Benchmarking Regional Innovation in the light of the Europe 2020 Agenda

The case of Twente

Master Thesis

European Studies 2012/2013

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Submitted on: **19.08.2013**

Table of Content

List of Figures

List of Tables

1   Introduction

'There is no doubt […] that the core driver of future improvements in our living standards, and our key asset, will be knowledge and creativity. Only new knowledge and new ideas will enable us to offer better products and services than our competitors and to bring forward solutions to today's challenges. But the way we create and use this knowledge today is not sufficient. On the whole, the EU lags behind the most innovative economies in the world. We need to reconfigure the way our economy works to bring in tomorrow's ideas, tomorrow's skills and tomorrow's technologies' (Barroso, 2010, p. 7).

In 2010, the European Commission has published the Europe 2020 Agenda for smart, sustainable and inclusive growth, presenting new instruments to improve the innovation capacity of the EU by introducing the flagship initiative *'Innovation Union'*. Achieving the Europe 2020 goals will require active involvement across all regions of the EU, as many European regions are the main drivers behind innovation policies, innovation strategies and the implementation of regional innovation systems. The analysis of the regional innovation system of a specific region and the comparison with i.e. other regions, the national or even European level has become more relevant for the local and governmental authorities as they want to get a better understanding of the individual strengths of a particular region and how this potential can be used to enhance the innovative capacity. Territorial benchmarking has become a prominent tool during the last years to compare the regional competitiveness between regions. As Huggins (2008) stresses, benchmarking means an improvement and learning method based on comparisons and the application of the knowledge generated from them. The idea of territorial benchmarking from the perspective of European authorities is that learning from successful policies does foster the regional competitiveness and speed up the regional development of those that are lagging behind without producing high costs.

1.1   Background and Research Objective

The region Twente in the Eastern Netherlands has already put some effort regarding their innovative ability in line with the Europe 2020 Agenda. The mayor of Enschede, Peter den Oudsten has pointed out in the Agenda voor Twente (2010) *'We moeten in de eerste plaats laten zien dat we een innovatieve topregio zijn met een grote diversiteit aan geweldige bedrijven en met een universiteit die - al is het woord ondernemend uit hun pay-off verdwenen - pal staat voor ondernemerschap en haar studenten en medewerkers stimuleert om de (wetenschappelijke) kennis ook te vermarkten'[1]* (den

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[1] *'First and most important we have to show that we are an innovative top region with a great amount of diversity of outstanding businesses plus with a university that — although the title entrepreneurial has been dissolved — still stands for entrepreneurship by stimulating students and staff to bring the (scientific) knowledge to the market'* (translated by the author)

Oudsten, 2010). As outlined in the Agenda voor Twente (2010) the region wants to become one of the most innovative regions in Europe by 2020 by (1) focusing on the international orientation of Twente by joining international operation of entrepreneurs, research and educational institutions and authorities, (2) internationally positioning and profiling Twente as a know-how, innovation and technology region by strengthening the technological leadership position, (3) facilitating knowledge, networks, funding and advocacy for programmes and projects (Regio Twente, 2011).

The general objective of the research thesis is to analyze the innovation performance of the region Twente, taking into account the strategic plan of the politics to become an innovative top region by means of the Europe 2020 Agenda. The empirical analysis will be a scientific assessment whether the claim of the politicians that the region Twente has the potential to become an innovative top region in Europe can be achieved and what the potential weaknesses are that have to be minimized. The central research question is therefore:

> **'Benchmarked with European reference regions, how does the region Twente perform with respect to innovation, taking into account the strategic goals of the Europe 2020 flagship initiative Innovation Union?'**

There are several research questions that have to be answered first in order to respond to the central research question. Sub-questions 1 up to 5 are the theoretical basis for building a basic understanding of the phenomenon of regional innovation and its link with the Europe 2020 Agenda.

Sub-question 1:   Why has the regional level become a key player European innovation policy today?

Sub-question 2:   Why has benchmarking regional innovation in the European Union become a prominent tool to enhance the regional competitiveness?

Sub-question 3:   What is the Europe 2020 initiative *'Innovation Union'* and how is it linked with the topic of regional innovation policy?

Sub-question 4:   What are the strategic aims of the Europe 2020 initiative *'Innovation Union'* with regard to regional innovation performances?

Sub-question 5:   Which indicators are available to measure the innovation performance of regions?

Before undertaking the actual regional benchmarking analysis, European reference regions have to be identified to compare the innovation performance of Twente with them.

Sub-question 6: What are suitable European reference regions to compare the innovation performance of Twente with?

After having obtained reference regions, Twente will be compared with its corresponding European reference regions with respect to the innovation performance in line with the innovation indicators proposed by the European Commission. Within the benchmarking analysis the strengths and weaknesses in the innovation performance of the region Twente compared with its reference group will become evident by dealing with the sub-questions 7 up to 9.

Sub-question 7: How does the region Twente perform with respect to the innovation indicators compared with the European reference regions?

Sub-question 8: How does the region Twente perform with respect to the innovation indicators in the light of the EU 2020 Agenda?

1.2   Methodology

The thesis starts with a theoretical part, realized by a literature study, wherein first the concepts of a *'region'* as well as the definition of *'innovation'* will be dealt with. Furthermore, a review of the academic literature regarding the increasing role of territorial innovation benchmarking and its strengths and weaknesses is included. For the elaboration on the recent European developments regarding the Europe 2020 Agenda and its flagship initiative *'Innovation Union'* relevant policy documents are the main sources used. Special emphasis is devoted to the regional contribution to enhance the innovation performance; therefore the innovation indicators of the Innovation Union Scoreboard (IUS) are described and its availability at the regional level is assessed.

The second element of the research methodology is the development of a model to identify reference regions. During this thesis, the approach proposed by Navarro et al. (2011) - who has undergone a benchmark analysis for the Basque Country - to identify and compare homogenous entities according to a range of characteristics (demographic and economic specialization) to obtain a distance matrix will be applied. Before the calculation takes place, the data will be standardized using the min-max method in order to bring all of the variables into proportion with one another.

The empirical part of the thesis contains the actual benchmarking analysis, investigating the innovation performance of the region Twente and comparing the results with the European reference regions in the light of the Europe 2020 targets. The scientific assessment contains an in-depth analysis of the innovation performance of the region Twente and will question whether the claim of the Twente politicians that the region has the potential to become an innovative top region in Europe is proven true.

1.3   Structure of the Thesis

Chapter 2 is the theoretical foundation to understand why the regional level has become a key player in the development and implementation of European innovation policies. It starts by briefly introducing the regional perspective and defining the concept of a region, followed by exploring the dynamic approach of innovation and how this concept has evolved over time. Finally, the development of regional benchmarking in the European Union and its usage as a tool to enhance the regional competitiveness will be discussed.

Chapter 3 is devoted to the Europe 2020 Agenda and in particular to its flagship initiative *'Innovation Union'* that clearly points out the challenge that the European Union does not succeed in the creation and usage of the generated knowledge in key areas and addresses the initiatives that have to take place in the future. Furthermore, the regional contribution to achieve the targets of the Europe 2020 Agenda with respect to innovation is outlined in this section. Thereby special emphasis is put on the question how to measure regional innovation in the European Union and what the corresponding suitable indicators are.

After having described the theoretical foundation, chapter 4 engages with the construction of a model that identifies European reference regions that are rather homogenous and/or share similar structural conditions with the region Twente. Therefore, on the one hand the demographic variables (a) population density and (b) aging rate and on the other hand the variable regarding the structural business structure (SBS) will be used for the calculation to identify reference regions for Twente.

Chapter 5 is devoted to the benchmarking analysis of the innovation performance of the region Twente and its corresponding reference group. Due to the limited availability of regional data at NUTS 2 level the analysis is restricted to the investigation of a few indicators. The section covers the innovation enablers, followed by the analysis of firm activities & intellectual assets and finally dealing with the innovation outputs. During the analysis the results of Twente are benchmarked broadly with the outcomes of all 20 reference regions and subsequently compared with the five closest reference regions Basse-Normandie (FR), Niederösterreich (AT), Aragón (ES), Norte (PT) and Cataluña (ES). The last sub section ranks the overall innovation performance of Twente and its closest European reference region and highlights the individual strengths and weaknesses.

Finally, chapter 6 summarizes the outcomes of the thesis and presents policy recommendations. While this thesis has been able to present some insights of the innovation performance of Twente and European reference regions in the light of the Europe 2020 Agenda, not all aspects of regional innovation policies were covered due to the limited scope of the thesis. Some limitations and a critical analysis regarding the research design complete this chapter.

2 The Region as a Key Player in Innovation Policies

For a long time in the last century, studies of competitiveness, innovation and economic development have dealt with the state and national policies as a unit of analysis. In the course of time, not only the understanding of the dynamic approach of innovation has changed, but several scholars suggest that the regional scale contribute to the study of innovation performances. This chapter starts by outlining the concept of a region and describes the changing perspective regarding innovation. Furthermore it deals with the questions why the region has become a key player in innovation policies and why benchmarking is used as a strategic tool to enhance regional innovation.

2.1 The Regional Fuzziness

Many scientific articles and books have been published during the past decades concerning the topics of regionalism and regionalization. As Buzan (1998) notices *'The concept of a region is widely used and seldom very clearly defined'* there is a problem of conceptualization when dealing with the regional level (Buzan, 1998, p. 68). Especially in the European Union this is the case as not only the concept of a region itself but also concepts such as province, country or municipality have dissimilar meanings in different EU-countries and until now there is no European-wide definition of what constitutes a region or province (Verboven, 2011, p. 6). The Baltic Sea is called a region as it is the case with Bremen or Brussels, although they distinguish significantly from the former ones (Schmitt-Egner, 2002, p. 179). A review of the academic discourse (for a detailed overview see appendix I) regarding conceptual reflections about the term *'region'* clearly underlines that the concept of the region is far away from being coherent or even compatible but remains rather fuzzy.

Despite that, Lagendijk (2003) concludes that especially in the European Union a progress has been made towards administrative and political reforms at the regional level (Lagendijk, 2003, p. 77). Due to the different meanings of the region within the Member States the European Union has developed a regional division primarily for statistical purposes in 1988. The regional division, developed by Eurostat, is the second level between the local and national stage and is called Nomenclature des Unités Territoriales Statistique (NUTS) with the purposes (a) collection, development and harmonization of the European Union's regional statistics (b) socio-economic analyses of the regions and (c) framing of EU regional policies (Eurostat, 2011, p. 6). Although Eurostat claims that NUTS preferably uses prevailing institutional divisions and breakdowns at the national level, it is also determined that regional units should be of a certain size and a general nature. This has resulted in criticism about the NUTS division that is regarded as rather viable and often inconsistent particularly with respect to size differences, which on the one hand are a result from historical modifications and on the other hand in some cases they have pure administrative background (Lagendijk, 2003, p. 87).

The current NUTS division applicable from 1 January 2012 subdivides the European territories into 97 regions at NUTS 1 level, 270 regions at NUTS 2 level and 1.294 regions at NUTS 3 level (Eurostat, 2011, p. 5f).

2.2   Innovation – A Changing Perspective

The important role of innovation is not a recent awareness but has been emerged more than 80 years ago. According to Joseph Schumpeter (1935), who was a pioneer with respect to the study of innovation in the 1930s, the major drivers of economic growth are productivity efficiency and adaptive efficiency that can be supported by actors like individuals but also by entire nations. In the Schumpeterian hypothesis innovation covers

1. the introduction of a new good or a new quality of the good
2. the introduction of a new method of production
3. the opening of a new market
4. the conquest of a new source of supply
5. the carrying out of the new organization of an industry, whereby the *'newness'* does not necessarily need to involve *'new'* knowledge but it may also concern the modification and/or advancement of already existing knowledge (Schumpeter, 1934, p. 66).

During the 1990s the thematic focus of OECD publications (see i.e. 1997a, 1997b, 1999, 2002) has been '*Boosting innovation'*, paralleled by the European Commission and its influential Green Paper on innovation in 1995, where it is stated that '*innovation is the renewal and enlargement of the range of products and services and the associated markets; the establishment of new methods of production, supply and distribution; the introduction of changes in management, work organization, and the working conditions and skills of the workforce'* (EC, 1995). The Green Paper has identified the European paradox with regard to innovation that, although the scientific performance of the European Union has been characterized as excellent, the transformation of technological research that results into innovation and competitive advantages has been a major weakness of the Union (EC, 1995). The target of the Green Paper was to set up the framework for a genuine European strategy for the promotion of innovation by proposing measures that has to be taken on Community and/or national level. Subsequently the First Action Plan for Innovation in Europe (EC, 1996), has introduced the *'Trend Chart on Innovation in Europe'* that should enable less favoured territories to learn from *'best practices'* (Zabala-Iturriagagoitia, 2006, p. 4). The European Lisbon Council in 2000 has become a milestone for the Community's approach to innovation policy. One of the aims of the Lisbon strategy was to prepare the transition to a knowledge-based economy and society by better policies for the information society and R&D, as well as by stepping up the process of structural

reform for competitiveness and innovation (EC, 2000). The European Commission has implemented several instruments, i.e. the European Innovation Scoreboard (EIS), the Community Innovations Surveys (CIS) and the Regional Innovation Scoreboard (RIS) to monitor the progress in Europe in relation to the aims defined at the Lisbon Council in 2000 (Zabala-Iturriagagoitia, 2006, p. 5).

The Oslo Manual, developed jointly by Eurostat and the OECD, states that *'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations is regarded as innovation'* (OECD and Eurostat, 2005).

The former linear innovation model or the more or less static Schumpeterian view has been superseded by the dynamic approach of systems of innovation in the 1980s. Innovation is a non-linear, interactive and evolutionary process that is built upon cooperation between the private sector as the individual firms, research bodies and universities, and public institutions as government agencies or financing associations. The system of innovation approach requires intensive communication and innovation activities are supported by formal and informal institutions (Trippl, 2006, p. 2). Lundvall (1992) was the first who has described the phenomenon that there has been a collective system evolved in which different actors as private enterprises, universities and public research institutes produce knowledge and technologies. Those developments were supported by governmental policies that created new institutions to increase those strengths. Lundvall (1992) has invented the term *'National Innovation System'* (NIS) that is defined as '*the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state.*' The concept of national systems of innovation combines ideas taken from rather distinct areas of analysis: economic policy, economic interdependence, and more or less radical economic change (Lundvall, 1992). But evidence has made clear that the nation-state forms a national boundary of many technological systems. As Edquist (2001) points out, the literature on national innovation systems has pinpointed that within a country there are huge differences regarding its economic structure, institutional set-ups, R&D bases and – as a consequence – innovation performances. As a consequence, Cooke et al. (1997) have emphasized the relevance of delegating innovation policies to the subnational or regional level which will be discussed in detail in the following.

2.3   Towards Regional Innovation Policies in the European Union

Why has the regional dimension become a key player in innovation policies? According to the OECD (2011) a policy paradigm shift has been taken place in innovation policies. The increasing importance of regions can be explained by (1) the inclusion of regions and their specific assets in national innovation policies and (2) the paradigm shift in regional development policies. The first case describes the fact that more national governments tend to include the regional dimension in the development and implementation of national innovation strategies due to the recognition that enhanced cooperation between national and subnational entities increase the effectiveness of innovation policies (OECD, 2011, p. 31). The paradigm shift in regional development policy is a result of the previous unsuccessful strategic approach just to transfer financial resources from wealthier to lagging regions. The new regional policy focuses on the mobilization of knowledge, assets and capacity of growth, using the existent local strengths and economic potentials (OECD, 2011, p. 32). Several studies outline the relevance of the regional level to study innovation (see, amongst others, Howells 1999; Cooke et al. 2000; Gertler 2003; Morgan 2004) by arguing that the geographical proximity as well as the regional governance sub-system plays an important role in the innovation process. For carrying out innovation activities the local exchange of knowledge and the subsequent localized knowledge spillovers score highest in a very distinctive geography. Within the regional context, trust amongst the different actors (business, universities, research centers) is one of the prerequisites in regional innovation systems (Trippl, 2006, p. 3). According to Porter (2003) regional innovation policy contains two core aims (1) the strategic positioning in terms of the development of unique regional strengths in chosen key areas of innovation and competitiveness must be pursued and (2) the development of potential weaknesses of the remaining determinants of innovation and competitiveness must be avoided.

Innovation has many sources, starting with aspects as a cultural diversity and a creative class up to entrepreneurship. The European Commission has since the mid 1990s stimulated the idea of Regional Innovation Systems (RIS) (for further information see appendix II) by encouraging partnerships within regions to foster the innovation environment within a region. The Committee of the Regions (CoR) has pointed out the significant role of the regions within this process of strengthening innovation policy. Within the communication paper *'The regional dimension of the European Research Area'*, the European Commission has published a strategic paper, which for the first time emphasizes the role of the regions in the innovation process (EC, 2001) as actors *'in training, providing assistance to laboratories, support for researchers and links with the expectations of local populations'* (EC, 2001, p. 4). Regions are considered as major drivers behind the development of the European knowledge-economy and regional development is considered key for

the EU's future growth and competitiveness. Despite advances in information and communication technologies, geographical proximity is considered to remain an important factor in innovation processes for the creation of i.e. regional networks of small and medium sized enterprises (SME), Spin-Offs and facilities as Science and Business Parks around universities (EC, 2001, p. 8). The Commission promotes the emergence of RIS in particular for benchmarking exercises to identify the most innovative/successful regions and has therefore created the Network of Innovating Regions in Europe to encourage the exchange of best practice (Benneworth et al., 2007, p. 29f). Also in financial terms the shift of EU innovation policy including the regional dimension becomes obvious by taking a closer look at the European Structural Fund. Whereas in the period 1989-1993 merely 4% of regional policy funds was spent for innovation, the percentage has been increased up to approximately 25% for the period 2007-2013 (OECD, 2011, p. 31).

2.4 Regional Innovation Benchmarking as a Strategic Tool in the European Union

This paragraph describes the development of regional benchmarking in the European Union and why it has become a prominent tool to enhance the regional competitiveness. Although benchmarking has its origins in the private sector it has found its application to the public sector in the meantime. Due to the complexity of public sector benchmarking, especially when it is applied internationally or interregional, some pitfalls and options to avoid are presented throughout this section.

