Brainport Industries is a network organisation which unites around 300 1st, 2nd and 3rd tier suppliers of original equipment manufacturers (OEMs) 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 very capital intensive, the BOM is an important source of additional funding.

7.4.2 Commitment of firms, knowledge institutions, and government
The major regional stakeholders are all represented within the board of the Brainport Foundation, 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 scale in education and research through collaboration. The Fontys UAS has co-located its engineering schools at the TU/e Science Park 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 subsequent higher education institutes such as Fontys.

All of the HEIs have also 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 comes to 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 affiliated with the top sector High Tech Systems and Materials with a focus on robotics, mechatronics in agriculture and 3D printing, the other focusing on 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 rather cooperative in nature. 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 focussed 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, 10,000 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. Brainport Development’s staff and financial capacity is limited, whereas the TU/e and its Innovation Lab have access to a much more substantial pool of human and other resources to start new initiatives and sustain them.

However, there is some scepticism amongst the interviewed within 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. The organisation is funded by its stakeholders, such as the 21 municipalities, dependent on the results of its activities and performance. The organisation is perceived as being present at every new initiative but not always capable of completing a project. As such, Brainport Development is designed as an effective marketing and broker organisation but is expected to change its role into 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 few graduates for the SMEs.

The local government attempts to facilitate and foster the ecosystem by improving the quality of life, accessibility 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 Centre 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 actively transfers knowledge to firms in the region and initiates, facilitates and completes projects that aim to improve the knowledge triangle;
- an active network organisation that facilitates the collaboration between public and private parties and aligns initiatives with the strengths of the region, but deliberately spins out these initiatives (if they are viable) 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 perceive 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 underdeveloped for the future;
- the ecosystem is very dependent on several large manufacturers;
- 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

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area</td>
<td>Hectares</td>
<td>406,054 ha</td>
</tr>
<tr>
<td>Active labour force 2014</td>
<td>Number of persons and percentage of total Dutch active labour force</td>
<td>1,265,000 (15.40%)</td>
</tr>
<tr>
<td>Labour force growth 2004-2014</td>
<td>Compound annual growth rate</td>
<td>1.05%</td>
</tr>
<tr>
<td>Gross added value 2014</td>
<td>Gross added value (× €1,000,-) controlled for full time equivalent years</td>
<td>93.4</td>
</tr>
<tr>
<td>Unemployment rate 2014</td>
<td>Percentage of total labour force</td>
<td>7.45%</td>
</tr>
<tr>
<td>Higher educated active labour force 2004</td>
<td>Percentage of total active labour force</td>
<td>34.2%</td>
</tr>
<tr>
<td>Higher educated active labour force 2014</td>
<td>Percentage of total active labour force</td>
<td>41.6%</td>
</tr>
<tr>
<td>Business demographic 2015</td>
<td>Number of businesses and percentage of total Dutch businesses</td>
<td>259,905 (18.33%)</td>
</tr>
<tr>
<td>Business demographic growth 2011-2015</td>
<td>Compound annual growth rate</td>
<td>3.42%</td>
</tr>
<tr>
<td>GDP growth 2011-2014</td>
<td>Compound annual growth rate</td>
<td>1.730%</td>
</tr>
<tr>
<td>R&amp;D expenditure as share of GDP based on CIS 2008</td>
<td>Percentage of GDP</td>
<td>1.14%</td>
</tr>
<tr>
<td>Innovation expenditure as share of GDP based on CIS 2008</td>
<td>Percentage of GDP</td>
<td>1.67%</td>
</tr>
</tbody>
</table>

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 of Amsterdam. The Amsterdam HEIs count more than 10,000 students (which is 12% of all Dutch students at universities for applied science, and 22% of all Dutch university students). Both UvA and VU have their own academic medical centres.

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. These departments offer 66 bachelor and 260 master degree programmes. It is located on four city campuses, including the Amsterdam Science Park - 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 South Axis of the city of Amsterdam. The Free University offers 50 different bachelor and 122 master degree programmes.

8.2.3 Amsterdam University of Applied Sciences

The Amsterdam University of Applied Sciences (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 unite research capacity: Amsterdam creative industries, Urban Management, Urban Vitality, Urban Technology, Entrepreneurship (theme), and Urban Education (theme). The HvA has 40 lectureships.

The University of Amsterdam (UvA) and the Amsterdam University of Applied Science (HvA) have a combined Executive Board. Main purposes for close cooperation were a better match between students and HEIs, innovation of education, 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 (AAA). 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, especially in science and engineering.

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.

The technology transfer offices of UvA-HvA, VU and both academic medical centres have formed a new collaborative entity: Innovation Exchange Amsterdam.

8.2.4 ROC Amsterdam

The largest institute for vocational education and training is the ROC Amsterdam, with 36,000 students, of which 27,000 are enrolled in vocational education programmes. The ROC Amsterdam has locations in Amsterdam, Hoofddorp, Hilversum and Amstelveen, and thus caters large parts of the MRA ecosystem. ROC Amsterdam and ROC-institutes in surrounding provinces increasingly cooperate to provide an efficient distribution of vocational education in the Amsterdam Metropolitan Area. An example of strong relationship between the regional economic clusters and VET is the Airport College. ROC van Amsterdam also collaborates with two Universities of Applied Sciences (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 the cities of Almere and Lelystad (province of Flevoland) are 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, following a decline in inhabitants and economic prosperity during the 1960s and 1970s. In this latter period Amsterdam lost a large number of manufacturing industries like printing and apparel. The economic structure of the city of Amsterdam now largely depends 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 diversified economic structure, including an important food processing industry (Zaan region), steel manufacturing (IJmond), 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 locations 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”. It was only in 1996 that 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), the Amsterdam Internet Exchange (AMS-IX, the world’s leading internet exchange) and 130 companies. In 2015 the Knowledge Mile was launched, a collaboration 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 includes 36 municipalities, 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 development. The coordination of regional economic policy is executed by the Platform Regional Economic Structure (PRES), chaired by the alderman of Economic Affairs of the City of Amsterdam. PRES oversees several organisations dedicated to 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 collaboration for innovation).

