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- DUTCH-GERMAN DOUBLE DEGREE PROGRAMME -

M.A. European Studies

M.Sc. European Studies

Benchmarked Regional Innovation in the light of the 'Innovation Union' of the Europe 2020 Agenda:

A comparative time series analysis on the innovation performance of Nordrhein-Westfalen and its top 31 European reference regions over the last six years (2007-2013)

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Abstract
Back in 1995 the European Commission acknowledged with its widely influential 'Green Paper on Innovation' that innovation is one of the major 'engines' behind economic growth of the European Union. As such, the in 2010 adopted research and innovation strategy Europe 2020 aims at the advancement of its economy by centring around three priorities: innovation, sustainability and social cohesion. Against this background, EU-wide strategies have been implemented to promote "smart, sustainable and inclusive growth" throughout the EU. Against this backgrounds, this research project benchmarked the regional innovation performance of the German "Bundesland" Nordrhein-Westfalen against its top 31 European reference regions in the light of the 'Innovation Union'—one of the major flagship initiatives of the Europe 2020 Agenda—by observing the innovation performance throughout the years 2007-2013. Through the collection of panel data the exercise was able to capture the influence of the since 2009 on-going economic crises and its constraints on the innovation performance of European regions. The performed regional benchmarking analysis thereby revealed the the EU's 'policy triad'—"smart, sustainable and inclusive growth"—has not yet fully reached all European regions, including Nordrhein-Westfalen. The region can be classified as an 'innovation follower' as it is performing exceedingly well in terms of 'Intellectual Assets' and 'Economics Effects' by being close to the top, however, it lacks behind in terms of the 'Human Resources' and the 'Firm Investment' dimensions. Hence more effort is required by the regional innovation (policy) actors in order to close gap and or even simply come close to the set benchmark targets for those indicators.

Keywords
Benchmarking Analysis, Regional Dimension Europe 2020, Innovation Performace, Innovation Union, Nordrhein-Westfalen, Economic crisis

Uittreksel
In 1995 heeft de Europese Commissie met de publicatie van zijn 'Groenboek over innovatie' innovatie erkend als een van de belangrijkste krachten achter de toekomstige economische groei in de Europese Unie. De in 2010 aangenomen Europa 2020-agenda concentreert zich op drie prioriteiten: innovatie, duurzaamheid en sociale cohesie. Op deze achtergrond worden er in de EU strategieën geïmplementeerd, om "slimme, duurzame en inclusieve groei" binnen de hele EU te verspreiden. Dit onderzoeksproject vergelijkt de regionale innovatie van de Duitse deelstaat Nordrhein-Westfalen met de top 31 Europese referentie regio's in het licht van de 'Innovation Unie'—een van de grote initiatieven van de Europa 2020-agenda—door het observeren van de innovatie tijdens de jaren 2007-2013. Door het verzamelen van panel data was de oefening in de gelegenheid om invloed uit te oefenen sinds de 2009 lopende economische crises die beperkingen op de innovatie prestaties van de Europese regio's heeft gehad. De uitgevoerde regionale benchmarking analyse toonde aan dat het EU-trio "slimme, duurzame en inclusieve groei" nog niet volledig alle Europese regio's, met inbegrip van Nordrhein-Westfalen, heeft bereikt. De regio Nordrhein-Westfalen kan aangemerkt worden als een 'innovation follower' aangezien de regio in het bezit is van 'Intellectual Assets' en 'Economics Effects' (beide keer dicht bij de top) maar de region "Nordrhein Westfalen" mist innovatie op het gebied van 'Human Resources' en 'Firm Investment' dimensies. Dus meer inspanning door de regionale innovatie (politicus) is nodig, zodat de regio Nordrhein-Westfalen in de buurt komen van de benchmark doelstellingen zal komen.

Sleutelwoorden
Benchmarking Analyse, Regionale dimensie van Europa 2020, Innovatie Performance, Innovatie-Unie, Nordrhein-Westfalen, Economische crises

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List of Abbreviations

Alphabetically sorted

Abbreviation	Explanation
BE	België (eng. Belgium)
DE	Deutschland (eng. Germany)
EPO	European Patent Office
ES	España (eng. Spain)
EU	European Union
ERDF	European Union Regional Development Fund
GDP	Gross Domestic Product
GERD	Expenditure on R&D as a percentage of the GDP
IUS	Innovation Scoreboard
NIS	National Innovation System
NRW	Nordrhein-Westfalen
NUTS	Nomenclature des Unités Territoriales Statistics (eng. Nomenclature of Territorial Units for Statistics)
OECD	Organisation for Economic Co-operation and Development
PL	Polska (eng. Poland)
R&D	Research & Development
RIS	Regional Innovation Scoreboard
RIS	Regional Innovation System
SME	Small and medium sized enterprises
UK	United Kingdom