The term benchmarking has been evolved in the construction sector during the 1990s when engineers used benchmarking as a tool to measure their products against a standard and the approach has been used widely in the business world to compare i.e. individual departments with better performing ones to close the gap by identifying those processes, services or strategies that lead to high performances und use this information to improve the own performance by implementing them. Benchmarking has been and is used as a tool to achieve efficiencies and increase productivity after having implemented so-called best practices (Bessant & Rush, 1998, p. 3f). After having successfully been used in the private sector, benchmarking has increasingly been used for various disciplines in the public sector after the emergence of New Public Management. The reasons for the implementation of performance or benchmarking studies in the public sector are ranged from the original purpose of the enhancement of performances up to the improvement of the legitimacy of government intervention. There are various types of benchmarking i.e. internal vs. external, functional vs. generic, cooperative vs. competitive benchmarking (Groenendijk, 2011, p. 182).

In line with the performance studies in the public sector, territorial (regional) benchmarking has become a prominent tool during the last years to compare the regional competitiveness between sub national entities, to identify the strengths and weaknesses of the analyzed regions. In the public

sector it can be distinguished between (1) benchmarking of public sector organizations, which is a very similar approach to the private sector; (2) benchmarking public policies, which has no counterpart in the private sector as policy outcomes are most relevant in the public sector and (3) benchmarking policy systems like the studies dealing with national innovation systems (Gronendijk, 2001, p.183ff). Huggins (2010) distinguishes three types of territorial benchmarking:

- Performance benchmarking – based on a comparison of metrics portraying the relevant characteristics of benchmarked regions
- Process benchmarking – based on a comparison of the structures and systems constituting the practices and functioning of benchmarked regions
- Policy benchmarking – based on a comparison of the types of public policy considered to influence the nature of the practices and subsequently the characteristics of benchmarked regions (Huggins, 2010, p. 642).

As the purpose of the paper is to benchmark the innovation performance of the region Twente with European reference regions, process and policy benchmarking are not taken into account here, but the nature of international/interregional performance benchmarking will be specified further.

The European Commission explicitly appreciates interregional benchmarking to identify so called *'best practices'* and engage subnational authorities from weaker regions to learn from successful ones (Hospers, 2004, p. 3). The idea behind territorial benchmarking from the perspective of European authorities is that borrowing successful policies does foster the regional competitiveness and speed up the regional development of regions that are lagging behind without producing high costs. Several scholars have concluded that there is no universally applicable *'One size fits it all – strategy'* (see i.e. Tödtling & Trippl, 2005; Nauwelaers and Reid, 2002) therefore a number of studies have been undertaken to identify, characterize and explain the source of regional innovation systems (Doloreux & Parto, 2005, p. 138). Due to the complexity of the nature of regional innovation systems it is not sufficient to identify *'best practices'* and to simply implement the whole strategy in another region, but, as outlined by i.e. Huggins (2008), systematic regional benchmarking can be useful to identify relative strengths and weaknesses of a region X to explain the regional differences in terms of innovation activities, economic performance and regional competitiveness. Dealing with territorial benchmarking it is important to identify first who can be compared with whom. Edquist (2008) has outlined three options for regional benchmarking, (1) to compare a region with the targets that were set for oneself, (2) with oneself along the time or (3) comparing one region with others. According to Doloreux and Parto (2005) mainly two types of studies have been conducted over the past years. The first one is a comparative case-study of regional innovation systems to articulate generalities on the

one hand and particularities of the specific region on the other hand (see i.e. Asheim et al., 2003; Sternberg, 2000; Tödtling and Kaufmann, 2001). The second set of research is an in-depth analysis of a specific region that gives a detailed *'snapshot'* of the regional innovation system and illustrates the unique character of the unit of analysis in terms of institutions, governance and policy initiatives (Doloreux & Parto, 2005, p. 138).

Several authors (amongst others see Gronendijk, 2011; Grozea-Helmenstein et al., 2009; Hospers, 2004) have outlined possible shortcomings of regional benchmarking methodologies. One pitfall is the appropriate selection of regions for benchmark analysis, particularly economic geographers stress the fact that interregional differences like the economic structure and institutional framework conditions may hamper the implementation of best practices (Hospers, 2004, p. 7). But also personal preferences of the researcher and/or the purchaser can play a role, i.e. as a regional authority wishes to enhance cooperation with another one, which can lead to an inclusion of irrelevant partners and an inappropriate choice of the benchmarked regions. Those non objective selection criteria have been criticized by academics as a proper diagnosis of successes and failures is not possible by comparing apples and oranges (Navarro, 2011, p. 2). Therefore, in the current academic discussion many scholars plead for regional benchmarking comparing homogenous entities according to a range of characteristics i.e. industrial structure (Akerblom et al., 2008; Atkinson and Andes, 2008), economic structure and institutional framework (Andersson and Mahroum, 2008); economic specialization, size of the economy, firms size, culture and social capital (Nauwelaers et al., 2003).

As briefly mentioned above, another failure of regional benchmarking has been the trend of copycat behaviour within the EU that regional policy has been converged in the sense that objectives, concepts and instruments were more or less equalized and aspire the regions to become ideally a replication of *'Silicon Valley'*. European regional policy makers have made efforts to copy the successful approach of the Californian region and to promote their regions to become what Hospers (2004) calls the next *'Silicon Somewhere'* (Hospers, 2004, p. 3). On the European level a shift has been taken place in the meantime form the copycat method towards a more individual approach. As it will be outlined more detailed throughout the next chapter, the European Commission requests regions to focus on the relative strength of the particular subnational entity where the chance is more likely to become an excellent forerunner in a particular field of specialization.

With regard to the analysis of regional performance criticism is evident concerning the availability and time lag of regional data. Grozea-Helmenstein et al. (2009) underline the fact that most regional data is available with a time lag of at least two or three years, which disadvantages especially regions that are in a process of economic restructuring (i.e. the regions of the new EU Member States) as

their positioning within the EU might have been improved significantly in the meantime (Grozea-Helmenstein et al., 2009, p. 288).

Despite the criticism, regional benchmarking studies can be a useful tool for regional policy makers if it is used as a learning method based on comparisons and rather than simply adopting successful policies trying to imitate *'Silicon Valley'* without fulfilling the preconditions. In recent years and in line with the Europe 2020 Agenda a shift has been taken place towards a more individual policy approach for each region. So whereas the first territorial benchmarking analyses have been labeled as more or less simplistic by pursuing a *'copy and paste approach'*, regional benchmarking studies have evolved towards *'intelligent'* or *'systematic'* analyses.

3   The Europe 2020 Flagship Initiative *'Innovation Union'*

The financial crisis in 2007/2008, the subsequent economic recession and the budgetary tension in 2010 - that has affected most of the advanced western economies - has resulted in criticism about the Lisbon Strategy that was not able to bring a European solution. The Europe 2020 Agenda points out what the fundamental questions are today. The Commission has formulated several essential topics that Europe has to deal with in the nearly future.

Problematic issues as

> *'what will be the basis for Europe's future competitiveness, as public deficits are reined in to repair public finances and as our labour force begins to shrink? How will we create new growth and jobs? How will we get Europe's economy back on track? How will we tackle growing societal challenges like climate change, energy supply, and scarcity of resources and the impact of demographic changes? How will we improve health and security and sustainably provide water and high-quality, affordable food?'*

have to be dealt with (EC, 2010a, p. 6). According to the European Commission the answer to those fundamental questions is to put more emphasis on innovation and innovative capacity which must be a policy priority for the next years. Going back to the Europe 2020 Strategy and its three mutually reinforcing priorities smart, sustainable and inclusive growth, five headline targets in terms of assessable indicators are outlined that should be achieved by the European Union in 2020:

1. The employment rate of the population aged 20-64 should increase to at least 75%
2. 3% of EU GDP should be invested in Research & Development
3. The 20/20/20 climate/energy targets should be achieved
4. The percentage of early school leavers should be reduced up to <10% and at least 40% of the population aged 30-34 should have a tertiary degree
5. The number of Europeans living below the national poverty lines should be reduced by 25%, lifting over 20 million people out of poverty (EC, 2010a, p. 10f).

To achieve those targets, the flagship initiative *'Innovation Union'* has been placed at the heart of it, underlying the importance of a sound innovation policy in Europe. The Commission aims to improve the overall framework for Research & Development and Innovation in the European Union. The knowledge-triangle education, research and innovation should work together more closely to act more successfully and to facilitate the overall innovation process. Focusing on innovation in the European Union means to deal with the economic development by increasing not only Europe's competitiveness but also to enhance the global competition, thereby creating new jobs to replace those lost in the crisis and to tackle the major demographic change that will affect Europe in the future. As a result, the future living standards will strongly depend on the innovative ability not only

in creating innovative products but also services, business and social processes. Furthermore, innovation shall have an influence on social aspects, such as climate change, energy and resource scarcity, health and ageing, which are becoming more urgent by the day (EC, 2010a, p. 2).

The Communication *'Europe 2020 – Flagship Initiative Innovation Union'* clearly points out the challenge that Europe does not succeed in the creation and usage of the generated knowledge in key areas and addresses the initiatives that have to take place in the future. The European Commission has identified two major weaknesses that impede innovation. First of all there are unfavourable framework conditions in the European Union that restrains private investment in research and innovation. Second, there are financial restrictions as patenting is too costly and the availability of getting financed is insufficient to bring innovative ideas to the market. Furthermore, outdated regulations and procedures and deliberate standard-setting hamper successful innovations. Another core failure is that, although having a single market in the European Union, there are still barriers that complicate cross-border activities and impede sharing and using knowledge from all sources. Next to that, the communication warns that too much money is spent due to costly duplications as there is no general European dimension but rather sparse different national and regional research and innovation systems. To avoid this overlap the European Union must be forced to bunch those efforts to enhance the quality of research and Europe's potential for major breakthroughs and increase the effectiveness of the investments needed to get ideas to market (EC, 2010b, p. 7).

To tackle the unfavourable framework conditions and to avoid a fragmentation of effort, the Communication calls for a European strategy that has to be adopted by all Member States and its regions. The flagship initiative *'Innovation Union'* incorporates three mutually reinforcing priorities that first of all it should be focused on innovations that address the major societal challenges identified in the Europe 2020 Agenda and mentioned above. This priority underlines the importance that innovation must become a key element in all EU policies. Secondly, a broad concept of innovation including not only research-driven innovation but also innovation in business models must be pursued to extent the strength of the creative industries that is able to generate growth and jobs for and in Europe. Last but not least the Communication stresses the significance to involve all actors in the innovation cycle, including the public sector, the social economy and citizens themselves. Not only major companies or a few high-tech areas should be a part of it, but every Member State and all regions in Europe shall act together in innovative partnerships (EC, 2010b, p. 7f). The Communication recognizes that Europe starts from a strong position with Member States that are already world leader in some sectors and that there are regions that are considered as highly innovative, but the overall strategy needs to be facilitated further. Therefore, the Commission has determined that the following improvements have to be made at the European level:

- deliver the European Research Area and setting out a sound strategic agenda that deals with the challenges identified by Europe 2020

- improve the overall framework conditions for businesses to innovate by i.e. create the single EU Patent, improve access to financial capital and make use of smart regulation

- initiate *'European Innovation partnerships'* between the EU and national levels to speed up the development of technologies that are needed to deal with the challenges of today and the future

- promote knowledge partnerships and strengthen links between education, business, research and innovation

- revise and update the EU instruments (e.g. structural funds, rural development funds, R&D framework programme, CIP, SET plan) to support innovation (EC, 2010b).

The headline indicators mentioned above monitor the progress towards the achievement of the Europe 2020 targets, the current indicator measuring Research and Innovation in Europe is the R&D intensity indicator (the 3% target). Regarded as not sufficient enough to cope with all aspects of innovation the High-Level Panel on the Measurement of Innovation was asked by the Commission to develop an output based indicator to complement this input based indicator. The output indicator that measures the share of fast-growing innovative companies in the economy was accepted by the Commission and will be developed in cooperation with the OECD. This new indicator will become a new headline indicator to benchmark the EU's performance against its main trading partners in the future (EC, 2010b, p. 30).

Underlining the importance of a sound collaboration with the Member States, the Communication also proposes reforms that have to be taken place at the national level. According to the Commission the national R&D and innovation systems have to be restructured to promote excellence and smart specialization. In line with this modification the knowledge-triangle education, research and innovation should work together more closely, cross-border co operations should be facilitated more and the national funding procedure should be simplified. With regard to higher education policy the curricula shall be adjusted to ensure a sufficient supply of science, maths and engineering graduates. Furthermore, the Member States will need to prioritize knowledge expenditure to promote more private R&D investments through tax incentives and other financial instruments (EC, 2010b, p. 33f). After having outlined the purpose and goals of the Europe 2020 flagship initiative *'Innovation Union'* and the contribution of the Commission, the following section will explicitly deal with the regional dimension of EU innovation policy and the corresponding strategic vision.

3.1   The Regional Dimension of the *'Innovation Union'*

In 2010, the European Commission has published the fifth report on economic, social and territorial cohesion to support the Europe 2020 strategy. The report argues that the headline targets mentioned above cannot be reached at Community or national level alone, but that regions have the capacity to contribute to the defined objectives. The relationship between the goals of Europe 2020 Agenda and the regional level are clearly outlined referring to the indicators mentioned above. The need for more innovation is clearly emphasized in the Europe 2020 target of investing 3% of GDP in R&D, but according to the European Commission the average EU spending on R&D in 2010 was 2.01%, whereby the disparities across the EU regions became even more visible. There are very few successful regions where expenditure is ranged at approximately 5-6% of GDP as it is the case in Stuttgart (Germany) and Vastsverige (Sweden). On the contrary there are regions with almost no R&D expenditure at all for instance in Lubuskie (Poland). On average it is stated that expenditure exceeds the Europe 2020 target of 3% in only one in 10 regions, while it is less than 1% in almost half (48%) the regions (EC, 2010c, p. 42f).

The same accounts for the target that at least 40% of the population aged 30-34 in the European Union should have a tertiary degree, but analysis has shown that – if the current trend continues – only half of EU regions will reach 30% by 2020. Today, only a fifth of the EU regions have a tertiary educated share among the population aged 25–64 of 30% or more. Solely national efforts will not be able to avoid this grievance; closer cooperation with regions is required to increase the number of young people remaining in higher education (EC, 2010c, p. 37).

Based on the conclusions of the fifth report on economic, social and territorial cohesion and the 2009 European Innovation Scoreboard the Communication *'Europe 2020 – Flagship Initiative Innovation Union'* addresses the fact that Europe must avoid an *'innovation divide'* between the strongest innovating regions and the others.

To maximize the territorial cohesion and spread the benefits of innovation across the Union, regions are requested to zoom in on the relative strength of the particular subnational entity where the chance is given to become an excellent forerunner. Therefore it has been proposed that regions must redirect funding based on a smart specialization approach. By deploying the European Union funding programmes (e.g. FP7 Regions of Knowledge, CIP funded cluster initiatives) the impacts on regional development shall be enhanced (EC, 2010b, p. 20). This redirection of the funding will be supported by the Commission that will establish a *'smart specialization platform'* by 2012.

Another part of the Innovation Union, where regions are explicitly addressed by the Communication, is the new approach of European Innovation Partnerships that will bring all actors at EU, national and regional level together. The aim of this approach is to generate a challenge-driven innovative

economy that acts across the whole research and innovation chain that streamlines, simplifies and coordinates the existing instruments and initiatives in a more effective way (EC, 2010b, p. 23).

Regions are requested further to reform the research and innovation systems to improve its quality, promote excellence, foster closer co-operation and pursue smart specialization. Those reforms are supported by the Commissions Self assessment tool that points out the features of a well performing national and regional research and innovation system. In line with that the regions should measure the progress that they made towards the Innovation Union (EC, 2010b, p. 30f).

As outlined above, the flagship initiative *'Innovation Union'* aims to tackle the unfavourable framework conditions within the EU and wants to avoid a fragmentation of effort by pursuing a broad concept of innovation that involves all actors and regions in the innovation cycle (EC, 2010b, p. 7f). However, the question what concrete objectives in terms of measurable indicators regional innovation performances needed to be achieved in the future remains unacknowledged in the communication that only instructs regions to develop and support a smart specialization approach. One step in this direction was made by the communication *'Regional Policy Contributing to Smart Growth in Europe'* that pursues the regional level to support the smart growth objectives of Europe 2020 through regional policy and reforms the EU Regional Development Funds (ERDF) as the latter is considered to be a *'key means of turning priorities of Innovation Union Flagship Initiative into practical action on the ground'* (EC, 2010b, p. 2).

The *'smart specialization strategy'* is explicitly outlined in this communication by calling the regions to identify its individual sectors and technological domains on which regional policies should be tailored to promote local innovation processes in these areas (EC, 2010d, p. 2). Examples of those comparative advantages are according to the Commission i.e. clusters, cross-sectoral activities, high value-added markets or specific research areas. In line with the *'Innovation Union'* regions are requested to make more and efficient use of financial instruments, particularly the ERDF. Other actions to attain the smart growth objectives of EU 2020 mentioned by the communication are the promotion of interregional cooperation and the use of international peer review (EC, 2010d, p. 11f).

3.2   Measuring Regional Innovation in the European Union

The Europe 2020 strategy and particularly the communication *'Innovation Union'* calls for a special attention at the territorial dimension of innovation and knowledge creation. The heterogeneity across regions in their ability to create knowledge and innovation motivates in-depth analyses of the territorial dimension of the knowledge economy (EC, 2011, p. 9). Politicians and policy-makers are highly interested in the innovation performance of subnational or regional entities as innovation is regarded as the main driver behind competitive advantages. Within the European Union special emphasis is put on the investigation and development of *'best practices'* in regional innovation policy. Several instruments i.e. scoreboards, evaluation frameworks or in-depth case studies of successful regions have been explored to encourage region in the European Union to raise their competitiveness by benchmarking their performance with other regions (Hospers, 2004, p. 9). In order to being able to analyze a specific region with regard to its innovation performance, indicators to measure and monitor regional innovation performances have to be determined. According to the Communication *'Innovation Union'* the European Commission has in line with the recommendations of the High-Level Panel on Innovation developed a Research and Innovation Union scoreboard that contains a list of indicators to measure an monitor the innovation performance at EU and Member State level. The scoreboard enables comparative benchmarking of EU and Member State performance against a broad set of indicators. Additionally, the Science, Technology and Competitiveness Report (STC) monitors the progress towards the headline target of investing 3% of GDP on research and innovation and the development towards the realization of delivering the European Research Area (ERA) for a competitive European economy (EC, 2010b, p. 30).

The Innovation Union Scoreboard (IUS) has superseded the former European Innovation Scoreboard (EIS) and has adapted the list of the innovation indicators to get a better understanding about the development of the national research and innovation systems. The IUS incorporates 25 indicators that are distinguished in three main and eight subgroups:

1. **<u>Enablers</u>**
    i.   Human Resources
    ii. Open, excellent and attractive research systems
    iii. Finance and support

2. **<u>Firm activities</u>**
    i.   Firm investment
    ii. Linkages & entrepreneurship
    iii. Intellectual assets

3. **Outputs**

      i.   Innovators

      ii.   Economic effects (EC, 2010b, p. 36f).