The Amsterdam Economic Board was established 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. The Kenniskring provided meet-ups between captains of industry, researchers and public bodies on a regular basis. The main goal was the reinforcement of the local knowledge infrastructure through the exchange of trends and ideas. Collaborative projects between firms and HEIs were a side effect, but no main purpose. The Amsterdam Innovation Motor (2004) was an important operational spin-off, stimulating entrepreneurship and innovation by means of projects in four
industries/themes (creative industries, life sciences, ICT and sustainability). In its regional review, the OECD in 2010 concluded that 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 both Kenniskring Amsterdam and Amsterdam Innovation Motor merged into the Amsterdam Economic Board.

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 invigorate the position of seven (and later eight) clusters in the metropolitan area (creative industries, knowledge intensive business services, logistics, ICT, life sciences, food & flowers, tourism, manufacturing) 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 a better match between education and labour market, the provision of a highly qualified workforce especially in the fields of ICT and technology, and international talent.

The Amsterdam Economic Board has 20 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, previous member of the Amsterdam city council (1990-1998), and minister of “Housing, Neighbourhoods 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 AEB as a platform for collective action. The AEB has been able to build upon existing networks and social capital, although these predecessors have been informal and non-committal. Part of the structure of AEB are two networks, one being the growing Amsterdam Network Council (paid membership, uniting nearly 150 influencers from large corporations, governments and knowledge institutions), the other being Young on Board (11 members, functioning as a liaison between young professionals and AEB).

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 AEB. Financial services, an important sector in the Amsterdam economy, is not represented directly; ING has been a board member until 2015.

Interviewees broadly share the observation that the AEB is not very much associated with the startup community in the Amsterdam region. The flourishing fintech startup community perceives difficulties to connect itself to the financial corporate world and its educational system. The AEB branch Young on Board links young professionals - not necessarily start-ups. One interviewee observed that ‘for start-ups there appear to be other focal points like [the accelerators] Rockstart and StartupBootcamp’. There are indirect connections between start-ups and the AEB, through projects but also through the Amsterdam Network Council. AEB and Startup Amsterdam, the startup programme initiated by the City of Amsterdam, collaborated on the organization of the Startup Amsterdam Capital Week. Connecting with and commitment from SMEs, in all sectors stretching from creative industries to manufacturing, is also difficult.

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 actively seeks collaboration with corporations, and was active in the constitution of the regional Knowledge & Innovation Agenda.
• The Free University on the executive board level aligns its strategy and actions with the regional ambitions.
• The Amsterdam University of Applied Science has seven local knowledge centres (e.g. health, education, social innovation, engineering, digital media) and 54 lectureships, 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 characterized 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, representatives from more knowledge-intensive new industries, like fintech, have been identifying 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 competition, even where collaboration to set up new programmes would be more appropriate and 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 AEB initiative that is broadly supported, is the Human Capital Agenda. This policy instrument should provide a better balance between (local) industry needs and educational propositions. Additionally, 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 AEB. At the start, the AEB could build upon the fundament of the seasoned all-government platform PRES. This platform has been able to provide finance and staffing of the AEB, and continues to do so. PRES also could be considered a living lab for regional cooperation between local governments. The AEB extended this cooperation to HEIs and enterprises. AEB aims to extend also its funding and staffing to the triple helix.

However, there are signals that local politicians sometimes prefer to launch a policy initiative under their own municipal signature instead of a collective, regional signature. Startup Amsterdam and Amsterdam Institute for Advanced Metropolitan Solutions (AMS) are two local examples. The latter was initiated after an idea by New York’s then-mayor Michael Bloomberg to set up a competition for alliances of research universities, UASs and third parties to develop a new research institute tackling metropolitan challenges. In Amsterdam, the competition was won by the alliance of Delft University of Technology / MIT / Wageningen University & Research. The establishment of AMS follows the completion of the ambitions to create "Harvard on the Amstel", by means of excellent university tracks. This resulted in the
establishment of the Duisenberg School of Finance, Amsterdam University College, and THNK (creative leadership).

8.4.3 Functioning of governance

There are different views on whether the AEB 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 AEB, 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 AEB would not have existed.’ Also the energy and commitment of individual members of the Amsterdam city council is widely praised.

The AEB 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 AEB) has been transferred to other parties. This role is thought to suit industry organizations and municipalities 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 AEB 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 in 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 has to deal with a very diversified economic structure and strong entrepreneurial dynamics:

- The governance appears to have become increasingly adapted to the diverse structure of the regional economy, moving its focus from sectors to societal challenges, a turn that paves the way to cross-sectoral and open innovations.
- The ecosystem seems to be largely driven by self-organization, without a firm guidance or steering by the AEB.
- 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 appear to be:

- the lack of connections of startup communities with the AEB and the ensuing limited entrepreneurial leadership in the entrepreneurial ecosystem;
- the lack of entrepreneurial leadership might also be an obstacle in the necessary adaptation of educational programmes - although there are some good examples of industry-led educational innovation;
- the wide variety of governmental actors (municipalities, regional authorities, two provinces) carries the risk of slowing down effective governance and collective action. In that sense, the recent collective policy agenda for MRA might be considered a milestone.