The IUS uses the most recent statistics from Eurostat and other available internationally recognized sources, wherever suitable to improve comparability between countries (IUS, 2011, p. 6). The target group of the IUS is the European Union and its Member States and therefore it does not provide regional data. The Commission admits that there is a lack of statistical sources including also the limited availability of indicators at the regional level (EC, 2010b, p. 30) but emphasizes that efforts will be made to make the data available at the regional level for all Member States (EC, 2010b, p. 36). The Oslo Manual (2005) has recognized that regional factors can influence the innovative capacity of firms and that analyzing the regional level has become more attractive. By identifying the core characteristics that promote regional innovation activity and analyzing the regional differences that exist in terms of innovation ability, value for regional policymakers will be created. Furthermore, the Oslo Manual points out the potential of regional innovation systems and its local features i.e. public research institutions, industry clusters, venture capital and a strong entrepreneurial environment that can influence the innovation performance of regions (Oslo Manual, 2005, p. 39).

Taking a closer look at the indicators and the availability at the regional level (for a detailed overview see table 1 beneath), it becomes obvious that the possibilities for a sound regional innovation analysis are limited. Only for 12 out of 25 indicators are regional data accessible, regarding the innovation enablers merely two indicators (Percentage population aged 30-34 having completed tertiary education and public R&D expenditures as % of GDP) can be used conducting a regional analysis. More regional information is available regarding the indicators at firm level; here 6 out of 8 indicators (Business R&D expenditure as % of GDP, Non-R&D innovation expenditures as % of turnover, SMEs innovating in-house as % of SMEs, Innovative SMEs collaborating with others as % of SMEs, Public-private co-publications per million population and PCT patents applications per billion GDP (in PPS€)) can generally be applied in the regional benchmarking analysis. With reference to the last group – outputs - regional measurement is possible for two indicators with respect to innovators (SMEs (more than 10 employees) introducing product or process innovations as % of SMEs and SMEs (more than 10 employees) introducing marketing or organizational innovations as % of SMEs) as well as two indicators concerning the economic effects (Employment in Knowledge-Intensive Activities as % of total employment and Sales of new to market and new to firm innovations as % of turnover).

Table 1: Innovation Union Scoreboard for Research and Innovation

Innovation Union Scoreboard for Research and Innovation		
Indicator	Data source	Regional data available
1 ENABLERS		
1.1 Human Resources		
1.1.1 New doctorate graduates (ISCED) per 1.000 population aged 25-34	Eurostat	No regional data available
1.1.2 Percentage population aged 30-34 having completed tertiary education	Eurostat	**Percentage population aged 25-64 having completed tertiary education**
1.1.3 Percentage youth aged 20-24 having attained at least upper secondary level education	Eurostat	No regional data available
1.2 Open, excellent and attractive research systems		
1.2.1 International scientific co-publications per million population	Thomson/Scopus	No regional data available
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	Thomson/Scopus	No regional data available
1.2.3 Non-EU doctorate students per million population	Eurostat/OECD	No regional data available
1.3 Finance and support		
1.3.1 Public R&D expenditures as % of GDP	Eurostat	**Identical**
1.3.2 Venture Capital (early stage, expansion and replacement) as % of GDP	EVCA/Eurostat	No regional data available
2 FIRM ACTIVITIES		
2.1 Firm investments		
2.1.1 Business R&D expenditure as % of GDP	Eurostat	**Identical**
2.1.2 Non-R&D innovation expenditures as % of turnover	Eurostat	**Similar (only for SMEs)**
2.2 Linkages & entrepreneurship		
2.2.1 SMEs innovating in-house as % of SMEs	Eurostat	**Identical**
2.2.2 Innovative SMEs collaborating with others as % of SMEs	Eurostat	**Identical**
2.2.3 Public-private co-publications per million population	Thomson/Scopus	**Identical**
2.3 Intellectual assets		
2.3.1 PCT patents applications per billion GDP (in PPS€)	Eurostat	**EPO patent applications per billion regional GDP (PPS€)**
2.3.2 PCT patent applications in societal challenges per billion GDP (in PPS€) (climate change mitigation, health)	OECD	No regional data available
2.3.3 Community trademarks per billion GDP (in PPS€)	OHIM/Eurostat	No regional data available
2.3.4 Community designs per billion GDP (in PPS€)	OHIM/Eurostat	No regional data available
3 OUTPUTS		
3.1 Innovators		
3.1.1 SMEs (more than 10 employees) introducing product or process innovations as % of SMEs	Eurostat	**Identical**
3.1.2 SMEs (more than 10 employees) introducing marketing or organizational innovations as % of SMEs	Eurostat	**Identical**
3.1.3 High-growth enterprises (with more than 10 employees) as % of all enterprises	Eurostat	No regional data available
3.2 Economic effects		
3.2.1 Employment in Knowledge-Intensive Activities (manufacturing and services) as % of total employment	Eurostat	**Employment in knowledge-intensive services + Employment in medium-high/high-tech manufacturing as % of total workforce**
3.2.2 Medium and High-tech manufacturing exports as % total product exports	UN/Eurostat	No regional data available
3.2.3 Knowledge-Intensive Services exports as % total service exports	UN/Eurostat	No regional data available
3.2.4 Sales of new to market and new to firm innovations as % of turnover	Eurostat	**Similar (only for SMEs)**
3.2.5 Licence and patent revenues from abroad as % of GDP	Eurostat	No regional data available

Source: European Commission (2010)

4 The Region Twente and European Reference Regions

The region Twente is located on the Eastern border of the Netherlands and belongs administratively to the Eastern part of the Province of Overijssel. In 1972, the Regional Research Programme Coordinating Committee (COROP) has subdivided the Netherlands into 40 regions for purposes of regional economic analysis, Twente being one of them. However, the Dutch COROP regions are not considered as administrative regions, but as statistical units for regional analysis. Therefore, they represent the NUTS 3 level in the Netherlands and are made up of municipalities. Although being recognized as an autonomous sub national entity of its own by many both within and outside the region, Twente is not designated as such by the Netherlands Government (OECD, 2006, p. 9). For a long time, Twente has been dominated by the textile industry and related sectors, but has been greatly affected by the fluctuations on the world markets in the 1970s and 1980s. Parts of the Twente textile industry have emerged from the restructuring process in better shape due to the introduction of new production methods and shift towards high-quality products (OECD, 2006, p. 16).

As mentioned above, the region Twente belongs to the NUTS 3 level, but due to the lack of available data for the NUTS 3 level, a choice has been made to use the higher NUTS 2 level as the statistical unit. It has been outlined earlier that in the current academic literature scholars pledge for the identification of reference regions that are rather homogenous and/or share similar structural conditions therefore the aim of this chapter is first to classify variables that are suitable and publically available to mirror the region Twente. According to Navarro et al. (2011) there are two possible options that are mainly used in territorial benchmarking studies to obtain reference regions. Probably more in common is the use of a cluster analysis; thereby a typology of regions is established by identifying groups of regions that share similar structural conditions with the selected region. This approach is particularly interesting for researchers and politicians who work with the entire European regional level as this method provides an excellent tool to give a complete overview of European regions. Criticism about the method of cluster analysis has been occurred in benchmarking studies as this technique tends to combine different types of variables that may interfere with each other as i.e. mixing up structural conditions, economic and innovation indicators (Navarro et al., 2011, p. 7). As outlined by Archibugi and Coco (2005) and Edquist (2008) the economic and the innovation system are two separate concepts and it must be distinguished between those as the economic performance is affected by innovation performance and vice versa. As this thesis does not deal with European regions as a whole, but seeks to benchmark Twente with reference regions it has been decided not to use a cluster analysis as the benchmarking technique here. Instead a distance matrix is used that indicates the distances between the selected region Twente and the other NUTS 2 regions. Based on this distance matrix it is possible to rank all regions and identifying those that are

closest to Twente according to the chosen variable. Following the approach by Navarro et al. (2011), who has undergone a benchmark analysis for the Basque Country, indicators that might be used to identify regions with similar conditions can be grouped in four blocks:

1. Size, demographic and location indicators
   a. Population, Population density, Aging rate
2. The economy´s industry structure
   a. Distribution of employment
3. Industrial specialization
   a. Industrial employment
4. Technological specialization
   a. Percentage distribution of EPO patents (Navarro, 2011, p. 5f).

Given the fact that for the analysis of the innovation performance of Twente and its reference regions the blocks industrial specializations as well as the technological specialization will be investigated in detail later in this thesis, a choice has been made to include in the calculation of the distance matrix only the first two blocks. Therefore, the demographic variables (a) population density and (b) aging rate are taking into account as these are frequently used in innovation economics. The population density has a direct effect on a regions productivity and innovative capacity as it facilitates the knowledge spillover by personal interaction that leads to an exchange of ideas and labour pooling. On the other hand scholars assume that there is a negative correlation between an ageing population and innovation as older workers are less flexible in reorganizing and renovate their work which may have a negative impact on the exploitation of new technologies that consequently hampers innovation (Carone et al., 2005 and Ozgen et al., 2011).

Second, the structural business structure will be used for the calculation as the economic background of the region Twente - still dominated by a strong industrial sector but making efforts to shift towards a more service-oriented industry - has been regarded as an important variable to identify reference regions for Twente.

4.1 Obtaining Reference Regions from Variables

The variables population density and aging rate can be obtained via Eurostat for almost all NUTS 2 regions, with the exception of Chemnitz (GER), Leibzig (GER), Emilia-Romagna (IT), Marche (IT), Cheshire (UK) and Merseyside (UK). Those regions are therefore excluded for the further analysis. The associated variable regarding the economy's industry structure is the distribution of employment among the ten major sectors[2] of Eurostat's regional economic accounts. The Structural business statistics (SBS) are presented according to the NACE activity classification and describe the conduct, structure and performance of businesses across the EU. Contrary to the EU-27 and Member State level that covers all sectors, the regional SBS data is restricted to the non-financial business economy, which includes NACE Sections B up to J and L up to N. The aggregate for the non-financial business economy therefore excludes Section A (agriculture) and public administration and other non-market services (such as education, health, arts and entertainment), as well as financial services (Section K)[3]. For reasons of simplicity, the structural business statistics are further subdivided into three main themes:

- Section B Industry & Construction covers the subsections B up to F
- Section C Trade covers the subsection G
- Section D Services covers the subsections H, I, J, L, M and N.

Due to the fact that the sections agriculture, financial services and non-commercial services are not available for the regional level one needs to calculate the percentage of people employed in the sections B - Industry & Construction, C - Trade and D - Services per region first. This is done by dividing each sector per region through the amount of active population. Again, Eurostat's regional economic statistics are not fully completely available for all regions; data is missing especially for regions in Belgium, Germany and Greece, totally 66 regions do provide just partial information regarding the SBS and are consequently rejected from further analysis. From the original database, including all 270 NUTS 2 regions plus the NUTS 3 region Twente, only 199 regions are left over after correction for outliers and missing values.

Before actually calculating the distance matrix the data has to be normalized or standardized in order to bring all of the variables into proportion with one another. By using the unity-based normalization all data values will take on a value of 0 to 100 by using the following equation:

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[2] Agriculture, forestry and fishing (Section A), Manufacturing (B, C, D, E), Construction (F), Trade, transportation, accommodation and food service activities (G, H e I), Information and communication (J), Financial and insurance activities (K), Real estate activities (L), Professional, scientific, technical, administration and support service activities (M, N), Public administration, defense, education, human health and social work activities (O, P, Q), Arts, entertainment, recreation and other services (R, S, T, U).

[3] http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/introduction, retrieved on 30/04/2013

$$X_{i,0-100} = \frac{(Xi-Xmin)}{(Xmax-Xmin)}*100$$

Xi is each data point i

Xmin is the minima among all data points

Xmax is the maxima among all data points.

By rescaling the data all values fall between 0 and 100 and composite indicators are obtained for all regions to measure the distance between them. The standardization has been done for all the variables that will be part of the calculation of the distance matrix in the next step, population density, aging rate and the distribution of employment Section B, C and D.

According to the study of Navarro et al. (2011) the total distance between two regions can be calculated through the following formula:

$$D\,(i, i') = \sum_{j}^{k}(Xij - Xi'j)^2$$

j is the variable

i is the first region

i' the second region

k the amount of regions used in the calculation.

Having the percentages the distance matrix will be calculated through the formula mentioned above. To gain a better understanding a practical example for the calculation will be given first by measuring the distance between the region Twente and Salzburg.

$$D\,(i, i') = \sum_{j}^{k}(Xij - Xi'j)^2$$

<u>Distance NL 213, AT 32</u>

$$= \sum_{\substack{\%\ employment\ distribution\ B,C,D \\ \%\ aging\ rate \\ \%\ population\ density}}^{199}$$

$$= (52,36 - 54,38)^2 + (4,30 - 0,75)^2 + (57,31 - 55,24)^2 + (58,66 - 60,31)^2 + (19,63 - 31,83)^2$$

   (Aging rate)   (Population density)   (Employment B)   (Employment C)   (Employment D)

= 173.

This calculation has been done for all 199 NUTS 2 regions and the 50 closest reference regions which can be found in Appendix 3 are the initial point for further analysis. The top 50 ranking includes mainly regions from the United Kingdom (11), followed by Austrian regions (6), Dutch regions (5) and Italian and Polish regions (respectively 4).

Based on the results of the distance matrix the closest region with similar demographic and structural economic conditions is the Austrian region Salzburg, followed by the two Dutch regions Noord Brabant and Overijssel. Furthermore, amongst the top ten closest regions another two can be found in the United Kingdom (Leicestershire, Rutland and Northamptonshire, Shropshire and Staffordshire) and Denmark (Syddanmark, Midtjylland) followed by respectively one region from Spain (Cataluña), Italy (Provincia Autonoma di Bolzano) and Austria (Tirol).

Despite already being more objective and precisely by determining homogenous reference regions with the distance matrix rather than following the more prominent approach of undertaking a cluster analysis, there are still some curiosities regarding the European reference regions. Taking a closer look at the distribution of employment for each section per region it becomes obvious that the calculation has to be narrowed down. The most evident example already occurs by comparing Twente with its closest region Salzburg. The region is well known for its large tourism sector (section I) which accounts for 10.85% of the distribution of employment, whereas in Twente only 3.96% of the active population is employed in accommodation activities. The same example accounts for the second Austrian region Tirol where even more people (12.42%) are employed in the tourism industry. For the two Dutch regions Noord-Brabant and Overijssel one can observe the same phenomenon by investigating section N, administrative and support service activities, which is an important business sector in both regions as it counts for 11.01% respectively 9.74% of the distribution of employment whereas in Twente only 3.92% of the active population is employed in there (for a complete overview of the 50 reference regions and the structural business structure see appendix IV). In order to obtain an even more accurate picture the distance calculation for the top 50 reference regions has been undertaken again, taking into account the distribution of employment amongst all available NACE activity classifications individually.

4.2   European Reference Regions

As visualized in table 2, the corresponding reference regions have changed significantly after having undertaken the second calculation. Whereas after the first result of the distance matrix Salzburg has been the most appropriate region to compare Twente with, it does not show up in the ranking of the 20 closest regions any more after narrowing down the calculation. As indicated above, this corresponds with the assumption that by taking into account the differences in employment for each sector separately it becomes obvious that some regions do not fit properly with the economic structure of Twente.

Table 2: European Reference Regions

Score	NUTS	Region	Distance
0	**NL 213**	**Twente**	**0**
1	FR 25	Basse-Normandie	82
2	AT 12	Niederösterreich	86
3	ES 24	Aragón	94
4	PT 11	Norte	102
5	ES 51	Cataluña	116
6	SE 22	Sydsverige	126
7	AT 22	Steiermark	130
8	UKN 0	Northern Ireland (UK)	131
9	AT 31	Oberösterreich	140
10	BE 31	Prov. Brabant Wallon	141
11	DK 04	Midtjylland	143
12	UKD 4	Lancashire	146
13	DK 03	Syddanmark	146
14	UKE 1	East Yorkshire and Northern Lincolnshire	147
15	NL 21	Overijssel	147
16	UKG 2	Shropshire and Staffordshire	153
17	ES 52	Comunidad Valenciana	155
18	SE 23	Västsverige	155
19	NL 22	Gelderland	159
20	PL 21	Malopolskie	178

Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), own calculation

According to the distance matrix the closest region to Twente regarding the distribution of employment is:

1. Basse-Normandie (FR)

2. Niederösterreich (AT)

3. Aragón (ES)

4. Norte (PT)

5. Cataluña (ES).

Quite surprisingly and not obvious, amongst the top five closest regions, four of them are located in Southern Europe, which indicates that the individual approach can be regarded as more objective that the cluster approach as it offers a broader array of regions and does not ignore regions due to i.e. lower visibility. As one could have been expected finding particularly regions from Western and Nordic Europe due to the geographic proximity and economic as well as cultural similarities, the distance matrix illustrates that those prejudices are proven to be wrong. Amongst the top ten closest regions there are still three Austrian regions represented.

5 Benchmarking Twente with European Reference Regions

Throughout this chapter the region Twente will be benchmarked with its corresponding reference regions regarding the innovation performance. Due to the limited availability of regional data at NUTS 2 level the analysis is restricted to the investigation of a few indicators. First it will be elaborated on the Europe 2020 headline indicator to measure innovation; the expenditure on R&D as percentage of GDP. Mainly in line with the proposed allocation by the IUS, the innovation enablers will be covered, followed by the analysis of firm activities & intellectual assets and finally dealing with the innovation outputs. Each paragraph opens with a brief introduction about the definition and purpose of the used indicator before analyzing the performance of Twente and its reference regions. During the analysis the results of Twente are benchmarked broadly with the outcomes of all 20 reference regions and subsequently compared with the five closest reference regions Basse-Normandie (FR), Niederösterreich (AT), Aragón (ES), Norte (PT) and Cataluña (ES).

5.1 The Europe 2020 Headline Indicator – R&D Expenditure

The Lisbon Agenda has already set out that the corresponding indicator to measure innovation is the *'Expenditure on R&D as a percentage of the GDP (GERD)'* in 2000 that should be 3% by 2010. As this goal has not been reached yet and due to a lack of more suitable indicator, it has also maintained the benchmark of R&D investment in the Europe 2020 Agenda. The use of solely using the 3% benchmark has been criticized by academics as it focuses primarily on the manufacturing industry and does therefore neglect to a large extent the service industry, which however does promote innovation activity in the EU to a certain degree (Gros & Roth, 2012, p. 11). The authors stress the importance to develop a new headline indicator to measure innovation performance more broadly, taking into account the rising service sector. On the regional level there is even more discussion whether it is feasible or even reasonable to transfer the 3% target to the regional scale. Amongst others, Capello (2013) claim that patterns of innovation vary among regions due to their framework conditions and stress that for developing a sound regional innovation policy an appropriate analysis of the regional setting is required. Despite the current academic discussion the European Commission argues that regions have the capacity to contribute to the defined objectives as briefly outlined in chapter 3.1. The huge disparities across regions in the EU between few very successful regions that even exceed the 3% target and regions with almost no R&D investment at all have to be minimized to reach the overall Europe 2020 target.

5.1.1 Results Twente and European Reference Regions – R&D Expenditure

The results of Twente and the European reference regions are summarized in table 6. By comparing the two lowest rows in the table, it is possible to characterize the position of Twente individually and the performance of the reference group against all European NUTS 2 regions for which data is available. This benchmarking procedure allows a simple and direct way to assess the position of the region Twente with respect to weaknesses and strengths not only with respect to the reference group but also its location in the European context. All other tables throughout this chapter are produced with the same purposes in mind.

Table 3: Expenditure on R&D as % of GDP Twente and European Reference Group (2010)

NUTS	Region	Expenditure on R&D as % of the GDP
NL 213	**Twente**	**1.70**
AT 12	Niederösterreich	1.36
AT 22	Steiermark	3.87
AT 31	Oberösterreich	2.45
BE 31	Prov. Brabant Wallon	7.66
DK 03	Syddanmark	0.74
DK 04	Midtjylland	1.19
ES 24	Aragón	1.12
ES 51	Cataluña	1.70
ES 52	Comunidad Valenciana	1.11
FR 25	Basse-Normandie	1.11
NL 21	Overijssel	1.53
NL 22	Gelderland	2.06
PL 21	Malopolskie	0.93
PT 11	Norte	1.42
SE 22	Sydsverige	4.65
SE 23	Västsverige	4.27
UKD 4	Lancashire	1.27
UKE 1	East Yorkshire and Northern Lincolnshire	0.56
UKG 2	Shropshire and Staffordshire	0.52
UKN 0	Northern Ireland (UK)	1.60
Average of 20 European Reference Regions		**2.06**
Average of all 199 NUTS 2 Regions		**1.46**

Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), CBS, own calculation

On average amongst all 199 NUTS 2 regions 1.46% of the regional GDP is invested in R&D, compared to a share of 2.06% of the reference group that achieve indeed a better result, but is still far away from the Europe 2020 target. Nonetheless, there are a few regions that even exceed the 3% expenditure as it is the case for the Province Brabant Wallon that has reported a share of even 7.66% in 2010 and is the absolute forerunner. Also good performances but with a considerable distance towards the Province Brabant Wallon have been achieved by the Swedish regions Sydsverige (4.65%) and Västsverige (4.27%) and the Austrian region Steiermark with a share of 3.87%. The bulk of regions invested 1% - 2% of their regional GDP in R&D, and four regions reported a share of less than

1% in 2010, Malopolskie (0.93%), Syddanmark (0.74%), East Yorkshire and Northern Lincolnshire (0.56%) and Shropshire and Staffordshire (0.52%).

The region Twente had an expenditure on R&D of 1.70% in 2010 and was above the average of all 199 NUTS 2 regions but well below the mean of the reference group. Compared with the results of the five closest reference regions Twente ranked on the top together with Cataluña, which achieved the same percentage. With a share of 1.4% in both cases Niederösterreich and Norte followed. On the bottom end there were Basse-Normandie and Aragón with an R&D expenditure of respectively 1.1%. Amongst the five closest reference regions and Twente none of them did even come close to the Europe 2020 target of investing 3% of the GDP on R&D

Figure 1: Expenditure on R&D as % of GDP Twente and 5 European Reference Regions (2010)
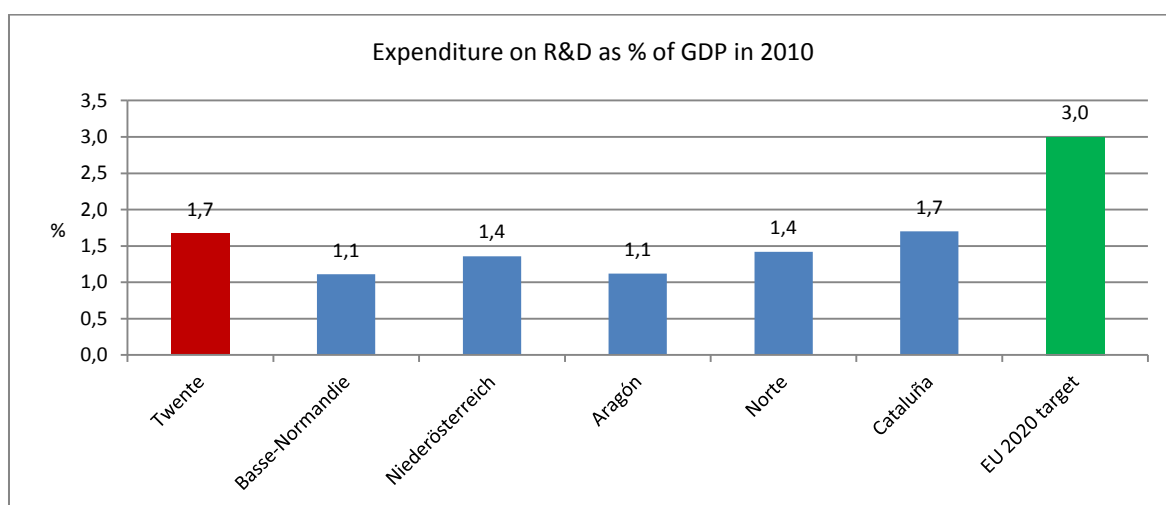
Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), CBS, own calculation

5.2   Innovation Enablers

The innovation enablers are the first main theme of the IUS and cover the innovation performance external to the firm activities by measuring the three dimensions (1) Human resources (2) Open, excellent and attractive research systems and (3) Finance and support. The former two dimensions include respectively three indicators. The human resources indicators measure the availability of a high-skilled and educated workforce, whereas the variables of the open, excellent and attractive research systems focus on the international competitiveness of the science base. The finance and support dimension includes two indicators that measure on the one hand the accessibility of investments for innovation projects and on the other hand the governmental support for R&D and innovation activities (Hollanders & Tarantola, 2011, p. 2). As already outlined in chapter 3.2 (table 1) the availability of regional data is extremely limited. The governmental support for R&D and

innovation activities is measured by the R&D expenditure in the public sector as percentage of GDP. As for the regions Twente, Brabant Wallon, Overijssel, Gelderland, East Yorkshire and Northern Lincolnshire as well as for Shropshire and Staffordshire no data on public expenditure is available, this indicator cannot be measured suitable. Anyway, an overview of the R&D expenditure in the public sector is given in the subsequent paragraph (table 7), when dealing with the business R&D expenditure. Therefore more or less only one indicator from the human resources dimension can be taken into account in the regional benchmark analysis and even this indicator has to be modified.

5.2.1 Human Resources

In the IUS the indicator *'Percentage population aged 30-34 having completed tertiary education'* measures the supply of skilled human resources in a particular region. The variable tertiary education does not only refer to science and technology as innovation also occurs in the service sector. Furthermore, the attractiveness of regions can be assessed with respect to the employment opportunities they may offer graduates. The indicator corresponds to the Europe 2020 target that at least 40% of the population aged 30-34 in the European Union should have a tertiary degree. By narrowing down the age group to 30-34 years instead of using the former age class 25-64, changes in educational policies that ultimately lead to more tertiary graduates are more easily to observe (Hollanders & Tarantola, 2011, p. 3). Due to the fact that regional data is not available for the age group 30-34 the analysis is restricted to the broader classification *'Percentage population aged 25-64 having completed tertiary education'.* The downside of this broader allocation is that it can be assumed that changes in the outcomes of this indicator will not become visible in the short run given the size of the age group. Nonetheless the percentage population aged 25-64 having completed tertiary education indicates whether high-skilled and educated workforce in a certain year in a particular region was available. As mentioned earlier, only a fifth of the EU regions have actually a share of 30% or higher of the population aged 25-64 having completed tertiary education. By taking the number of persons in the corresponding age class (25-64) with post-secondary education (ISCED 5 and 6) and dividing them through the reference population of all age classes between 25 and 64 years one gets the total share (Hollanders & Tarantola, 2011, p. 3).

According to Eurostat (2013)[4] in 2011 there were huge disparities amongst Member States and regions regarding the percentage of the population aged 25-64 having completed tertiary education. In line with the European target of a share of 30%, the highest regional percentage was recorded for Inner London UK with a total amount of 59.7%, followed by the Belgian Province Brabant with 55.7%, which was also the only other region in the EU with a majority of its working age population that had attained higher education. At the bottom end of the ranking, 75 regions in the EU reported that 20 %

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[4] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Education_statistics_at_regional_level; retrieved on 07/05/2013

or less of their resident population aged 25-64 had attained a tertiary level education. Most of these regions are located either in Southern or in Eastern Europe, particularly Italy suffered from a comparatively low share with 19 regions that achieved a share of 20% or less. Furthermore, Austrian regions perform badly on this indicator as eight out of nine regions do not even reach a share of 20%.

5.2.2 Results Twente and European Reference Regions – Human Resources

For the calculation of the percentage of population aged 25-64 with higher education data was obtained by Eurostat for 195 regions. The average share for the indicator for all 195 regions was 25.4% in 2010 which is below the European target of 30%. The 20 closest reference regions score better on this indicator as the average percentage of those was 28.2% in 2010 which is within reach of the 30%. But within the group there are also huge disparities observable as the province Brabant-Wallon (BE) is the absolute forerunner achieving 49.5% and the region Norte (PT) that is at the bottom end with a share of only 12.9%. Contrary to many regions in Southern Europe, the Spanish regions in the reference group perform very well on this indicator as the percentages range from 28 up to 33.1%. Other well-performing regions are located in Sweden and the United Kingdom. As already indicated above one of the poorly performing Member states is Austria, all regions achieved a share of less than 20% of the working population having attained higher education.

Table 4: Percentage population (25-64) with tertiary education Twente and European Reference Group (2010)

NUTS	Region	Percentage population aged 25-64 with tertiary education
NL 213	**Twente**	**28.8**
AT 12	Niederösterreich	17.9
AT 22	Steiermark	15.5
AT 31	Oberösterreich	17.5
BE 31	Prov. Brabant Wallon	49.5
DK 03	Syddanmark	27.5
DK 04	Midtjylland	31.6
ES 24	Aragón	33.1
ES 51	Cataluña	30.8
ES 52	Comunidad Valenciana	28.0
FR 25	Basse-Normandie	24.8
NL 21	Overijssel	27.5
NL 22	Gelderland	30.9
PL 21	Malopolskie	23.5
PT 11	Norte	12.9
SE 22	Sydsverige	35.9
SE 23	Västsverige	33.0
UKD 4	Lancashire	34.4
UKE 1	East Yorkshire and Northern Lincolnshire	27.8
UKG 2	Shropshire and Staffordshire	30.0
UKN 0	Northern Ireland (UK)	31.4
Average of 20 European Reference Regions		**28.2**
Average of all 199 NUTS 2 Regions		**25.4***

* Average of 195 regions due to missing values
Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), CBS, own calculation

In 2010 the region Twente achieved a better result than the European regional average and the average of its reference group and is nearby to the European target as 28.8% of population aged 25-64 has completed tertiary education. Amongst the five closest regions, Aragón scored highest with a share of 33.1%, followed by the second Spanish region Cataluña (30.8%). On the third place ranked Twente (28.8%) with a considerable distance to the subsequent region Basse-Normandie (24.8%). Far behind the centre on the last two positions ranked Niederösterreich and Norte with a share of 17.9% and respectively 12.9% of the population aged 25-64 with higher education.

Figure 2: Percentage population (25-64) with tertiary education Twente and 5 European Reference Regions (2010)
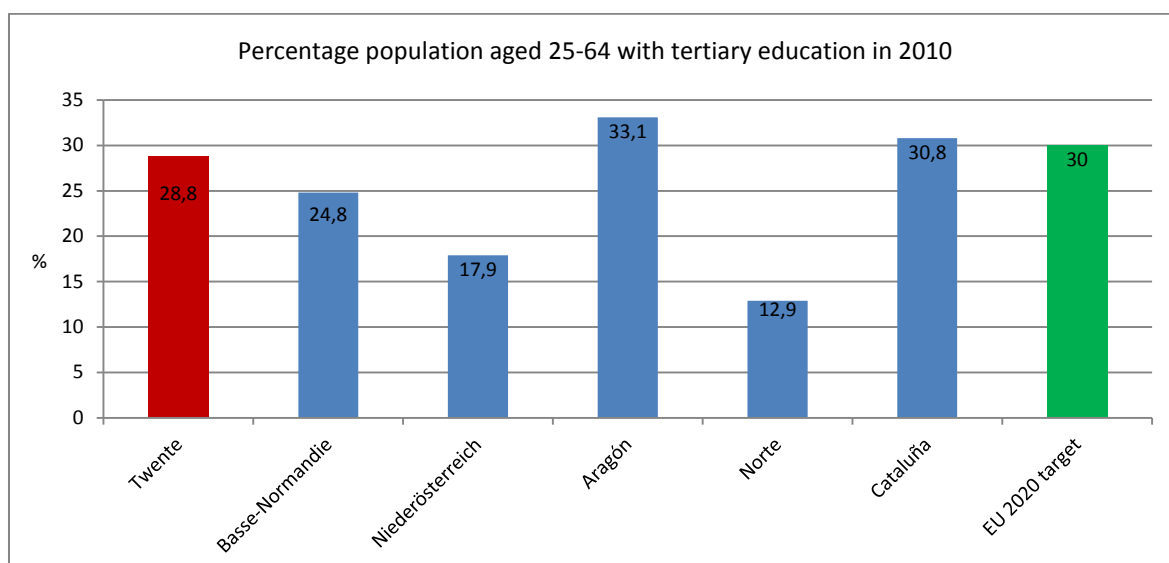
Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), CBS, own calculation

Within the Europe 2020 strategy, education indicators are selected to monitor progress towards a knowledge-based economy, delivering high levels of employment and productivity. As this indicator may be used to assess the attractiveness of European regions, it can be concluded that the region Twente does have a significant amount of high-skilled employees.

5.3   Innovation – Firm Activities

The IUS has incorporated three dimensions that belong to the innovation activities on the business level. The first dimension firm investments include two indicators regarding both R&D and non-R&D investments that firms make in order to generate innovations. Second, entrepreneurial and collaboration efforts among innovating firms are captured by the dimension linkages & entrepreneurship. Finally, the intellectual assets dimension measures various forms of Intellectual Property Rights (IPR) which are generated as a throughput in the innovation process (Hollanders & Tarantola, 2011, p. 2). According to the European Commission (2010) sufficient regional information is available regarding the indicators at firm level as 6 out of 8 indicators can usually be applied in the regional benchmarking analysis, but during the data collection it has become evident that not all NUTS2 regions were covered, therefore again limitations has been made with respect to the analyzed indicators. Therefore, only two out of eight indicators (business R&D expenditure and the number of EPO patent applications) can be applied to Twente and its reference group.

5.3.1   Firm Investments

The IUS indicator '*R&D expenditure in the business sector (BERD)*' captures the creation and production of new knowledge within firms, which can ultimately result in new patents. Especially in the science-based sector (electronics, pharmacy, transportation and chemistry) R&D investments are a requisite for the improvement of production methods and the generation of new products. Generally, R&D provides enterprises with the capability of gaining greater market shares as R&D can increase firm competitiveness. In the research-intensive economies, the business sector is the main funder of R&D as well as the main performer of R&D expenditures. The indicator is calculated by dividing all R&D expenditures in the business sector (according to the Frascati-Manual) in national currency and current prices through the GDP in national currency and current prices (Hollanders & Tarantola, 2011, p. 9).

As reported by Eurostat (2010)[5], R&D in the business sector in the European Union amounted to € 151.4 billion in 2008, accounting for 63.9% of total R&D expenditure in the EU. This means that in 2008 the target that ⅔rd of all R&D expenditures should be created by business R&D expenditure, which was set by the Barcelona Council in 2002, was nearly achieved. This result could not have been repeated in the following year, probably influenced by the financial crisis and the beginning of the subsequent recession, only 54.1% of the total R&D expenditure was funded by business enterprises. Business R&D intensity is above 1% of GDP in barely more than one quarter of NUTS 2 regions. This source of funding is relatively important in some Nordic and Western European countries, as

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[5] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/R_%26_D_expenditure_in_business_enterprises; retrieved on 07/05/2013

business-funded R&D accounted for about two thirds of total R&D investments in Finland, Germany and Luxembourg, whereas in Eastern European countries like Bulgaria, Poland and Romania a majority of the gross expenditure on R&D was funded by the government sector.

5.3.2 Results Twente and European Reference Regions - Firm Activities

Table 7 summarizes the results of the business R&D expenditures as percentage of the GDP, its relative weight compared to the total R&D expenditure and gives an overview about the public R&D expenditure, which - due to data limitations - will not be discussed further.