However, the MRA region appears to entail a huge capability for bottom-up self-organization, enabled by the density of entrepreneurial individuals, and the density and diversity of ventures, skills and human talent. As a result, the constraints previously listed might not be very binding for the performance of the region.
9 The Twente case study

9.1 Overview

Table 16: overview of Twente ecosystem economic indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area</td>
<td>Hectares</td>
<td>150,371 ha</td>
</tr>
<tr>
<td>Active labour force 2014</td>
<td>Number of persons and percentage of total Dutch active labour force</td>
<td>298,000 (3.63%)</td>
</tr>
<tr>
<td>Labour force growth 2004-2014</td>
<td>Compound annual growth rate</td>
<td>0.41%</td>
</tr>
<tr>
<td>Gross added value 2014</td>
<td>Gross added value (× €1000) controlled for full time equivalent years</td>
<td>75.9</td>
</tr>
<tr>
<td>Unemployment rate 2014</td>
<td>Percentage of total labour force</td>
<td>7.60%</td>
</tr>
<tr>
<td>Higher educated active labour force 2004</td>
<td>Percentage of total active labour force</td>
<td>24.0%</td>
</tr>
<tr>
<td>Higher educated active labour force 2014</td>
<td>Percentage of total active labour force</td>
<td>30.1%</td>
</tr>
<tr>
<td>Business demographic 2015</td>
<td>Number of businesses and percentage of total Dutch businesses</td>
<td>46,205 (3.26%)</td>
</tr>
<tr>
<td>Business demographic growth 2011-2015</td>
<td>Compound annual growth rate</td>
<td>2.20%</td>
</tr>
<tr>
<td>GDP growth 2011-2014</td>
<td>Compound annual growth rate</td>
<td>-0.003%</td>
</tr>
<tr>
<td>R&amp;D expenditure as share of GDP based on CIS 2008</td>
<td>Percentage of GDP</td>
<td>1.05%</td>
</tr>
<tr>
<td>Innovation expenditure as share of GDP based on CIS 2008</td>
<td>Percentage of GDP</td>
<td>1.73%</td>
</tr>
</tbody>
</table>

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 behavioural sciences as well as in engineering. It currently has 10,000 enrolled students and about 3,000 staff members. In line 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. The UT has been awarded the prize of most entrepreneurial university in both 2013 and 2015 and is regarded as one of the leaders in entrepreneurship and venturing. The Business and Technology Centre Twente meanwhile manages four properties near and on the campus of the university where incubators and high-tech firms can locate themselves and gain access to additional services such as administration and coaching (Panteia, 2015).
9.2.2 Saxion University of Applied Sciences
Saxon was established in 1998, as a merger of two schools. Saxion now is a UAS 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. In line with the region’s profile, one spearhead of Saxion is high-tech systems and materials in which it aims to realise crossovers between different areas of application. 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 centred around agriculture and services, and to a lesser degree on the tourism and transportation sectors. Until the 19th century, 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 through highly creative entrepreneurship, 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). In the wake of the textile industry, a large manufacturing industry arose with companies like Stork and Hazemeijer. Moreover, the Twente region also gave 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 is now also open for other firms.

In recent years, an opposite movement is also visible as companies such as Foseco and Apollo have relocated their R&D activities to Twente because of the business climate and the access to knowledge and talent. Moreover, several fast-growing firms (e.g. Undagrid and RingCredible) have recently moved to the Twente region, which also suggests that the region is becoming increasingly attractive.

Overall, the knowledge networks in the Twente region are heavily centred 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. To stimulate informal network formation, Powered by Twente organises around 150 events a year for the Twente stakeholders (Panteia, 2015).

9.4 Functioning of the ecosystem

9.4.1 Governance structure

Next to the two higher education institutes (the University of Twente and Saxion University of Applied Sciences) and 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, which has the legal status of a foundation. Kennispark Twente’s mission is to further ‘develop an innovative entrepreneurs’ 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 start-ups: 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 meet 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 metrics 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. The committee’s report 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 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 labour 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 fulfil this role, but instead many start-ups 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 venture 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 start-up 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 institute (or other type of applied research organization) 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 centre 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 (including headquarters) in Twente, which makes the regional ecosystem largely dependent on start-ups 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 ‘start-up 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 (previous CEO of Stork), 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 enhance 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 capability and added value (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 start-ups as well as SMEs and large corporations have access to, given limitations arising from the local labour market, and so forth;
• a current regional profile around “High Tech Systems and Materials” that in the longer run may not be sufficiently distinctive to attract new investors, companies and knowledge institutes.
10 Assessment and Conclusions

This report draws on a study of knowledge triangles of research-education-innovation within Dutch entrepreneurial ecosystems. Knowledge triangles do not evolve in a vacuum, but are part of a broader set of interdependent actors and factors that, if coordinated in an adequate way, might enable productive entrepreneurship within a particular territory. We have especially focused on the role of regional governance (i.e. networks and leadership) in the knowledge triangle and the entrepreneurial ecosystem more broadly. This is reflected in the main question of this report: How is the interaction between research [knowledge] and education [talent] coordinated [by networks and leadership] in ways that enable or inhibit productive entrepreneurship in regional ecosystems in the Netherlands?