Table 5: Business R&D Expenditure as % of total R&D expenditure Twente and European Reference Group (2010)

NUTS	Region	Business R&D expenditure	Business R&D expenditure as % of total R&D expenditure	Public R&D expenditure
NL 213	**Twente**	**0.99***	**59.28**	**n.a.**
AT 12	Niederösterreich	1.19	87.50	0.09
AT 22	Steiermark	2.63	67.96	0.15
AT 31	Oberösterreich	2.18	88.98	0.04
BE 31	Prov. Brabant Wallon	1.68**	21.93	n.a.
DK 03	Syddanmark	0.47	63.51	0.03
DK 04	Midtjylland	0.29	24.37	0.04
ES 24	Aragón	0.64	57.14	0.25
ES 51	Cataluña	0.99	58.24	0.32
ES 52	Comunidad Valenciana	0.45	40.54	0.15
FR 25	Basse-Normandie	0.72	64.86	0.08
NL 21	Overijssel	0.86	56.21	n.a.
NL 22	Gelderland	0.82	39.81	n.a.
PL 21	Malopolskie	0.23	24.73	0.26
PT 11	Norte	0.62	43.66	0.09
SE 22	Sydsverige	3.44	73.98	0.11
SE 23	Västsverige	3.33	77.99	0.12
UKD 4	Lancashire	0.96	75.59	0.07
UKE 1	East Yorkshire & Northern Lincolnshire	0.43	76.79	n.a.
UKG 2	Shropshire and Staffordshire	0.41	78.85	n.a.
UKN 0	Northern Ireland (UK)	1.00	62.89	0.06
Average of 20 European Reference Regions		**1.53**	**59.28**	**0.12**
Average of all 199 NUTS 2 Regions		**0.36*****	**23.39*****	**0.16******

* Estimation based on the average of the reference regions Business R&D expenditure as share of total R&D expenditure; ** Data not available for the province, but for the region Wallon; *** Average of 187 regions due to missing values; ****Average of 168 regions due to missing values

Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), CBS, own calculation

Regional data on R&D expenditures financed by business enterprises was available for 187 NUTS 2 regions and is on average only 0.36% of the GDP and is far away from the European target of 2%.The reference group has performed considerably better in 2010 as the average value is 1.53%. The performance of the region Twente with a business R&D expenditure of almost 1% was significantly

above the European regional average, but much less than the average of the reference group. Both Swedish regions had an outstanding performance in 2010 as more than 3% of the regional GDP was spent by the business sector on R&D, followed by the Austrian regions Steiermark and Oberösterreich which both have achieved a percentage of more than 2%. Low results were reported for the Polish region Malopolskie (0.23%) and the Danish region Midtjylland (0.29%). Not only the nominal business R&D expenditure as percentage of the GDP is an important indicator, also the business R&D expenditure as percentage of the total R&D expenditure must be taken into account as the European target proposes that the latter one should at least be ⅔rd of the total R&D expenditures. For all 187 NUTS 2 regions, the average share in 2010 was 23.39% compared to 59.28% that was achieved in the reference group. Again, Oberösterreich achieved the best performance as 88.98% of all R&D expenditure was financed by the private sector, followed by Niederösterreich with 87.50%. The lowest share was accomplished by the province Brabant Wallon with a share of 21.93%, but this percentage must be regarded with suspicion as regional data was not available for the province itself, but only for the region Wallon. In Twente 59.28% of the total R&D expenditures was funded by the business sector which is again significantly above the European average, but is in line with the average of the reference group.

Figure 3: Business R&D expenditure as % of total R&D expenditure Twente and 5 European Reference Regions (2010)
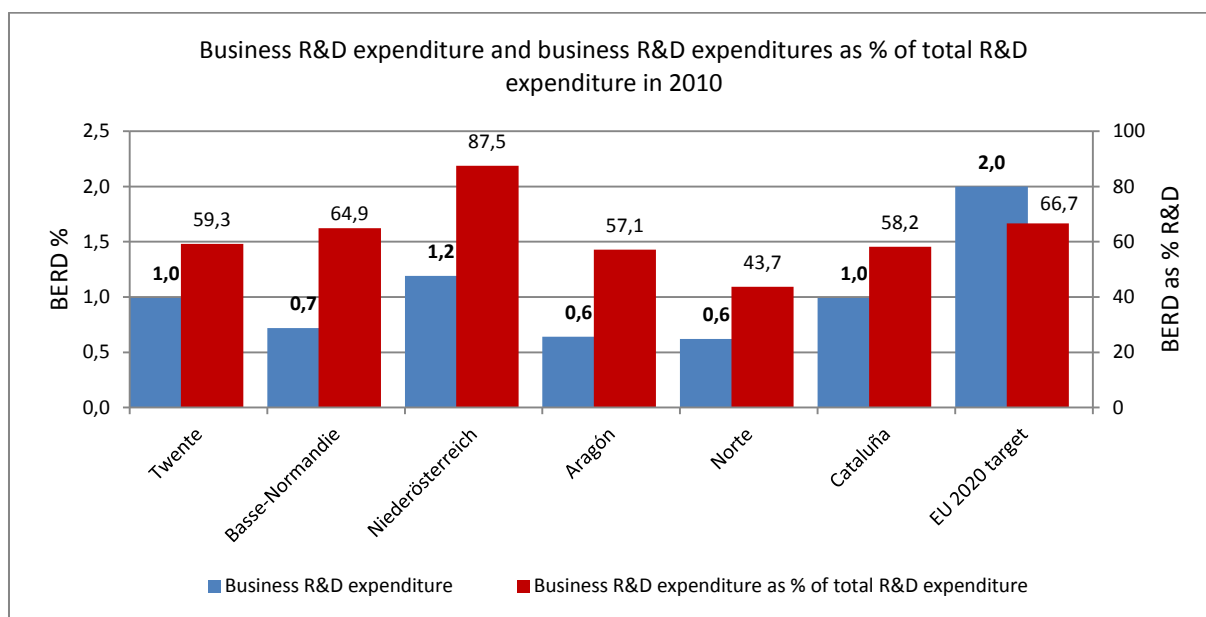
Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), CBS, own calculation

Amongst Twente and the 5 closest reference regions none of them even came close to the European target of 2% business R&D expenditures. The highest share in 2010 achieved Niederösterreich with 1.2%, followed by Cataluña (0.99%) which is the same percentage that Twente has accomplished. The French region Basse-Normandie had business R&D expenditures of 0.7% in 2010, and Aragón as

well as Norte achieved 0.6%. With respect to the European target that ⅔ʳᵈ of all R&D expenditures should be financed by the private sector the results of Twente and the reference group were slightly better. With a percentage of 87.5% Niederösterreich scored best on this indicator and was miles ahead of the EU target. Although Basse-Normandie did only have business R&D expenditures of 0.7% this accounted for almost 65% of its total R&D expenditures and means is nearby the EU target. Thereafter Twente is placed with a share of 59.3%, slightly above the shares of Cataluña (58.2%) and Aragón (57.1). Again, at the bottom end of the ranking is Norte with the lowest private R&D expenditure of 0.6% which accounts for only 43.7% of all R&D expenditures.

5.3.3 Intellectual Assets

Protection over intangible elements like the idea, the name or the logo of a certain product is safeguarded by the intellectual property law that ensures the owner that those intangible elements remain the property of the creator. Protection of industrial property is usually done by obtaining a patent; particularly the results of R&D efforts are assured by a patent as an inventor wants his ideas to be prevented from imitations. On the national level a count of patents is used to assess the inventive and innovation performance of countries.[6] The RIS indicator *'Number of EPO patent applications per million inhabitants'* measures the capacity of firms to develop new products, which is also an indicator for the competitiveness of businesses. The number of patent applications demonstrates the inventive activity of a country, a region or a firm and highlights its capacity to exploit knowledge and translate it into potential economic gains. Measuring innovation solely on the basis of the number of patents should be done with caution; according to Eurostat (2013)[7] regional statistics are built upon the address of the inventor, which is not automatically also the place where the invention takes place. Furthermore, not all inventions are actually patented as the attitude towards patenting is different across activities and businesses. Up to 2009 the indicator to measure intellectual assets was the number of EPO patent applications per million inhabitants, which was replaced in the IUS in 2010 when a switch in the denominator from million population to GDP in Purchasing Power Parity Euros (PPP€) has taken place. Within the European Union this change has only little effect on the relative performance, the replacement has its origin to simplify international comparisons for benchmarking analysis between the EU and the US, Japan and the BRIC countries (Hollanders & Tarantola, 2011, p. 11). As in this analysis interregional benchmarking within EU Member States is applied, the former RIS indicator will be used for the benchmark.

In 2009 (latest data available) about 55.000 patent applications were made to the European Patent Office (EPO) across the EU-27, which accounts for an average of 111 EPO patents per million

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[6] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Patent_statistics; retrieved on 07/10/2013
[7] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Patent_statistics; retrieved on 07/10/2013

inhabitants. In line with the former indicators there is a huge disparity amongst the European regions. Eurostat (2013) reported that in 2009 there were 158 NUTS 3 regions in the EU that had more than 250 patent applications per million inhabitants, whereof 26 (24 German, 1 French and 1 Dutch region) of those regions even had more than 500 patent applications per million inhabitants. The high amount of patent applications of those regions had a considerable impact on the European average, as according to Eurostat (2013) the median of all NUTS 3 regions was considerably lower with 60.9 patent applications per million inhabitants. Amongst those well performing 26 NUTS 3 regions there were even four that recorded more than 1.000 patent applications relative to the population size in 2009:

1. Erlangen (GER) 1.435,8
2. Zuidoost-Noord-Brabant (NL) 1.381,3
3. Erlangen-Höchstadt (GER) 1.228,9
4. Heidenheim (GER) 1.059,2.

Aside from the regions located in Germany, France and the Netherlands with these high performances, there were regions in Austria, the Nordic countries and the United Kingdom with results above the European average. At the bottom end there were also 26 NUTS 3 regions in 2009 that reported only 1 patent application per million inhabitants or less. These were spread across eight different Member States, primarily located in Eastern and to some extend Southern Europe, with the highest number of regions from Romania, followed by Poland and Portugal. Two regions are located either in Bulgaria or Spain, while there was a single region with one patent application per million inhabitants or less from each of Greece, Hungary and Lithuania[8].

Whereas in 2001 high-technology patent applications to the EPO accounted for 23.7% of all patent applications, this score decreased in absolute and relative terms across the years. In 2009 there were only 4.765 high-technology patent applications (compared to 12.188 in 2001). The highest rates per million inhabitants between 22.2 and 17.7 applications per million inhabitants were recorded in Sweden, Finland, Germany, the Netherlands, Belgium and France, followed by relatively high performances from Denmark and Austria[9].

5.3.4   Results Twente and European Reference Regions - Intellectual Assets

An overview about the number of EPO patents and high-technology EPO patents and its relative weight in terms of patents per million inhabitants in 2009 is given in table 8. Eurostat provides data for 193 NUTS 2 regions regarding the EPO patent application and data for 174 NUTS 2 regions with

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[8] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Science_and_technology_statistics_at_regional_level; retrieved on 07/10/2013
[9] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Patent_statistics; retrieved on 07/10/2013

respect to the application of high-technology patents. For all 193 NUTS 2 regions there were on average 122.3 patent applications at the European Patent Office which account for 61.8 patent applications per million inhabitants. Twente's reference group scores higher than the European mean as they applied for 151.5 patents which corresponds to 97.9 patent applications per million inhabitants. The reverse accounts for the number of high-technology patents as the European average of 27.9 is higher than the results of the reference group that scores 21.0 which means that in 2009 174 NUTS 2 regions applied for 12.3 high-technology patents per million inhabitants compared to an average value of 14.9 from the reference group of Twente.

Table 6: Number of EPO patent applications per million inhabitants Twente and European Reference Group (2009)

NUTS	Region	Number of EPO patents	EPO patents per million inhabitants	Number of High-tech patents	High-tech patents per million inhabitants
NL 213	**Twente**	**91.5**	**147.3**	**7.9**	**12.6**
AT 12	Niederösterreich	188.2	117.2	20.6	12.8
AT 22	Steiermark	230.2	190.7	32.2	26.6
AT 31	Oberösterreich	313.0	222.0	26.2	18.5
BE 31	Prov. Brabant Wallon	64.3	171.1	14.5	38.6
DK 03	Syddanmark	157.2	131.0	11.1	9.2
DK 04	Midtjylland	213.8	171.3	21.8	17.5
ES 24	Aragón	61.3	46.6	1.5	1.1
ES 51	Cataluña	400.7	55.0	37.7	5.2
ES 52	Comunidad Valenciana	93.2	18.7	4.5	0.9
FR 25	Basse-Normandie	58.6	39.9	12.3	8.3
NL 21	Overijssel	136.6	121.3	12.0	10.7
NL 22	Gelderland	219.3	110.2	27.6	13.9
PL 21	Malopolskie	40.2	12.2	3.0	0.9
PT 11	Norte	24.6	6.6	4.8	1.3
SE 22	Sydsverige	360.0	263.4	134.3	98.2
SE 23	Västsverige	274.7	148.3	30.0	16.2
UKD 4	Lancashire	53.0	36.7	8.3	5.7
UKE 1	East Yorkshire & Northern Lincolnshire	17.7	19.3	1.7	1.8
UKG 2	Shropshire and Staffordshire	67.3	44.3	9.7	6.4
UKN 0	Northern Ireland (UK)	56.6	31.8	6.1	3.4
Average of 20 European Reference Regions		**151.5**	**97.9**	**21.0**	**14.9**
Average of all 199 NUTS 2 Regions		**122.3***	**61.8***	**27.9****	**12.3****

* Average of 193 regions due to missing values; ** Average of 174 regions due to missing values
Source: Eurostat (2013)

On both indicators the Swedish region Sydsverige has achieved the highest results in 2009 with 263.4 EPO patent applications per million inhabitants and 98.2 high-technology EPO patent applications per million inhabitants. Both scored are far above the average of all European regions and the reference group. With respect to the former indicator, second best performed Oberösterreich (AT) with a score of 222.0, followed by Steiermark (AT) with 190.7. Regarding the high-technology patent application per million inhabitants the Province Brabant Wallon (BE) ended up behind the forerunner from

Sweden with an amount of 38.6 which was far behind the result from Sydsverige (SE). Again on the third place ranked the Austrian region Steiermark with an amount of 26.6. In 2009 Twente performed well with 147.3 patent applications per million inhabitants; above the average of all European regions and the reference group. With respect to the high-technology patent application per million inhabitants the results of Twente did reflect the European average with 12.6 and performed therefore slightly above the reference group. Low results were reported for the regions Norte (PT) with a score of 6.6 patent applications and 1.3 high-technology patent applications per million inhabitants, for the Polish region Malopolskie with 12.2, respectively 0.9 and for the Spanish region Comunidad Valenciana with 18.7 patent applications and correspondingly 0.9 high-technology patent applications per million inhabitants.

Figure 4: Number of EPO patent applications per million inhabitants Twente and 5 European Reference Regions (2009)
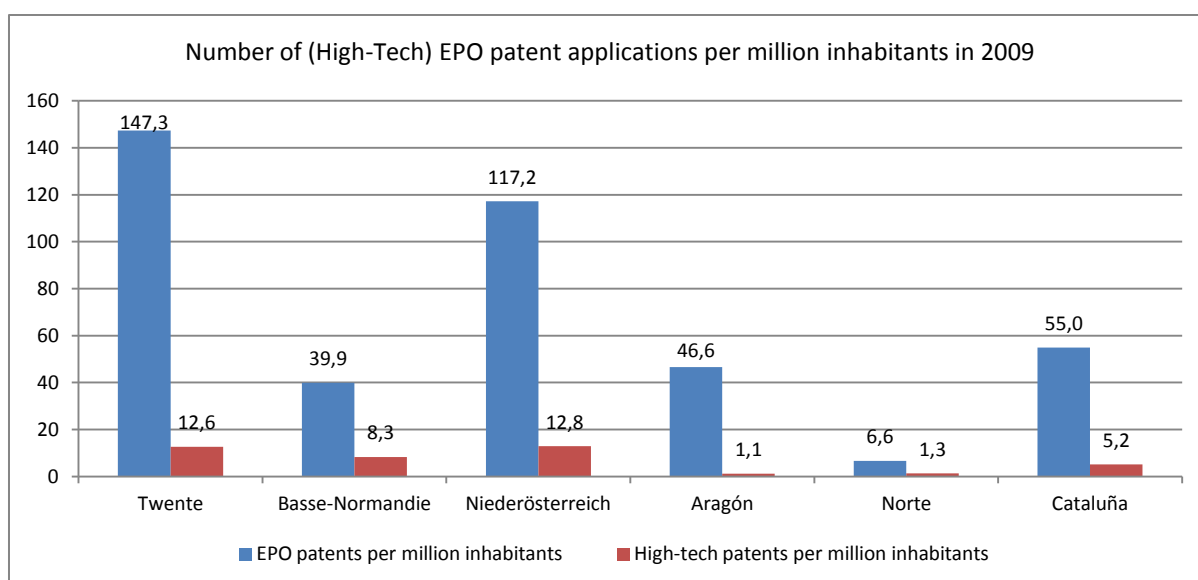
Amongst the top 5 reference regions, Twente had the most patent applications per million inhabitants in 2009 (147.3), with a considerable distance to the runner-up Niederösterreich (117.2). The other three regions performed far below the European and the reference groups mean as Cataluña achieved a score of 55.0, followed by Aragón (46.6) and Basse-Normandie (39.9). As already mentioned above, the region Norte scored badly on this indicator with only 6.6 patent applications per million inhabitants. With respect to high-technology patent applications per million inhabitants Niederösterreich and Twente swapped places as the former region with an amount of 12.8 scored slightly better than Twente with 12.6. With those scores both regions performed faintly above the European average but were still below the mean of the reference group. Basse-Normandie ranked on the third rank with an amount of 8.3, followed by Cataluña (5.2). At the bottom end were Norte and Aragón with 1.3 and respectively 1.1 high-technology patent applications per million inhabitants.

5.4 Innovation Outputs

Innovation outputs finally capture the efforts and/or of the enablers and firms activities. The IUS distinguishes between two dimensions, the first one 'Innovators' includes 3 indicators and measures (1) the number of firms that have introduced innovations either onto the market or within their organizations, (2) technological and non-technological innovations and (3) the presence of high-growth firms. The third indicator on fast-growing innovative firms is recommended and supported by the Level Panel on the Measurement of Innovation to become a new headline indicator for the Europe2020 Agenda that complements the actual R&D intensity indicator. The second dimension 'Economic Effects' captures the economic success of innovation in employment, exports and sales due to innovation activities and includes 5 indicators:

1. Employment in knowledge-intensive activities (manufacturing and services) as % of total employment
2. Medium and high-tech product exports as percentage of total product exports
3. Knowledge-intensive services exports as percentage of total service exports
4. Sales of new to market and new to firm innovations as percentage of turnover
5. License and patent revenues from abroad as percentage of GDP (Hollanders & Tarantola, 2011, p. 2f).

This section can only cover the dimension with regard to the economic effects due to restricted data availability. As mentioned in chapter 3.2 there are only two indicators available at regional level, employment in knowledge-intensive activities and sales of new to market and new to firm innovations as percentage of turnover, whereupon there is not enough information regarding the latter indicator, therefore the focus will be on the former one.

5.4.1 Economic Effects

Innovation is regarded to be a driver behind the Europe 2020 key priority smart growth to enhance the economic progress. An important element next to the availability of high-skilled workforce and investments in R&D is the development of a knowledge-based economy, which has led to an increased interest in measuring and monitoring the employment in science and technology-related activities. The IUS captures the concentration of highly qualified people by looking at the degree of human resources in science and technology as those provide inputs to the innovation activities of other firms in all sectors of the economy. The corresponding indicator is the *'Employment in knowledge-intensive activities (manufacturing and services) as % of total employment'*, which replaces and combines the former indicators on employment in medium-high and high-tech manufacturing and employment in knowledge-intensive services (Hollanders & Tarantola, 2011, p.