In this final chapter, we first assess the outputs and outcomes of the ecosystems studied. Second, we explore and compare the role of knowledge networks and especially leadership on the functioning of regional ecosystems. The final section describes the key conclusions arising from this study.

10.1 Assessment of the ecosystems

A well-functioning entrepreneurial ecosystem delivers high rates of entrepreneurial activity and ultimately secures high levels of aggregate value creation. In this study, we are particularly interested in productive entrepreneurship, that is, forms of entrepreneurship in which new value is generated not only for the business owner, but also for the economy at large. A measure frequently used for productive entrepreneurship is the prevalence of high-growth firms, which have identified a business opportunity and are demonstrating the capacity to scale up their business and fulfil societal demand (Stam et al. 2012). Other relevant, but harder to measure, indicators of productive entrepreneurship might be networks of small and young firms, and intrapreneurship in SMEs and large corporations. Table 10.1 shows the absolute number of gazelles per region in the Netherlands in 2014. In absolute terms, MRA and South-Holland stand out. However, more interesting is the relative prevalence of gazelles, shown as their occurrence in the ecosystem compared to the average occurrence in the Netherlands. This shows that MRA and especially Utrecht have the highest outputs, with the other regions performing better than the average of the non-case study regions in the Netherlands, but still below national average, especially the Twente region.
Figure 13: Gazelles distributed over ecosystems (Het Financieele Dagblad, 2014), edited by the authors

Table 17: Gazelles, prevalence and rate per region (Het Financieele Dagblad, 2014), combined with CBS data and edited by the authors

<table>
<thead>
<tr>
<th>Region</th>
<th>Prevalence</th>
<th>Share (%)</th>
<th>(prevalence/business population)</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainport</td>
<td>15</td>
<td>4,5</td>
<td></td>
<td>0,99</td>
</tr>
<tr>
<td>MRA</td>
<td>69</td>
<td>20,7</td>
<td></td>
<td>1,13</td>
</tr>
<tr>
<td>Twente</td>
<td>10</td>
<td>3,0</td>
<td></td>
<td>0,92</td>
</tr>
<tr>
<td>Utrecht</td>
<td>50</td>
<td>15,1</td>
<td></td>
<td>1,89</td>
</tr>
<tr>
<td>South-Holland</td>
<td>65</td>
<td>1,6</td>
<td></td>
<td>0,97</td>
</tr>
<tr>
<td>Remaining NL</td>
<td>123</td>
<td>37,0</td>
<td></td>
<td>0,81</td>
</tr>
<tr>
<td>NL (total)</td>
<td>332</td>
<td>100</td>
<td></td>
<td>1,00</td>
</tr>
</tbody>
</table>

Twente’s performance in generating this type of productive entrepreneurship thus appears to be the lowest, in terms of the net growth of the number of businesses (reported in Chapter 9) as well as the relative number of gazelles. Even though the University of Twente and other HEIs do a very good job in nurturing spin-offs, the region seems to lack other ecosystem elements and conditions (outlined in Chapter 2) that enable the subsequent growth of start-ups.

Most important for the region as a whole, is the aggregate value generated by the ecosystem (as discussed in section 2.2). In this respect, the most adequate measure is the value added per person in the region (see Figure 14). Other relevant indicators are the growth of employment (see Figure 15); this indicator provides a measurement of the inclusiveness of the productivity growth (evident from Figure 14).

The value added in the case study regions and the Netherlands at large shows an upward trend in the last decade, with a clear setback after the 2008 financial crisis. The Brainport region faced the most severe setback, but also revealed the greatest rebound, from the worst position after the financial crisis, to the second best position at the end of the decade. This high volatility is a direct implication of Brainport’s focus on high tech systems (as discussed in chapter 7). Twente started with the lowest position and remained there after the 2008 financial crisis, while it suffered hardly any setback during the crisis. MRA shows the best performance in terms of value added, and increased the difference with other regions in
recent years. Utrecht started with a second best position, and continued to grow its value added, with hardly any setback during the crisis.

Figure 14: Productivity in terms of added value in ecosystems compared

Utrecht and MRA also outperform the other regions with respect to employment growth in the (post financial-crisis) period 2011-2015 (more than 3% per year on average), while Brainport and especially Twente have experienced an employment growth rate below the national average of 2.7%. This suggests the MRA and Utrecht regions are better positioned to absorb the growth arising from entrepreneurship in ways that are beneficial to the labour force in the region.

Figure 15: CAGR of ecosystems, based on employed persons, 2004-2014
Employment growth and competitiveness (cf. value added) have always been on the agenda of regional economic boards of the regions studied in Chapters 7 to 9. More recently, the need to tackle societal challenges has become more prominent as a desired outcome of the ecosystem. However, we do not yet have adequate indicators of this broader outcome, nor can short-term effects be expected: the efforts required to tackle grand societal challenges (such as arising from climate change and an aging population) require a relatively long time period to come to fruition.

The Amsterdam and Utrecht entrepreneurial ecosystems appear to perform very well, in terms of gazelles, added value, and employment growth, while Brainport caught up in a remarkable way with respect to added value, and Twente lags behind the national average on all output and outcome measures. Of course, each regional ecosystem does not operate in isolation, that is, some of the value added and other economic effects of entrepreneurial activity in one region spill over to other regions (cf. the relocation of Booking.com from Twente to MRA and the opening of a third location of Twente founded (1993) high tech firm Demcon in Eindhoven in 2011). More structurally, large OEMs like ASML and TomTom created and located in one region are also likely to generate economic growth elsewhere — by means of their supply chains that include many firms located in other regions. In this report, we did not analyze these inter-regional economic effects of entrepreneurial activity, but assumed that each region is a self-contained entity in terms of ecosystem elements and outcomes. This is in line with the prevailing perspective of all regional boards. These boards define their desired outcomes for a formal region, that equals the domain of the specific government(s) that are represented on the board (and also are important for funding and/or providing capabilities in policy development). At the same time, however, they acknowledge that the scope of entrepreneurial ecosystems extends beyond these formal borders.

The MRA and especially Utrecht have a high proportion of higher educated people, but also a high proportion of jobs that require a higher (or medium higher) education. The rise in education level is absorbed by the regional labour market. Brainport and especially Twente had a similar rise in higher educated people but still are on a lower level, thus constraining the rise in growth in higher level jobs. A rise in job level (as described in chapter 6) will contribute to rising productivity. Especially in region specific jobs, people can reach a higher job level with the same education level. Brainport has the most specific labour market whereas Twente profits less from job rise towards specific jobs (although this is the only ecosystem were mobility leads towards technical professions).

With this limitation in mind, the output differences between several Dutch regions raise the question to what extent any regional governance effort explains these outcome patterns. With this study, we can only hint at the potential causalities involved. For example, some of the regional boards in the Dutch regions we studied appear to have successfully created a shared vision on and ambition for the future of the region. In order to test the impact of these forms of regional governance, we need to adopt a long-term perspective to trace the (relative) effect of regional governance on entrepreneurial activity and, ultimately, the aggregate value creation in these regions. In the next section, we will summarize our findings on the nature and evolution of regional governance in the case studies in previous chapters, and suggest some possible causal links to the outputs and outcomes of the entrepreneurial ecosystems.

10.2 Governance of the Knowledge Triangle

In this report, we focussed on two elements of the regional governance of the knowledge triangle: inter-organisational knowledge networks and leadership via regional economic boards. The knowledge networks are mechanisms for providing connection, whereas leadership involves a mechanism for giving direction. Connections between education, research and entrepreneurial actors are at the heart of the
knowledge triangle, while direction is needed to target the most binding constraints in the ecosystem and to facilitate collective action in tackling key socio-economic challenges in the region.

In each region, the knowledge networks are dominated by different types of organizations. In Twente, the two HEIs are most central, also due to the absence of very large Dutch corporations. The knowledge networks in Amsterdam are dominated by a larger set of HEIs. In the Brainport region two large OEMs as well as two HEIs are central. With respect to the nature of knowledge networks, the Twente region stands out in many respects: it has the highest average number of partnerships, the highest density, the highest connectedness, and the lowest average distance between nodes. The Twente region thus appears to be more connected. The other regions do not seem to differ substantially with respect to the nature of knowledge networks within their territory, all having better scores than the national average, but not as high scores as the Twente region.

The exceptional characteristics of the knowledge network in Twente can be explained from its relatively small size (e.g. in terms of the total number of firms), the acquisition of its key firms and consequently diminishing R&D position of its home grown companies, and the deliberate strategy to focus the development of knowledge networks around two HEIs (especially via Kennispark Twente).

Overall, the regional economic boards in all three case study regions aim to make HEIs and other educational institutes more relevant for their regional ecosystem, and share a triple helix-based approach in which key stakeholders are frequently consulted. Even though the regional economic boards in all three case study regions have adopted a regional governance approach, centred around an ongoing dialogue between key agents in the region, they differ substantially in several key domains. The remainder of this section outlines four major differences, and then concludes with a note on the complementarity of the various regions in the Netherlands.

1. The ability to prepare the region for the future

The Brainport region faces the huge challenge to make its successful high tech systems ‘recipe’ more future-proof, by enabling more bottom-up new economic activities in order to make the region more resilient and less dependent on a limited number of high-tech OEMs. Amsterdam region competes with metropolitan areas like London and Berlin in attracting foreign firms and high level professionals. The growing collaboration between HEIs in the MRA region may facilitate the development of new knowledge (networks) and thus make it more competitive compared to these metropolitan areas. The Twente region has an excellent track record in new business incubation and creation, but its capacity to nurture and retain fast growing firms is relatively low. This illustrates that regions differ significantly in how they (as an entrepreneurial ecosystem) are configured, and therefore also face fundamentally different challenges in terms of economic growth and competitiveness.

2. The coordination of and emphasis on industrial clusters

The three regions studied earlier in this report are distinct in their place-based strategies and policies. The Twente region has a well-established Kennispark, entirely governed by public agents. The Brainport region has deliberately developed a larger portfolio of campuses, some initiated by public agents and others by private agents. MRA can draw on a large number of attractive locations, including a Science Park, an emerging university campus, and an abundance of market-driven co-working spaces that serve the community of start-ups and scale-ups — even in the absence of a regional strategy for industrial clusters. This suggests that a collective sense of urgency about the local economic situation (e.g. in
Twente and Eindhoven in the 1980s respectively 1990s) may be a critical condition for any regional leadership to initiate a strategy for industrial clusters. In the MRA, this scattered pattern of locations with each its own strategy and client base, did not hinder rise and growth of start-ups. The Amsterdam region decided to make use of these dynamics and to start a cooperative strategy to create more societal value from its beta scientific knowledge (concentrated at Amsterdam Science Park).