14f). Despite the replacement in 2010, the *'Employment in high-tech manufacturing as % of total employment'* is nonetheless taken into account in the following analysis to gain a broader perspective. According to the OECD (2011) next to the R&D expenditure in general, a proxy to measure innovation activities in regions is the indicator *'Employment in Research & Development as % of total employment'* that covers all persons employed directly in R&D activities, such as researchers, technicians and support staff.

AT EU level, the stock of human resources in science and technology is used to indicate how developed the knowledge-based economy is. According to Eurostat (2013) around 18% of the European active population was employed in this industry[10] in 2010, with a high concentration in most capital NUTS 2 regions, where the share significantly exceeded the European average i.e. Inner London (UK), Luxembourg (LU) and Stockholm (SE). Regions that are either located close to capital cities and/or are highly urbanized particularly in Western Europe show a high share too. On the contrary NUTS 2 level regions with a low share of human resources in science and technology were widely distributed across Southern and Eastern Europe.[11]

Out of 34 million people working in the manufacturing sector in 2010 at EU level, 3.7% were employed in the high-tech sectors (high-tech manufacturing and high-tech knowledge intensive services); ⅓rd working in the manufacturing and ⅔rd employed in the service sector. Again there was a high concentration in the high-tech cluster in capital regions and those situated close to them with share above the national and European mean. Next to the regions close to London in the United Kingdom there were only a few regions at NUTS 2 level that achieved a share of 8% and higher: Province Brabant Wallon (BE) and the capital city regions of Hovedstaden (DK), Praha (CZ), Stockholm (SE) and Île de France (FR). By contrast, the lowest shares of less than 1 % were registered i.e. in Nord-Est (RO) and Región de Murcia (ES).[12]

Employment in research and development (including researchers) accounted for 1.07% in the European Union, while the regional average at NUTS 2 level was 0.77% in 2010. There were 20 NUTS

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[10] These industries include:

Extraction of crude petroleum and natural gas, Mining support service activities, Manufacture of coke and refined petroleum products, Manufacture of basic pharmaceutical products and pharmaceutical preparations, Manufacture of computer, electronic and optical products, Air transport, Publishing activities, Motion picture, video and television programme production, sound recording and music publishing activities, Programming and broadcasting activities, Telecommunications, Computer programming, consultancy and related activities, Information service activities, Financial service activities, except insurance and pension funding, Insurance, reinsurance and pension funding, except compulsory social security, Activities auxiliary to financial services and insurance activities, Legal and accounting activities, Activities of head offices; management consultancy activities, Architectural and engineering activities; technical testing and analysis, Scientific research and development, Advertising and market research, Other professional, scientific and technical activities (Hollanders & Tarantola, 2010, p. 14).

[11] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Science_and_technology_at_regional_level; retrieved on 07/15/2013
[12] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/High-tech_statistics; retrieved on 07/15/2013

level 2 regions in the EU where the share of researchers in total employment rose above 2.0 %, mainly located in Germany and the United Kingdom (North Eastern Scotland had far the highest share with 4.65% in 2010). At the bottom end there were more than 60 regions that reported a share of R&D personnel below 0.5% of total employment.[13]

5.4.2 Results Twente and European Reference Regions – Economic Effects

Table 9 summarizes the most important findings regarding the indicators (1) employment in knowledge-intensive activities, (2) Research and Developments and (3) high-tech manufacturing as a percentage of the total employment. Data was available for 170 regions in 2010 in the first case, for 174 regions in 2009 with respect to the second and 181 regions in 2008 for the third indicator at NUTS 2 level.

Table 7: Employment in Knowledge-Intensive Activities, Research & Development and High-Tech Manufacturing as (%) of total Employment Twente and European Reference Group

NUTS	Region	Employment in Knowledge-Intensive Activities (%) in 2010	Employment in Research & Development (%) in 2009	Employment in High-Tech Manufacturing (%) in 2008
NL 213	**Twente (Overijssel)**	**2.50**	**2.80**	**7.26**
AT 12	Niederösterreich	3.40	0.87	3.73
AT 22	Steiermark	3.20	3.07	3.91
AT 31	Oberösterreich	2.30	1.79	3.10
BE 31	Prov. Brabant Wallon	8.90	4.08	5.91
DK 03	Syddanmark	2.30	0.86	3.30
DK 04	Midtjylland	4.30	1.53	4.58
ES 24	Aragón	2.70	1.61	3.29
ES 51	Cataluña	4.60	1.84	3.41
ES 52	Comunidad Valenciana	1.70	1.27	2.30
FR 25	Basse-Normandie	1.80	n.a.	3.76
NL 21	Overijssel	2.50	1.12	4.63
NL 22	Gelderland	3.20	1.20	4.19
PL 21	Malopolskie	2.60	0.99	3.31
PT 11	Norte	1.20	1.50	1.50
SE 22	Sydsverige	4.90	2.42	5.90
SE 23	Västsverige	3.80	2.49	5.84
UKD 4	Lancashire	3.20	1.47	4.03
UKE 1	East Yorkshire and Northern Lincolnshire	2.50	0.59	3.10
UKG 2	Shropshire and Staffordshire	3.00	0.47	5.70
UKN 0	Northern Ireland (UK)	3.70	1.28	3.38
Average of 20 European Reference Regions		**3.29**	**1.60**	**3.94**
Average of all 199 NUTS 2 Regions		**3.42***	**0.83****	**4.13*****

 * Average of 170 regions due to missing values; ** Average of 174 regions due to missing values; *** Average of 181 regions due to missing values

Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), CBS/CIS 2008/2010, own calculation

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[13] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Science_and_technology_at_regional_level; retrieved on 07/15/2013

With respect to the first indicator on average 3.42% of the active population of the 170 NUTS 2 regions for which data is available was employed in knowledge-intensive activities in 2010, the share of the reference group was slightly below the mean with 3.29%. An outstanding performance was achieved by the Province Brabant Wallon (8.9%) with a significant distance to the following regions Sydsverige (4.9%) and Cataluña (4.6%). In most instances the percentage of people employed in knowledge-intensive activities in 2010 fell between 2.00 and 4.00, apart from Basse-Normandie (1.8%), Comunidad Valenciana (1.7%) and at the bottom end Norte (1.2%). As there are no regional data on NUTS 3 level, the share of Twente had to be replaced with the data for Overijssel in this case. With a percentage of 2.5% employed people working in knowledge-intensive activities this share is below the mean of the reference group as well as below the regional average.

In 2009 there were on average 0.83% of the working population employed in research and development in the NUTS 2 regions for which data was available. The share of the reference group was almost twice the size with a percentage of 1.60%. Again the Province Brabant Wallon had the highest share and was the only region that achieved a score over 4 percent. The Austrian region ranked on the 2nd place with 3.07% followed by the region Twente (in 2008) where 2.80% of the active population was employed in research and development. Both Swedish regions Västsverige (2.49%) and Sydsverige (2.42%) were the only region left that achieved a result of more than 2%. A low share of less than 1% was reported by the five regions Shropshire and Staffordshire, East Yorkshire and Northern Lincolnshire, Niederösterreich, Syddanmark and Malopolskie.

With respect to the percentage of people employed in high-tech manufacturing the mean of all 181 NUTS 2 regions in 2008 (latest data available) was 4.13%, the average of the reference group in the same period was 3.94%. For this indicator Twente achieved by far the highest share with 7.26% which corresponds to the fact that the region has its focus on the high-tech sector. Percentages far above the average were also reported by the Swedish regions Västsverige (5.84%) and Sydsverige (5.90%) and Shropshire and Staffordshire (5.70%) in the United Kingdom. The only regions with a share of less than 3% in 2008 were Comunidad Valenciana (2.30%) and Norte (1.50%).

Amongst the five closest reference regions Twente only ranked on the fourth place with respect to the percentage of people employed in knowledge-intensive activities with a share of 2.5%, although one has to keep in mind that this score does not necessarily reflect the situation in Twente as this number belongs to the whole province Overijssel. Due to the fact that Twente has a high employment intensity with regard to high-tech manufacturing and services it can be suggested that the score at NUTS 3 level for Twente might be superior. Nevertheless, calculating with the data available, Cataluña has out valued even both averages with a share of 4.6%. Niederösterreich

followed as there was 3.4% of the active population employed in knowledge-intensive activities. To the middle-ranking regions counted in 2010 Aragón (2.7%), closely followed by Twente (2.5%). As briefly mentioned above, the regions Basse-Normandie and Norte had a low value with only 1.8% and 1.2% employment in knowledge-intensive activities in 2010.

Figure 5: Employment in Knowledge-Intensive Activities, Research & Development and High-Tech Manufacturing as % of total employment Twente and 5 European Reference Regions
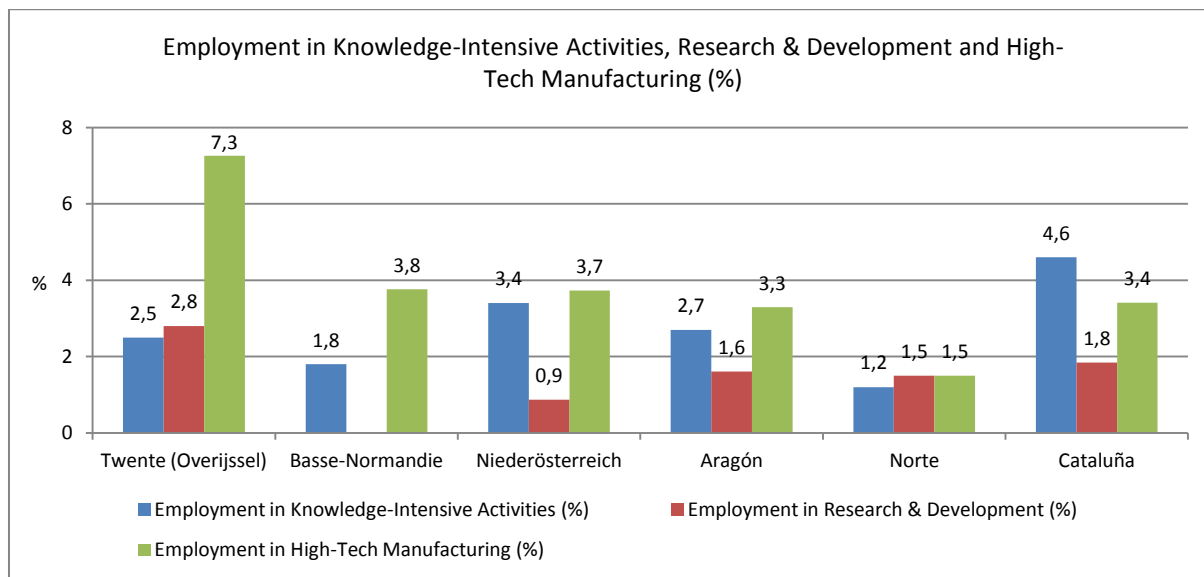
Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), CBS/ CIS 2008/2010, own calculation

Twente has achieved the highest share of people employed in research and development in 2009 with 2.8%, far above the average of all NTUS 2 regions and the reference group. With a percentage of 1.84% and therefore almost one basis point beneath Cataluña ranks second, closely followed by Aragón (1.61%) and Norte (1.5%). Niederösterreich only achieved a percentage of 0.87% in 2009, which is in fact nearby the average of all NUTS 2 regions, but far away from the mean of the reference group. Unfortunately, there is no data available for French regions; therefore the share of Basse-Normandie cannot be analyzed on this indicator.

With respect to the last indicator, Twente has out valued all other regions from the reference group as in 2008 7.26% of the active population was employed in the high-tech manufacturing industry. With the exception of Norte (1.5%) the other four regions have achieved shares that fall between 3.41% and 3.76% and are close to the mean of the whole reference group.

5.5   Innovation Performance Twente and European Reference Regions

So far, the level of regional innovation performance was measured through three types of indicators: one linked to human resources (percentage of population aged 25-64 having completed tertiary education), others linked to firms' activities and intellectual assets (R&D expenditure in the business sector as percentage of GDP) and (patent applications at EPO per million inhabitants) and finally some indicators regarding economic effects (employment in knowledge-intensive activities, research & development and employment in high-tech manufacturing as percentage of the total workforce).

After having analyzed in depth the performance of each innovation dimension, the purpose of this section is to provide a complete overview about the overall innovation performance of Twente and the five reference regions in the light of the Europe 2020 Agenda by ranking all scores. The analysis enables the identification of relative strengths and weaknesses in innovation performance of the region Twente and assesses whether those are shared with the reference regions or whether differential scores can be related to the specific circumstances of the region in question. As it has been done in chapter four to obtain reference regions, the percentages used previously throughout this chapter are standardized for all regions from the reference group (including Twente) in order to bring all of the variables into proportion with one another.

By using the min-max-method ($X_{i,0-10} = \frac{(\text{Xi}-\text{Xmin})}{(\text{Xmax}-\text{Xmin})}*10$) all shares get a value from 0 to 10, where 10 represents the highest and 0 the lowest share. For instance, with respect to the EU 2020 headline indicator R&D expenditure the province Brabant-Wallon achieved the highest share with 7.66% (Xmax) in 2010 whereas Shropshire and Staffordshire only reported 0.52% (Xmin) in the same year and Twente got a share of 1.7%.

The result for Twente following this model is therefore: ((Xi (1.7) - Xmin (0.52)) / (Xmax (7.66) – Xmin (0.52))*10 = 2. This calculation has been done for each region from the whole reference group and each indicator as outlined in Appendix V. The region with the highest percentage gets a 10 on the ranking (for the headline indicator thus Brabant-Wallon) and the region with the lowest share gets a 0 (in this case Shropshire and Staffordshire). For some indicators the European Commission has proposed values that should be achieved by 2020; if available, those are also included in the standardization procedure. Due to the fact that some regions even out value the proposed European target (i.e. Brabant-Wallon with respect to the headline indicator or Aragón regarding the human capital dimension), the EU 2020 target does not necessarily gets a 10 in the ranking. In this sense table 8 summarizes the overall innovation performance of Twente and the reference group and can be considered as a ranking that indicates on a scale from 0 to 10 where each region is situated. In line

with the previous approach of this chapter, the average of all 199 NUTS 2 regions as well as the average of the reference group is taken into account, too.

Table 8: Innovation Performance Twente and 5 European Reference Regions

Region	EU 2020 headline indicator R&D expenditure	Human Capital	Firm Activities	Intellectual Assets	Human Resources in S&T	Employment R&D
Twente	2	4	2	5	2	6
Niederösterreich	1	1	3	4	3	1
Aragón	1	6	1	2	2	3
Cataluña	2	5	2	2	4	4
Basse-Normandie	1	3	2	1	1	n.a.
Norte	1	0	1	0	0	3
Average of 20 closest regions	*2*	*4*	*3*	*4*	*3*	*3*
Average of all 199 NUTS	*1*	*3*	*0*	*2*	*3*	*1*
EU 2020 target	**3**	**5**	**6**	**n.a.**	**n.a.**	**n.a.**

Source: Own calculation; based on the information of the previous chapter

Starting with the Europe 2020 headline indicator, the region Twente had an expenditure on R&D of 1.70% in 2010, far below the 3% target. Compared with the results of the five closest reference regions Twente ranked on top together with Cataluña, followed by Niederösterreich and Norte and at the bottom end there were Basse-Normandie and Aragón. None of them did even come close to the Europe 2020 target of investing 3% of GDP on R&D. Due to other well performing regions in the reference group outside the six this difference between actual and the optimal performance is not clearly visible in the ranking above, but looking at the percentages the disparities become obvious.

Regarding the innovation enablers, the human resources indicator corresponds to the Europe 2020 target that at least 40% of the population aged 30-34 in the European Union should have a tertiary degree which correlates with a share of 30% for the age class 25-64 having completed tertiary education. Amongst the reference regions there are huge disparities as the group is distinguished into a well-performing and a low-performing group. The Spanish regions Cataluña and Aragón have already achieved the 30% target and therefore Aragón has scored a 6 in the ranking, whereas the EU 2020 target is just a 5. Twente has reported results just below that value, whereas the other regions have to put more effort to enhance this indicator as all three of them clearly missed the target.

With respect to the indicator at firm level that R&D expenditure in the business sector as percentage of GDP should compose 2% of all R&D expenditures, neither Twente nor any of the reference regions has even come close to the target. The percentages achieved ranked from 1.2% in Niederösterreich up to 0.6% in Norte, which means that all regions from the group are significantly lagging behind and there is the need to strengthen the performance at firm level as R&D provides enterprises with the

capability of gaining greater market shares and can also increase firm competitiveness. Next to the R&D expenditure in the business sector the number of EPO patent applications per million inhabitants is an important indicator at firm level as it measures the capacity of firms to develop new products. The European Commission has not formulated a concrete target in terms of the number of EPO patent applications per million inhabitants, but generally a high share corresponds with a high degree of innovation activity within the region as intellectual property rights provide a link between inventions, innovations and the marketplace. Twente did out value all other regions in the reference group with respect to this indicator and also the number of high-technology patent applications has been on a high level (aside from Niederösterreich that scored slightly better). A possible explanation for the good performance of Twente and Niederösterreich (i.e. performance above the European average) might be the presence of universities that contain research institutes as well as science parks. The regions from Southern Europe in this group have achieved lower performances far below the European average which means that their capacity to exploit knowledge and translate it into economic gains is limited.