3. The balance between top-down steering and bottom-up leadership

In regions with a relatively homogenous and interwoven economic base and knowledge network, like Brainport, there is more chance for effective collective action due to the shared understanding of how economic value is created in the region. MRA’s diversity in industries and knowledge institutes and its almost autonomous economic development constrain the ability of a regional board to steer it in new directions. In this type of highly distributed setting, bottom-up leadership in emerging niches might be much more effective.

Regarding the ability to guide a region in a particular direction, targeted industrial policies seem to have become a remnant of the past. All three regions studied in this report followed, until recently, an industrial cluster strategy: backing strong sectors. Two of the regional boards in the Dutch regions we studied are now moving away from this type of industrial policy in favour of an approach aimed at grand societal challenges. For example, the AEB is increasingly addressing these societal challenges, frequently using the government as launching customer to support new ventures and other firms that propose solutions. The Brainport region has done the same by formulating the main themes for which the region appears to have the relevant capabilities. In the Brainport ecosystem the argument is explicit that shaping an economic portfolio is less productive than making the region more adaptive towards yet unknown circumstances. This suggests each region has a unique history in shaping collective action, and has also been developing a (region-specific) balance between top-down steering and bottom-up leadership.

In contrast to the expectations of the recent entrepreneurial ecosystem literature, none of the economic boards includes entrepreneurs that (sufficiently) represent the community of (potential) scale-ups. This omission seems to be a significant constraint on improving the conditions for this kind of productive entrepreneurship that has been recognized to be of major importance for the regional economy.

4. Relation with government

All three regions have gradually been moving towards a tripartite mode of collaboration. Even the Twente region, where local industry has for a long time not been directly involved in the governance of Kennispark Twente, has recently established a tripartite Twente Board. The Twente Board, as it currently operates, is highly dependent on the administrative support and project management capacity offered by governmental agencies. This may create a tension between the intentions and policies developed in the tripartite constellation of the board itself and the capability to make these intentions and policies work. When it was first established, the Amsterdam Economic Board was for a major part dependent on staffing and collective funding by nearly 40 local governments. Business partners and HEIs were member of the board but not financing it and were merely financially participating at the level of programmes and projects. With AEB’s recent strategic change, the financial commitment will be redistributed to all partners in the triple helix. The Brainport board, by contrast, has its own support staff and budget for project management, which may enable it to operate more independently between all stakeholders of
the knowledge triangle. The latter model, as such, may therefore better enable business leaders to participate in and contribute to regional governance (cf. the Boulder hypothesis, discussed in Chapter 2), in the context of a regional board that co-creates conditions for enhancing the viability of the region. Overall, there are substantial differences between regional boards with regard to their ability to choose where, when and how to act — especially as a result of how they are funded and organized.

5. The Netherlands as a single metropolitan area

Earlier in this chapter, we already signalled that there are major interdependencies between the various regions in the Netherlands as a result of, for example, new firms created in one region relocating to another region and the supply chains of (e.g. fast growing) firms that extend beyond regional boundaries. The large numbers of people commuting on a daily basis from home to work (and vice versa) between different regions are another indicator of regional interdependencies. In addition to these economic interdependencies, the various Dutch regions are also highly complementary from a social and recreational point of view (e.g. most people living in regions other than MRA are in fact within a 1.5 hour travel distance of the main cultural destinations and offerings of Amsterdam). For many foreigners, including most expatriates in the Netherlands, this country therefore constitutes a single metropolitan area. In this respect, at a global level only the entire Dutch delta can truly count as a metropolitan area of about 17 million people — on par with for example Delhi and Shanghai or the metropolitan areas of New York, London and Paris. This suggests there is also a strong case for reinforcing the complementarities and synergies between the (relatively small) regions within the larger Dutch metropolitan area, instead of competing on the same resources. This necessitates a nested structure of regional entrepreneurial ecosystems within one Dutch entrepreneurial ecosystem, with a strategy enabling the national ecosystem to be more than the sum of its regional components.

10.3 Conclusions

Key conclusions arising from this study are:

- The performance of knowledge triangles embedded in (entrepreneurial) ecosystems is highly conditioned by local and historical factors — such as culture, formal institutions, physical infrastructure, financial resources, and the available pool of talents.
- The knowledge networks provide connection in such an ecosystem, whereas leadership involves a mechanism for giving direction. Knowledge networks and leadership capabilities are two critical systemic conditions for entrepreneurial activity and value creation, but their role and impact cannot be isolated from the broader set of conditions.
- The entrepreneurial ecosystems of Amsterdam and Utrecht appear to perform very well, in terms of gazelles, added value and employment growth, while Brainport increased its performance remarkably since the financial crisis in 2008. On all economic indicators, Twente underperforms compared with the national (average) rates. The growing knowledge production in the region cannot be fully absorbed in the region itself.
- The Amsterdam, Utrecht, Brainport and South-Holland regions do not differ substantially with respect to the structure of their knowledge networks, all having better scores than the national average. The network characteristics of the Twente region are, however, significantly different (e.g. denser and connected) than those in the other four regions. In Twente, the two HEIs are central in the network, also due to the demise of most large corporations in this region. The knowledge networks in Amsterdam are dominated by a larger set of HEIs. In the Brainport region two large OEMs as well as two HEIs are central.
• Ecosystems have a certain specificity in firms and professions. This is helpful for firms and for workers. Specific jobs are also helpful for individual workers in their pathway on the labour market: it simplifies their navigation through a more fluctuating labour market. Labour market dynamics are supportive to catch productivity potential of human capital. People that change jobs achieve on average an increase in occupation level. 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. MRA and Utrecht seem to retain most earnings of ecosystem specific firms and jobs. Guidance from ecosystem leaders helps both firms and employees to make use of this potential of increase in occupation level and additional productivity. Labour market policy has only recently come to the agenda of the regional boards. But there seems to be a high potential for guiding knowledge more towards the existing firms and existing workforce by cooperation with vocational education and training and lifelong learning, but also by guiding labour market mobility. Job mobility is high, but not always as productive for the outcomes of the ecosystem as it can be.

• The Amsterdam, Brainport and Twente regions have been developing ‘triple helix’ forms of regional governance, involving an ongoing dialogue between key stakeholders. However, these three regions are also demonstrating distinct patterns and abilities in terms of:
  o **How they prepare the region for the future**: the three regions differ significantly in how they (as an entrepreneurial ecosystem) are configured, and therefore also face fundamentally different challenges in terms of competitiveness.
  o **The coordination of and emphasis on industrial clusters**: our case studies suggest that a collective sense of urgency about the local economic situation is a critical condition for initiating a strategy for industrial clusters.
  o **The balance between top-down steering and bottom-up leadership**: each region has a unique history in shaping collective action, and has also been developing a (region-specific) balance between top-down steering and bottom-up leadership.
  o **Relation with government**: the three case studies suggest there are substantial differences between regional boards, with regard to their ability to choose where, when and how to act — especially as a result of how they are funded and organized.

• While not explicitly measured in this study, there are many examples of major interdependencies between the various regions in the Netherlands as a result of, for example, the supply chains of (e.g. fast growing) firms that extend beyond regional boundaries. These economic interdependencies in combination with other synergies and complementarities between various regions suggest the Netherlands is actually a single metropolis. At the global level, only the entire Dutch delta can truly count as a metropolitan area of about 17 million people. As a result, there is a strong case for reinforcing the complementarities and synergies between the (relatively small) regions within the larger Dutch metropolis.

• Overall, entrepreneurial ecosystems emerge and develop in highly specific historical, social and geographical settings. As such, there is unlikely to be a single-best solution for shaping and governing (the development of) entrepreneurial ecosystems, and local governments and other agents should therefore be very careful and cautious in any attempt to copy ‘best practices’ observed in other regions.
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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 16 shows the 14 largest programmes that together account for over 80% of all projects in the database. Of special note is the European Framework Programme category, which contains all FP7 projects and accounts for almost half of all projects.

![Figure 16: Distribution of innovation projects over innovation programmes](image)

This data is extracted from the following public databases:

- VolgInnovatie.nl, the RVO database of innovation projects (all projects from 2010-2014)
- SIA RAAK project database for applied research (all projects from 2005-2014)
- Innovation Performance Contracts (all projects up to 2014)
- FOM Industrial Partnership Programme (all projects up to 2014)
- STW projects of the Technology Foundation (all projects 2012-2013)

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 17.
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

<table>
<thead>
<tr>
<th>MRA</th>
<th>BEROEP</th>
<th>Aandeel Niveau</th>
<th>Aandeel Haagstijn</th>
<th>Twente BEROEP</th>
<th>Aandeel Niveau</th>
<th>Aandeel Haagstijn</th>
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<tbody>
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<td>Schoonmaaksters huishouding</td>
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<td>1,1%</td>
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<tr>
<td></td>
<td>Productiewerkers</td>
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<td>1,0%</td>
<td>Productiewerkers</td>
<td>2,2%</td>
<td>1,0%</td>
</tr>
<tr>
<td></td>
<td>Secretarissen</td>
<td>3,8%</td>
<td>3,3%</td>
<td>Magazijnmedewerkers</td>
<td>1,1%</td>
<td>2,1%</td>
</tr>
<tr>
<td></td>
<td>Medewerkers kinderopvang</td>
<td>3,6%</td>
<td>2,9%</td>
<td>Groepswerk enz.</td>
<td>1,1%</td>
<td>3,0%</td>
</tr>
<tr>
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<td>1,2%</td>
<td>Klantenservice-netwerkmedewerkers</td>
<td>0,9%</td>
<td>3,0%</td>
</tr>
<tr>
<td></td>
<td>Magazijnmedewerkers</td>
<td>3,4%</td>
<td>2,1%</td>
<td>Topman/manager</td>
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<td>2,1%</td>
</tr>
<tr>
<td></td>
<td>Managers sales, marketing en reclame</td>
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<td>4,0%</td>
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<td>2,9%</td>
</tr>
<tr>
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<td>2,0%</td>
<td>Secretarissen</td>
<td>0,7%</td>
<td>3,2%</td>
</tr>
<tr>
<td></td>
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<td>Specialisten personeels en artsen</td>
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<td>3,7%</td>
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<tr>
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<tr>
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<tr>
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<td>2,1%</td>
<td>Kaasmakers/kaasmakers</td>
<td>0,3%</td>
<td>2,1%</td>
</tr>
<tr>
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<td>Chauffeurs individuelpersonenverzekeraars</td>
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<td>2,0%</td>
<td>Chauffeurs individuelpersonenverzekeraars</td>
<td>0,3%</td>
<td>2,0%</td>
</tr>
<tr>
<td>�</td>
<td>Directeur beursbedrijven</td>
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<td>Directeur beursbedrijven</td>
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<td>2,0%</td>
</tr>
<tr>
<td>�</td>
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<td>Rechters (technisch, hardware)</td>
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<tr>
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<td>Koekkarnemakers</td>
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<td>Koekkarnemakers</td>
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<td>2,0%</td>
</tr>
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</table>