Figure 6: Innovation Performance Twente and 5 European Reference Regions (2010)
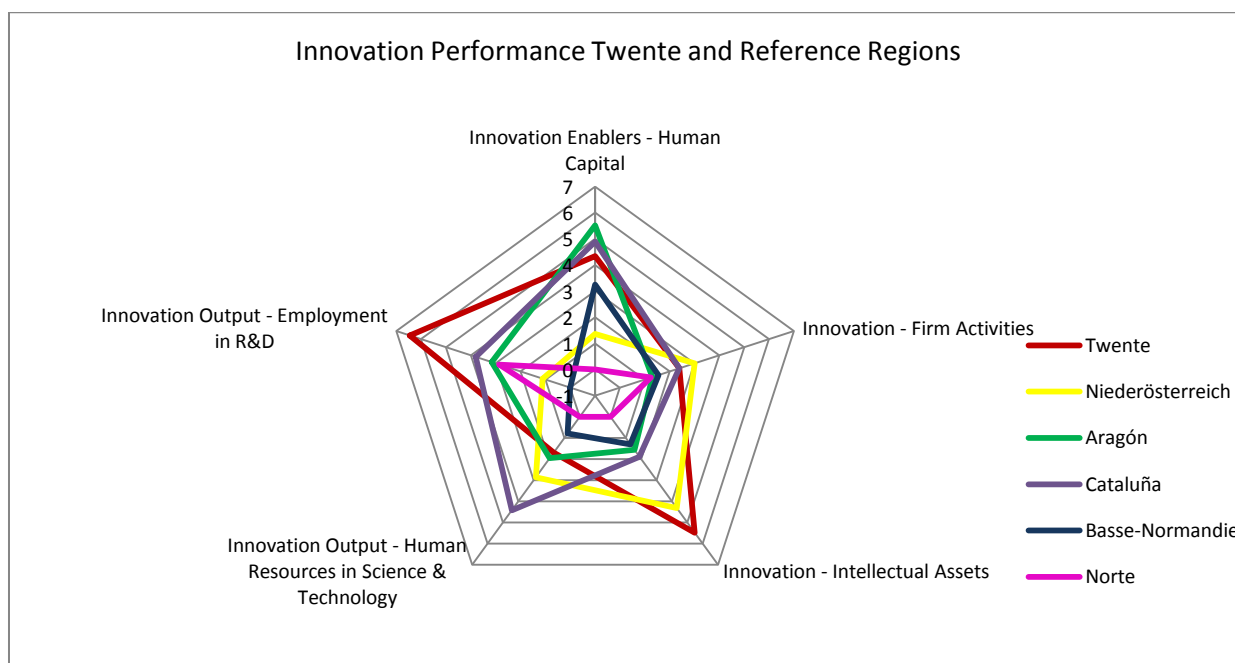
Source: Own calculation; based on the information of the previous chapter

The economic effects dimension captures the economic success of innovation to create the knowledge-based economy by measuring the employment in knowledge-intensive activities, employment in research & development and employment in high-tech manufacturing as percentage of the total workforce. Cataluña has out valued the European average, followed by Niederösterreich as both recorded a high share of the active population employed in knowledge-intensive activities.

Amongst the reference group, Twente did belong only to the middle-ranking regions; although this data must be analyzed with caution, as the information was simply transferred from Overijssel and does not necessarily reflect reality. But Twente has achieved the highest share of people employed in research and development and the highest percentage with respect to the share of the active population employed in the high-tech manufacturing industry. The other reference regions scored at least one basis point lower than Twente with Niederösterreich being up the rear. With the exception of Norte all other regions from the reference group achieved shares of people employed in the high-tech manufacturing industry around the European mean.

Taking purely the proposed indicators by the Innovation Union Scoreboard into account, the region Twente performed very well with respect to intellectual assets, below the European mean and better than the regions from reference group. Quite well results were achieved with regard to human resources, where Twente realized a share close to the European target. All regions scored rather badly on the firm activities, where the whole reference group was far away from the Europe 2020 goal that business R&D should count for 2% of all R&D investments. Regarding the innovation output, Twente was defeated by three regions that had a better share of human resources employed in science and technology.

6　Conclusion

The thesis has outlined the innovation performance of the region Twente and homogenous European reference regions in the light of the Europe 2020 Agenda, in order to identify potential strengths and weaknesses. By highlighting the innovation performance of Twente in 2010 and by pointing out on which indicators performance could be improved, it contributes to making effective the ambition, laid down in the Agenda voor Twente (2010), of this region to become one of the most innovative regions in Europe by 2020. The conclusion starts by briefly reiterating the objective of the thesis, presents the key findings and subsequently deals with policy recommendations building on the analysis. While this thesis has been able to present some insights into the innovation performance of the region Twente and European reference regions in the light of the Europe 2020 Agenda, not all aspects and themes of regional innovation policies were covered due to the limited scope of the thesis. A discussion of some limitations and a critical analysis regarding the research design complete this chapter.

6.1　Key Findings

The thesis presented an overview of the role of the regional level as a major driver of innovation policies today. Contrary to the previous discussions, where the national level was regarded as the main driver behind innovation policies, it is argued today that geographical proximity as well as the regional governance sub-system plays an important role in the innovation process. At the European level, this is outlined in the Europe 2020 flagship initiative *'Innovation Union'*, which sets out the strategic approach in which innovation will contribute to solve a range of challenges by turning ideas into jobs and growth. The role of the regional level is clearly addressed as the European Union wants to avoid an 'innovation divide' between regions with a high innovation performance and those that do hardly innovate. As the single indicator on R&D expenditures as a percentage of the GDP is not able to cover all aspects of innovation, the Innovation Union Scoreboard has adapted the list of the innovation indicators and distinguishes between enablers, firm activities and outputs to get a better understanding about the development of the national research and innovation systems. The Regional Innovation Scoreboard makes use of the same indicators (as far as possible) to analyze innovation performance at the regional level. In line with the Europe 2020 Agenda a shift has also been taken regarding regional benchmarking analysis, whereas previous attempts were dominated by a *'copy and paste'* approach, regional benchmarking studies have evolved towards *'systematic'* analyses. One of the requirements for conducting a sound regional benchmarking analysis is the identification of reference regions that are rather homogenous and/or share similar structural conditions.

A distance matrix has been calculated to obtain reference regions for Twente based on variables regarding demographic variables and the economy´s industry structure. Based on this indicators the European reference group that share similar conditions consists of (1) Basse-Normandie, (2) Niederösterreich, (3) Aragón, (4) Norte and (5) Cataluña. After having built the foundation, the regional benchmark analysis was conducted and has generated the following results:

- Although being criticized by academics, the corresponding headline indicator in the Europe 2020 Agenda to measure innovation is the *'Expenditure on R&D as a percentage of the GDP (GERD)'* that should be 3% by 2020. The region Twente had an expenditure on R&D of 1.70% in 2010 and has achieved the best result in the reference group along with Cataluña, although not even come close to the Europe 2020 target.

- Following the allocation of the Innovation Union Scoreboard the innovation enablers dimension includes the human resources indicator *'Percentage population aged 30-34 having completed tertiary education'* that measures the supply of skilled human resources in a particular region. According to the Europe 2020 Agenda in 2020 at least 40% of the population aged 30-34 in the European Union should have a tertiary degree. As regional data is not available for this age class, the broader classification *'Percentage population aged 25-64 having completed tertiary education'* has been used throughout the analysis instead with the European target of having a share of at least 30%. In 2010 the region Twente achieved a result nearby the European target as 28.8% of population aged 25-64 has completed tertiary education. Amongst the reference group the two Spanish regions have already exceeded this target, whereas Basse-Normandie only belonged to the middle-ranking regions. Far behind the centre on the last two positions ranked Niederösterreich and Norte with a share of less than 20% of the population aged 25-64 having completed higher education.

- At business level, the Innovation Union Scoreboard provides three dimensions, whereof two indicators were used in the benchmarking analysis. The indicator '*R&D expenditure in the business sector'* captures the creation and production of new knowledge within firms, which can ultimately result in new patents. The European target is that 2% or respectively ⅔rd of all R&D expenditures should be created by business R&D expenditure. Amongst Twente and the reference regions none of them even came close to the European target. The highest share in 2010 achieved Niederösterreich with 1.2%, counting for 87.5% of all R&D expenditures and therefore at least fulfilling the second European target. Twente and Cataluña followed with a share of 0.99%, counting for 59.3% respectively 58.2%. The French region Basse-Normandie

had business R&D expenditures of 0.7% (=64.9%) in 2010, and Aragón as well as Norte achieved 0.6%, accounting for 57.1% and 43.7% of all R&D expenditures.

- The *'Number of EPO patent applications per million inhabitants'* measures the capacity of firms to develop new products. There is no target set by the European Commission but a high share demonstrates the inventive activity of a region or and highlights its capacity to exploit knowledge and translate it into potential economic gains. Amongst the top 5 reference regions, Twente had the most patent applications per million inhabitants in 2009 (147.3), with a considerable distance to the runner-up Niederösterreich (117.2). The other three regions performed far below the European average as Cataluña achieved a score of 55.0, followed by Aragón (46.6), Basse-Normandie (39.9) and finally Norte with only 6.6 patent applications per million inhabitants.

- Economic Effects belong to the innovation output and captures the economic success of innovation in employment as the development of a knowledge-based economy is a key priority of the Europe 2020 Agenda. The corresponding indicator *'Employment in knowledge-intensive activities (manufacturing and services) as % of total employment'* measures the degree of human resources in science and technology. There is no data obtainable at NUTS 3 level; therefore there is no exact share for Twente available and the data for the province Overijssel is used throughout the analysis instead. This implies that the share of 2.5% that Twente has achieved in 2010 does not necessarily reflect reality, as the region has high employment intensity with regard to the percentage of the population employed in the high-tech manufacturing and services it can be suggested that the actual score for Twente might be superior to Overijssel. This relatively low share is reflected in the benchmarking analysis with the reference regions, as only ranked fourth after Cataluña with a share of 4.6%, Niederösterreich (3.4%) and Aragón (2.7%). The two other regions Basse-Normandie and Norte had a low value with a share of only 1.8% and 1.2% employment in knowledge-intensive activities in 2010.

The objective of this thesis was to answer the following research question: **'Benchmarked with European reference regions, how does the region Twente perform with respect to innovation, taking into account the strategic goals of the Europe 2020 flagship initiative Innovation Union?'** The individual results were outlined above in detail. In a nutshell the regional benchmarking analysis has exposed that compared with the reference regions Twente performed best with respect to intellectual assets and achieved quite good results with regard to human resources. All regions

scored rather badly on the dimension firm activities, where the whole reference group, including Twente, was far away from the Europe 2020 target. Regarding the innovation output, Twente was defeated by three regions that had a better share of human resources employed in science and technology, although this result must be considered with caution as the percentage used throughout the analysis was simply transferred from the province Overijssel, because the share at NUTS 3 level was not available. Twente has high employment intensity with regard to high-tech manufacturing and services, therefore it can be argued that the actual share of human resources employed in science and technology in Twente might be higher than 2.5%.

6.2   Policy Recommendations

As outlined in the Agenda voor Twente (2010) the region Twente is to become an innovative top region and a forerunner in the European Union by 2020. The question remains, whether this objective can be achieved and what the potential weaknesses are that have to be minimized in the future.

Purely looking at the outcomes of the quantitative analysis and the European targets, Twente has to enhance its overall R&D expenditure as well as its business R&D expenditure as these are far below the European target. With respect to the innovation enablers it depends on the actual share of the population having completed tertiary education in the age class 30-34, for which regional data is not available to actually make a statement whether and to what extent Twente needs to adjust its education policy to achieve the European target of 40%. Taking into account the data that are available for the broader age class 25-64, I would argue that the Twente does fulfill the requested targets or is close to it. The same accounts for the innovation outputs, due to its strong high-tech sector I would suggest, that the percentage of people employed in knowledge-intensive activities is higher than the data of the province Overijssel imply. All in all, the region Twente is on the right track with respect to its innovation performance although I doubt that the region will be an innovative forerunner in terms of quantitative achievements by 2020. I will not discuss in detail here whether a purely quantitative measurement is the right tool to judge whether or not a region is innovative or not, nor will I start the debate about the appropriateness of the actual headline indicator. In my opinion the region Twente will not be one of the regions that reports an R&D intensity of 3% or higher by 2020; this gap from 1.67% to 3% will be too big to close within ten years.

Instead of focusing on the indicator of R&D intensity, Twente should focus on its local strengths and expand them by using the Innovation Union framework as a foundation. The European Commission advises that the knowledge-triangle education, research and innovation should work together more closely to act more successfully and to facilitate the overall innovation process. In this respect, the

region Twente is also requested further to reform the research and innovation systems to improve its quality, promote excellence, foster closer co-operation and pursue smart specialization. Twente should make use of the *'smart specialization strategy'* proposed by the European Commission that requests the regions to identify its individual sectors and technological domains on which regional policies should be tailored to promote local innovation processes in these areas. The research institutes MESA and MIRA that are both located in Twente belong to the top 30 knowledge and research institutes in the Netherlands, focusing on nanotechnology, high-tech materials (MESA) and biomedical technology (MIRA). Furthermore, as indicated during the analysis, Twente had a share of 7.26% people employed in high-tech manufacturing sector far above the European average. Those are a few examples of areas, where Twente can make use of the *'smart specialization strategy'* to become a forerunner in these particular sectors in the European Union by 2020.

6.3   Limitations and Critical Analysis of the Thesis

With respect to the chosen research design, there are other options to assess the innovation performance at the regional level. As already mentioned in chapter 4, there is also the possibility to execute a cluster analysis to identify groups of regions with similar structural conditions. By obtaining a typology of regions based on the cluster analysis it is likely that the outcome would present other reference regions than resulted from the approach I have chosen here. The same is true, if one would opt to assign weight to the variables to obtain reference regions, which was not done here.

Furthermore, and this is arguably the most crucial restriction of this thesis, even though the most comprehensive and recent data available have been used, the data were limited and slightly outdated. Although the European Commission is aware of the problem that innovation statistics are only limited available at the regional and has emphasized that effort will be made to improve data, currently the possibilities to conduct a sound regional innovation analysis are limited. Only for 12 out of the proposed 25 indicators on innovation are regional data available in general; during the phase of data collection it has become obvious that even for those 12 indicators regional data is only limitedly present and/or accessible. As a result, it was ultimately possible to conduct the analysis with only 4 indicators proposed by the Innovation Union Scoreboard plus the headline indicator of the Europe 2020 Agenda. As outlined in chapter 4 due to data restriction it was not even possible to take into account all 270 regions at NUTS 2 level to obtain the reference regions as for instance data on the distribution of employment was not fully available for most of the German and Greek regions. Therefore, only 199 NUTS 2 level regions could be included in the benchmarking analysis.

In addition to the limited availability of regional innovation statistics, the currentness of the data is the second point of criticism. Most of the statistics for the regional level are available at Eurostat

with a delay of two up to three years, whereby the most recent information are related to the year 2010. Particularly with respect to the economic recession in the European Union as a result of the financial crisis in 2007/2008 it would have been interesting to investigate whether this aspect did have any consequences on the innovation performance of the regions today.

Although this case study design has been valuable to gain insights of the innovation performance at the regional level, there is more research needed to address the full scope of the individual regional innovation systems of Twente and its reference regions. As outlined in Appendix II, regional innovation systems are embedded in the national, supranational and international system of a globalized economy. Asheim and Isaksen (2002) argue that a regional innovation system contains amongst other aspects an institutional infrastructure with public authorities and policy agents. Furthermore it involves research and higher education institutions, technology transfer agencies, organizations that foster firm's innovation capacity as well as business associations and finance institutions. All these aspects have not been dealt with in this thesis, but could be addressed within further work.

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Appendix I   Literature Review – The Concept of a Region

Many scientific articles and books have been published during the past decades concerning the topics of regionalism and regionalization. As Buzan (1998) has noticed *'The concept of a region is widely used and seldom very clearly defined'* (Buzan, 1998, p. 68) there is a problem of conceptualization when analyzing a region. Especially in the European Union this is the case as the range of regions in the EU includes a variety of areas with different characteristics that cannot be entitled with a clear-cut definition in the literature. Not only the concept of a region itself but also concepts such as province, country or municipality have different meanings in different EU-countries and until now there is no European definition of what constitutes a region or province (Verboven, 2011, p. 6). The Baltic Sea is called a region as it is the case with Bremen or Brussels as entities such as the West Midlands and North Rhine-Westphalia are which distinguish significantly from the first category are also called regions (Schmitt-Egner, 2002, p. 179). There are several approaches on how to define a region based on concepts such as natural region, historical region and security region. Other - more recently published - studies categorize regions in terms of geographical boundaries and - more prominent - administrative and/or economic factors. In his book *'A World of Regions'* Katzenstein (2002) even gets along without any clear definition of a region, but argues that *'although often described in geographical terms, regions are political creations and not fixed by geography'* (Hemmer & Katzenstein, 2002, p. 575).

Investigating regions and regionalism is particularly in the European debate confronted by a conceptual dilemma. The term *'region'* is defined differently by scholars depending on their academic background. Geographers, but also economists, political scientists and anthropologists do research regarding the regional level and the variety of definitions has led to conceptual confusion when analyzing the regional question (Loughlin, 1996, p. 146). As a result of the lacking conceptual clarity, scholars and academics face the problem that there is no clear methodological foundation and subsequently no practical tools which makes i.e. benchmarking regions almost impossible. Several attempts have been made to define the concept of a region. In 1998, Smouts has pointed out that:

> *It is a characteristic of the region to have neither a definition nor an outline. The empirical criteria that allow the socioeconomic entity to be recognized as sufficiently homogenous and distinct are vague and mixed. The 'regional category' regroups disparate aggregates and the same term serves to denote sub-national formations, intermediaries between local and the national levels within the state, various cooperation zones including the state, indeed entire subcontinents and transborder areas* (Smouts, 1998, p. 30).

Another political scientist, who is more prominent in the study of regionalism, Michael Keating (1998) has admitted that that a minimal definition would define the region as an intermediate territorial level, between the state and the local level. Following on this extremely basic conception, he continues by adding:

> *A broader functional definition would add patterns of social interaction, including leisure, recreation and travel patterns … Regions, like other territorial units, are a construction of various elements with greater or lesser cohesion … the definition of regional space is contested in different forms across the economic, cultural and political dimensions* (Keating, 1998, p. 9f).

Not only the political scientists but also scholars of other disciplines have failed to develop a sufficient concept. According to Schmitt-Egner (2002) there exist discrepancies about the question whether the region must be regarded as a territorial unit or as an action unit. Whereas political scientists tend to shift the concept towards the latter, geographers mainly focus on the region as an action space. Blotevogel, Weichart and Giddens, have identified three basic elements necessary for a definition of region: (1) spatial relationships, (2) issues of scale and (3) relations between subjects and their territory.

The review of the academic discourse regarding their conceptual reflections about the term *'region'* has made clear that the concept of the region is far away from being coherent or even compatible but remains a rather fuzzy concept. But despite this fuzziness, Lagendijk (2003) has concluded that especially within the European Union a process has been made towards administrative and political reforms at the regional level (Lagendijk, 2003, p. 77). Due to the different meanings of the region within the Member States (a *'region'* in France has a very dissimilar constitutional position compared to a *'region'* in Belgium, or even a *'Land'* in Germany) the European Union has developed a regional division primarily for statistical purposes. The regional division, developed by Eurostat, is the second level between the local and national stage and is called Nomenclature des Unités Territoriales Statistique (NUTS) with the purposes (a) collection, development and harmonization of the European Union's regional statistics (b) socio-economic analyses of the regions and (c) framing of EU regional policies (Eurostat, 2011, p. 6). Although Eurostat claims that NUTS preferably uses prevailing institutional divisions and breakdowns at the national level, it is also determined that regional units should be of a certain size and a general nature. This has resulted in criticism about the NUTS division that is regarded as rather viable and often inconsistent particularly with respect to size differences, which on the one hand are a result from historical modifications and on the other hand in some cases they have pure administrative background (Lagendijk, 2003, p.87).