Vegetarisch: beroepsgroepen die, van beide regio's, alleen in deze regio in top 20 staan.
Aandeel: aandeel van dit beroep in de regio
Niveau: gemiddeld (gezogen) niveau van de onderliggende registerberoepen (1-5)
Haagstijn: gemiddelde periode (kalenderdagen) tussen dit en voorgaande beroep (Indien hiast tussen 2004-2014)

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Top 20 locatiecoëfficiënt voor beroepen ≥ 10 pp per regio

<table>
<thead>
<tr>
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<th>LC</th>
<th>Haagstijn</th>
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<td>Boekhouders</td>
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<tr>
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<tr>
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</table>

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

<table>
<thead>
<tr>
<th>MRA</th>
<th>BEROEP</th>
<th>Niveau Nv.</th>
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<td>Medewerkers kinderopvang</td>
<td>3,9</td>
<td>289</td>
<td>2,9</td>
</tr>
<tr>
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<td>Technisch medewerken</td>
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<td>202</td>
<td>2,7</td>
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<td>Kunst en culturele medewerkers</td>
<td>3,5</td>
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<tr>
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<td>Producenten, musici, theater, film, tv, bedrijf</td>
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</tr>
<tr>
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<td>Specialisten, effectenhandel</td>
<td>4,0</td>
<td>95</td>
<td>2,6</td>
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<tr>
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<td>Stevendearden</td>
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<td>121</td>
<td>2,5</td>
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<tr>
<td>�</td>
<td>Film</td>
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<td>40</td>
<td>2,3</td>
</tr>
<tr>
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<td>Medewerkers kinderopvang en gezondheidszorg</td>
<td>2,6</td>
<td>10</td>
<td>2,3</td>
</tr>
<tr>
<td>�</td>
<td>Managers productiedealers, theater, film, tv, bedrijf</td>
<td>4,0</td>
<td>55</td>
<td>2,2</td>
</tr>
<tr>
<td>�</td>
<td>Journalisten, redacteuren</td>
<td>4,0</td>
<td>1014</td>
<td>2,1</td>
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<tr>
<td>�</td>
<td>Architecten, bouwtechnici en technische medewerkers</td>
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<td>129</td>
<td>2,1</td>
</tr>
<tr>
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<td>Cabinepersoneels</td>
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<td>24</td>
<td>2,1</td>
</tr>
</tbody>
</table>

Totaal 2.224 personen; 11,2% van het totaal in de regio Twente
Niveauverandering in MRA
Top 20 aantal en Top 20 LC

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<tr>
<th>MRA Top 20 aantal</th>
<th>Gem niv. aantal</th>
<th>Gem niveau</th>
<th>Niveauverandering</th>
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</thead>
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<td>Productiebedrijven</td>
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<td>1,1</td>
<td>-0,4</td>
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<td>2,1</td>
<td>2,0</td>
<td>-0,1</td>
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<tr>
<td>Chauver fs individueel personeenvervoer</td>
<td>1,9</td>
<td>2,0</td>
<td>0,1</td>
</tr>
<tr>
<td>Magazijnmedewerkers</td>
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<td>2,1</td>
<td>0,0</td>
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<tr>
<td>Klantendienst</td>
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<td>0,5</td>
</tr>
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<td>Mediawerk- en kinderopvang</td>
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<td>2,9</td>
<td>0,3</td>
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<td>Bewijzers</td>
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<td>8,8</td>
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<tr>
<td>Marketing- en reclame</td>
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<td>0,5</td>
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<tr>
<td>docenten beroepsonderwijs</td>
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<td>4,4</td>
<td>0,8</td>
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<tr>
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<td>1,5</td>
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<table>
<thead>
<tr>
<th>MRA Top 20 LC</th>
<th>Gem niv. aantal</th>
<th>Gem niveau</th>
<th>Niveauverandering</th>
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<td>0,8</td>
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<td>3,7</td>
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<td>1,2</td>
</tr>
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<td>1,0</td>
</tr>
<tr>
<td>Artiesten leden dans</td>
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<td>1,5</td>
</tr>
<tr>
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<td>1,9</td>
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Niveauverandering in Twente
Top 20 aantal en Top 20 LC

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<th>Gem niv. aantal</th>
<th>Gem niveau</th>
<th>Niveauverandering</th>
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<td>-0,6</td>
</tr>
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<td>Schoonmaak en huishouding</td>
<td>1,6</td>
<td>1,1</td>
<td>-0,5</td>
</tr>
<tr>
<td>Assistentensecretariet</td>
<td>2,1</td>
<td>2,0</td>
<td>-0,1</td>
</tr>
<tr>
<td>Chauverfs individueel personeenvervoer</td>
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<td>0,0</td>
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<td>Wagenbedrijven</td>
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<td>0,5</td>
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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) overheidsdaar 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 regionaal ecosysteem? Via welke personen en organisaties? Hoe is de wisselwerking tussen het regionaal ecosysteem en het regionaal systeem (specifieker 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 regionaal ecosysteem? Op wat voor manier?
4. Wat is de rol 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?
5. 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 regionaal 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 over het 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?
3. Wat voor effect heeft "het landelijk beleid" op dit ecosysteem? Specifieker: wat is de invloed van bijvoorbeeld fiscaal beleid, topsectorenbeleid, ondernemerschapsbeleid?
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 onderzoeksinstituten 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 onderzoeksinstituten 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.