It can be concluded that the conceptualization of the region is a definitional morass, depending on the academic field the respondent belongs to. Clearly the regional level has become an ever more important subject to study regarding the number of books, articles and other academic literature that employ the term region in their titles. As Levis and Wigen (1997) conclude, the regional picture is often based on unexamined and partly outdated conceptions as regions disappear and reappear as they are transformed by various economic, political, and cultural factors. Therefore, academics are defining, applying and appraising the concept of a region differently as there are also no clear defaults on how to measure and combine the interrelated territorial, economic, cultural and political elements. To put it simply, the term region is not matched by the political and/or economic and/or cultural reality.

Appendix II Regional Innovation System (RIS)

Cooke (1998) has applied the former work of Lundvall (1992) on *'National Innovation Systems'* to the regional scale and developed the concept of *'Regional Innovation System'* (RIS). In this context, regional innovation systems are understood as *'cooperative innovation activities between firms and knowledge-creating and diffusing organizations, such as universities, training organizations, R&D institutes, technology transfer agencies etc., and the innovation-supportive culture that enables both firms and systems to evolve over times'* (Doloreux & Parto, 2005, p. 135). In recent years the concept of regional innovation systems has evolved into a widely used analytical framework that builds the empirical foundation for the development of innovation policy.

Figure 7: An ideal-type Regional Innovation System (RIS)
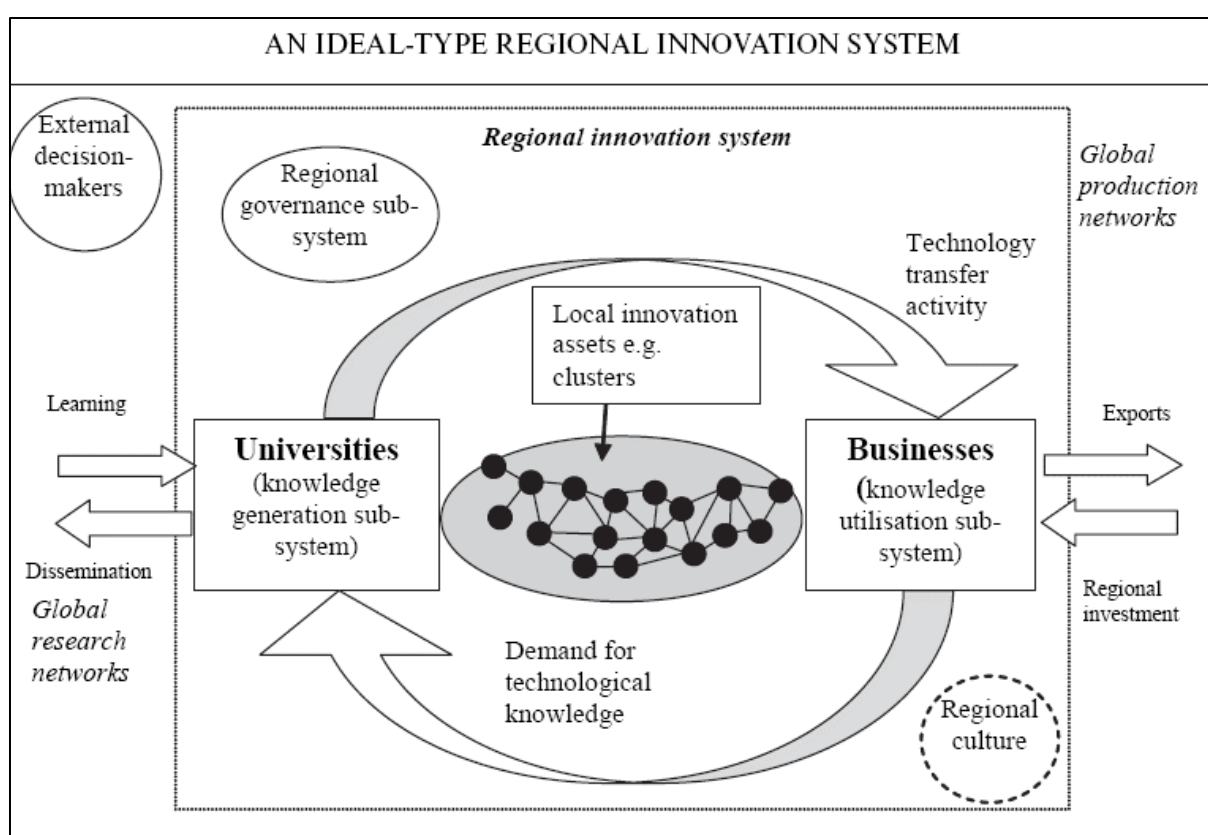
Source: OECD (2008) after Cooke & Piccaluga, 2004

Asheim and Isaksen (2002) argue that a regional innovation systems with a rich institutional infrastructure, involving research and higher education institutions, technology transfer agencies, organizations that foster firms innovation capacity, business associations, finance institutions, etc., hold important competence to support regional innovation. Hence, the institutional infrastructure helps local companies to increase their co-operation, competence building, and innovation activity. As it is outlined in Figure 1, regional innovation systems are characterized by a complex architecture that contains of several sub-systems. Within the inner circle, the educational institutions are the key

actors for knowledge generation, whereas the businesses around form the dimension of knowledge utilization and application and foster the demand for new technologies. A crucial element is the local interaction that facilitates a continuous flow of knowledge, human capital and (financial) resources. The regional governance system, in which public authorities and policy agents are involved, influences the long-term development of a region, thereby responsible for creating the requested environment for the local innovation process. Next to the implementation of congruent policies, the institutional structure of a region, both formal as well as informal, facilitates innovation and competitiveness (Trippl, 2006, p. 4f). Nevertheless, Regional Innovation Systems (RIS) are obviously embedded in the national, supranational and international system of a globalized economy and are partly driven by international competition.

Appendix III Distance Matrix – The 50 Reference Group

Table 9: Top 50 Reference Group

NUTS	Region	Distance
NL 213	**Twente**	**0**
AT 32	Salzburg	173
NL 41	Noord-Brabant	281
NL 21	Overijssel	294
DK 03	Syddanmark	299
UKF 2	Leicestershire, Rutland and Northamptonshire	311
ES 51	Cataluña	346
ITH 1	Provincia Autonoma di Bolzano/Bozen	348
DK 04	Midtjylland	386
AT 33	Tirol	399
UKG 2	Shropshire and Staffordshire	399
PL 21	Malopolskie	439
ITF 3	Campania	445
BG 34	Yugoiztochen	446
BE 21	Prov. Antwerpen	451
BG 41	Yugozapaden	478
AT 12	Niederösterreich	500
UKG 1	Herefordshire, Worcestershire and Warwickshire	503
FR 25	Basse-Normandie	512
CY 00	Kypros	525
ITF 4	Puglia	526
HU 10	Közép-Magyarország	538
ES 52	Comunidad Valenciana	545
BE 31	Prov. Brabant Wallon	551
UKD 4	Lancashire	552
LT 00	Lietuva	569
NL 34	Zeeland	569
NL 22	Gelderland	582
PL 41	Wielkopolskie	602
SE 23	Västsverige	611
BG 42	Yuzhen tsentralen	613
UKD 1	Cumbria	623
UKL 2	East Wales	637
UKN 0	Northern Ireland (UK)	639
AT 21	Kärnten	653
PT 11	Norte	671
UKE 1	East Yorkshire and Northern Lincolnshire	677
AT 22	Steiermark	683
SE 22	Sydsverige	688
NL 42	Limburg (NL)	692
UKF 1	Derbyshire and Nottinghamshire	716
DK 05	Nordjylland	724
PL 51	Dolnoslaskie	727
AT 31	Oberösterreich	762
UKE 4	West Yorkshire	765
ES 24	Aragón	769
PL 63	Pomorskie	797
UKM 5	North Eastern Scotland	808
PT 20	Região Autónoma dos Açores (PT)	809
ITH 2	Provincia Autonoma di Trento	811

Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), own calculation

Appendix IV Employment Distribution in the Top 50 Reference Group

Table 10: Distribution of Employment in the Top 50 Reference Group

Region	Mining	Manufacturing	Electricity	Water supply	Construction	Wholesale and retail trade	Transportation	Accommodation and food service	Information & communication	Real estate	Professional, scientific and technical activities	Administrative and support service activities
Twente	**0.04**	**14.23**	**0.17**	**0.22**	**7.68**	**18.17**	**3.71**	**3.96**	**1.29**	**0.64**	**6.08**	**3.92**
Niederösterreich	0.24	12.79	0.40	0.42	6.03	14.53	5.21	4.05	1.11	0.61	3.28	2.85
Kärnten	0.26	13.14	0.90	0.42	6.71	13.68	4.00	7.77	1.51	0.94	3.56	3.95
Steiermark	0.24	16.09	0.63	0.49	6.32	13.34	4.06	5.43	1.51	0.83	4.44	4.00
Oberösterreich	0.18	21.25	0.42	0.42	6.54	14.02	4.36	3.88	1.55	0.86	3.96	5.04
Salzburg	0.19	13.01	0.72	0.40	7.31	18.53	6.07	10.85	1.52	1.25	4.93	4.41
Tirol	0.22	13.34	0.68	0.37	7.20	14.58	5.48	12.42	1.35	0.86	4.21	3.20
Prov. Antwerpen	0.04	13.79	0.27	0.62	6.52	14.67	6.04	3.63	2.33	1.14	5.38	9.20
Prov. Brabant Wallon	0.19	11.86	0.18	0.27	5.39	14.10	2.26	3.06	3.58	1.30	6.43	6.75
Yugoiztochen	1.90	16.25	1.34	0.83	0.00	14.29	3.60	5.28	0.54	0.99	1.55	2.04
Yugozapaden	0.83	13.27	1.43	1.01	0.00	19.64	6.24	4.69	5.18	1.62	5.19	5.43
Yuzhen tsentralen	0.62	19.50	0.42	0.94	0.00	13.67	3.79	3.42	0.52	0.61	1.42	1.33
Kypros	0.14	8.55	0.37	0.37	8.72	16.09	5.22	9.78	2.43	0.41	4.98	1.76
Syddanmark	0.36	13.23	0.56	0.36	5.59	15.10	4.70	3.29	1.59	1.75	3.21	2.70
Midtjylland	0.06	12.59	0.37	0.32	5.27	14.80	3.71	2.68	2.48	1.77	4.64	2.97
Nordjylland	0.14	12.34	0.36	0.48	5.53	13.23	3.08	3.21	2.09	1.62	2.76	2.40
Aragón	0.18	13.71	0.31	0.51	8.01	13.73	4.51	5.08	1.42	1.01	3.58	4.01
Cataluňa	0.09	11.73	0.24	0.49	7.39	14.92	4.57	5.48	2.00	1.28	5.05	6.72
Comunidad Valenciana	0.08	9.24	0.17	0.65	6.90	14.47	3.47	4.85	0.97	0.91	3.56	4.12
Basse-Normandie	0.10	9.57	0.01	0.38	7.69	16.37	3.54	2.25	0.39	0.66	2.69	2.62
Közép-Magyarország	0.07	11.88	0.43	0.86	5.65	18.91	6.56	3.72	5.75	2.86	8.96	7.42
Campania	0.04	10.17	0.24	0.98	6.83	14.42	4.94	4.38	1.46	0.61	4.19	4.27
Puglia	0.10	11.00	0.27	0.91	7.61	14.06	3.44	4.46	1.18	0.45	4.03	3.67
Provincia Autonoma di Bolzano/Bozen	0.16	12.80	0.67	0.42	9.29	16.17	4.03	14.89	1.72	1.44	4.35	3.31
Provincia Autonoma di Trento	0.30	14.25	0.59	0.66	9.86	13.69	4.55	9.22	2.27	1.55	4.53	3.66
Lietuva	0.15	10.95	0.97	0.73	4.96	14.17	5.54	2.07	1.43	1.11	2.72	2.44

Overijssel	0.02	10.89	0.32	0.32	6.55	16.32	3.65	4.19	1.89	0.76	5.20	9.74
Gelderland	0.03	8.76	0.27	0.39	5.74	16.39	4.05	4.14	2.10	0.82	6.35	8.69
Zeeland	0.05	9.71	0.90	0.31	5.41	15.91	4.71	6.41	0.73	0.83	4.04	6.30
Noord-Brabant	0.02	11.81	0.17	0.38	6.16	17.72	4.43	4.24	2.14	0.82	6.39	11.01
Limburg (NL)	0.07	10.25	0.28	0.46	4.15	15.86	4.52	5.17	1.65	0.79	4.43	8.81
Malopolskie	0.71	12.27	0.66	0.62	6.21	14.85	3.57	1.95	1.72	0.93	3.40	2.27
Wielkopolskie	0.53	18.96	0.61	0.62	6.08	17.17	4.28	1.21	1.32	0.98	2.85	2.42
Dolnoslaskie	1.71	15.36	0.85	0.78	5.30	13.18	3.33	1.61	1.41	1.10	3.15	4.18
Pomorskie	0.13	15.52	0.91	0.73	6.45	13.50	4.65	2.06	1.57	1.33	2.96	2.43
Norte	0.20	18.00	0.10	0.46	7.90	13.49	2.03	3.64	0.83	0.74	3.20	4.63
Região Autónoma dos Açores (PT)	0.22	6.34	0.61	0.59	10.19	13.90	3.84	4.82	0.69	0.37	2.49	4.91
Sydsverige	0.09	12.06	0.48	0.39	6.73	13.43	5.10	2.65	2.97	1.44	6.08	4.76
Västsverige	0.07	15.24	0.66	0.38	6.33	13.31	5.94	3.10	2.83	1.58	4.92	4.31
Cumbria	0.12	14.07	0.08	0.69	4.99	15.28	3.69	8.26	1.37	1.18	4.81	3.47
Lancashire	0.02	11.95	0.21	0.44	4.47	14.62	2.78	5.47	2.02	1.15	4.37	4.61
East Yorkshire and Northern Lincolnshire	0.15	12.18	0.36	0.36	4.29	13.88	4.26	4.54	1.34	0.86	2.79	4.86
West Yorkshire	0.05	10.18	0.55	0.49	4.08	14.95	3.44	4.67	2.77	1.52	4.54	7.25
Derbyshire and Nottinghamshire	0.23	12.24	0.60	0.48	4.30	13.29	3.59	4.66	2.59	1.19	4.19	6.52
Leicestershire, Rutland and Northamptonshire	0.12	12.75	0.85	0.44	3.73	16.51	5.62	4.62	2.15	1.03	4.88	8.11
Herefordshire, Worcestershire and Warwickshire	0.13	11.79	0.42	0.64	4.58	16.38	4.29	5.74	3.36	1.37	4.33	6.46
Shropshire and Staffordshire	0.06	11.88	0.29	0.50	4.37	16.44	4.03	4.75	2.54	1.08	3.16	5.37
East Wales	0.05	10.27	1.00	0.64	4.42	14.62	3.18	6.31	2.43	0.99	5.05	6.15
North Eastern Scotland	11.08	10.50	0.32	0.26	6.09	16.28	4.38	7.74	2.34	0.83	13.60	6.46
Northern Ireland (UK)	0.21	8.92	0.15	0.45	5.08	16.15	2.98	5.29	1.73	1.09	5.16	4.84

Source: Eurostat (2013); Arbeidsmarktprognose Overijssel/BIRO/LISA (2011), own calculation

Appendix V   Ranking - Innovation Performance Twente and Reference Regions

Table 11: Ranking - Innovation Performance Twente and Reference Regions

NUTS	Region	R&D expenditure	Ranking R&D expenditure	Persons with tertiary education	Ranking Human Capital	Business R&D expenditure	Ranking Firm Activities	EPO patents per mio inhabitant	Ranking Intellectual Assets	HRST employment	Ranking HRST	R&D employment	Ranking R&D employment
NL 213	Twente	1.67	2	28.80	4	0.99	2	147.3	5	2.50	2	2.80	6
AT 12	Niederösterreich	1.36	1	17.90	1	1.19	3	117.23	4	3.40	3	0.87	1
AT 22	Steiermark	3.87	5	15.50	1	2.63	7	190.65	7	3.20	3	3.07	7
AT 31	Oberösterreich	2.45	3	17.50	1	2.18	6	221.95	8	2.30	1	1.79	4
BE 31	Brabant Wallon	7.66	10	49.50	10	0.22	0	171.15	6	8.90	10	4.08	10
DK 03	Syddanmark	0.74	0	27.50	4	0.47	1	131.00	5	2.30	1	0.86	1
DK 04	Midtjylland	1.19	1	31.60	5	0.29	0	171.33	6	4.30	4	1.53	3
ES 24	Aragón	1.12	1	33.10	6	0.64	1	46.65	2	2.70	2	1.61	3
ES 51	Cataluña	1.70	2	30.80	5	0.99	2	54.97	2	4.60	4	1.84	4
ES 52	Comunidad Valenciana	1.11	1	28.00	4	0.45	1	18.67	0	1.70	1	1.27	2
FR 25	Basse-Normandie	1.11	1	24.80	3	0.72	2	39.87	1	1.80	1	n.a.	0
NL 21	Overijssel	1.53	1	27.50	4	0.86	2	121.34	4	2.50	2	1.12	2
NL 22	Gelderland	2.06	2	30.90	5	0.82	2	110.16	4	3.20	3	1.20	2
PL 21	Malopolskie	0.93	1	23.50	3	0.23	0	12.22	0	2.60	2	0.99	1
PT 11	Norte	1.42	1	12.90	0	0.62	1	6.57	0	1.20	0	1.50	3
SE 22	Sydsverige	4.65	6	35.90	6	3.44	10	263.35	10	4.90	5	2.42	5
SE 23	Västsverige	4.27	5	33.00	5	3.33	10	148.34	6	3.80	3	2.49	6
UKD 4	Lancashire	1.27	1	34.40	6	0.96	2	36.67	1	3.20	3	1.47	3
UKE 1	East Yorkshire &Northern Lincolnshire	0.56	0	27.80	4	0.43	1	19.34	0	2.50	2	0.59	0
UKG 2	Shropshire & Staffordshire	0.52	0	30.00	5	0.41	1	44.28	1	3.00	2	0.47	0
UKN 0	Northern Ireland	1.59	1	31.40	5	1.00	2	31.78	1	3.70	3	1.28	2
	Average 20 closest regions	2.06	2	28.18	4	1.09	3	97.87	4	3.29	3	1.60	3
	Average of all 199 NUTS	1.46	1	25.40	3	0.36	0	61.80	2	3.45	3	0.84	1
	EU 2020 target	3.00	3	30.00	5	2.00	6						

Source: Own calculation; based on the information of the previous chapter