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1. Introduction

1.1 Background and Research Objective

Back in 2010, the former President of the European Commission José Manuel Barroso (2010:7), whose presidency lasted from 2004 to 2014, stressed the importance of innovation as one of the key 'engines' for Europe's future development when stating that "[t]here 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. [...] [T]he 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." The importance of the idea of innovation was also transported into the Europe 2020 Agenda, which centres around three priorities: innovation, sustainability and social cohesion. This plan was the successor of its ten years earlier started Lisbon Strategy that failed in its aims to make the European Union (EU) "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion" (europarl.europa.eu, n.d.). As such, the Europe 2020 Agenda also centres around the three earlier established pillars: innovation, sustainability and social cohesion by renewing the underlying approach of the Lisbon Strategy, based on a partnership for growth and job creation that relies on a mix of the commitment of Member States to take action at the national level (including the usage of indicators and target levels), while making also the best use of governance mechanisms and instruments at the EU level. In that regard, also greater emphasises on the coordination of those levels, hence national and European policy, has been given as well as a more binding character for the achievement of the goals as underlined in the final agreement (Barroso, 2010; Natali, 2010).
In order to measure progress on the agreed and established priorities five EU-wide headline targets have been developed, which in turn were translated into national target levels. Of those headlines, number two addresses the topic of Research and Development (R&D) that is often used as general term for activities in connection with innovation. Innovation is thereby defined and understood in this research project, as established by the European Commission in 2010 (2010e; 2010f) when the 'Innovation Union'—which will be analysed in this research project—was introduced. Back then Máire Geoghegan-Quinn, the Commissioner for Research, Innovation and Science and Vice-President Antonio Tajani, also responsible for industry and entrepreneurship said that the first important lesson in relation to innovation is the acknowledgement of the fact that there is no single definition of the term innovation. "But innovation as described in the Innovation Union plan broadly means *change that speeds up and improves the way we conceive, develop, produce and access new products, industrial processes and services.* Changes that create more jobs, improve people's lives and build greener and better societies" (European Commission, 2010e; 2010f, emphasis added by author). Hence to make it short: Innovation is about finding a new way of doing something!

The headline goal number two, which addresses the topic of R&D has set its benchmark target goal at the value of three per cent of the EU's Gross Domestic Product (GDP), which should be invested into R&D. This should be achieved with the help of the Europe 2020 flagship initiative 'In-

novation Union.' This EU-wide strategy is meant to facilitate an innovation-friendly environment that would make it easier to transform innovative ideas into products and services that could bring the European economy growth, jobs and progress. To speak in concrete numbers: Meeting the Europe 2020 target of increasing R&D investment to three percent of GDP could create roughly 3.7 million jobs and increase annual GDP by up to €795 billion by 2025 (Zagamé, 2010). This goal is thereby to be achieved by considering "smart, sustainable and inclusive growth" on all possible (geographical) levels of the European Union (Baroso, 2010; Natali, 2010). Thereby this "smart, sustainable and inclusive growth" of the Europe 2020 Agenda apparently does not happen somewhere but, as earlier research suggests (e.g. Engelhardt, 2013; Navarro et al., 2011; 2014; Groenendijk et al., 2013; Groenendijk, 2015), it happens within so-called regional innovation systems. According to innovation system theory, innovation and technology development are results of a complex set of relationships among actors in this system, which includes people working in enterprises, universities and government research institutes. Regions are recognised now in official EU policy documents and publications (e.g. European Commission, 1995; 1996; 2000; 2001; 2002; 2010a; 2010b; 2010c; 201d; 2011; 2012; 2014; 2015; ESPON, 2014) to be one of the 'main drivers' behind the European (innovative) economic growth. As regions are the 'drivers' behind innovation policies, innovation strategies are one of the 'keys' to enable growth. Therefore it seems obvious and imperative first to understand how one could possibly analyse the innovation strategies into the regional innovation systems, and then in a second step benchmark this innovation strategy against pre-set set/defined goals in a particular timeframe, and consequently engage in a learning process by assessing the shortcomings and surpluses in this particular observed region and draw conclusions from this in terms of e.g. policies that facilitated the relationship of the different actors (i.e. enterprises, universities and government research institutes) within the region innovation system.

Taking this premisses on an European-wide level of analysis this means that a successful implementation of the Europe 2020 Agenda also requires the agenda to sufficiently trickle down to the regional level. Understanding how a region works in terms of innovativeness is a useful research exercise as the analysis of the regional innovation system of a specific region and its consequent comparison to other European regions (and their innovation systems) in terms of innovativeness is a useful exercise that may help (local) policy makers, scholars, and citizens better understand innovation, governance and (regional) geography interacts and possibly influences each other. When regional policy actors are able to understand oneself in terms of individual regional strength this knowledge can be used to enhance ones own innovative capacity and potential and finally those regions would be able to contribute and improve the overall economic and innovation performance of the whole EU, which is still behind the United States or Japan in terms of top-end research (European Commission, 2015a).

In the EU the importance of this regional perspective is also translated as a territorial dimension of Europe 2020. In the heart of the Territorial Agenda 2020 (ESPON, 2014)—that was adopted in May 2011—took the 'policy triad' of "smart, sustainable and inclusive growth" (Barroso, 2010) and rephrased it in its sub-title as "[t]owards an inclusive, smart and sustainable Europe of Diverse Regions" (ESPON, 2014:4). As such, the topic of spatial planning and development of the Member States of the European Union as expressed by the topic of territorial cohesion has become a shared

competence of the EU and its Member States as laid down in article four of the Treaty on the Functioning of the European Union (Consolidated Version of the Treaty on European Union, 2010). As the European countries are following different strategies in regard to the enhancement of their regions, e.g. in terms of investing and transferring money, it does not seem to surprise that the development of the regions seem to vary across the EU. Some regions seem to be more successful in terms of R&D intensity than other regions, which more straightforward stated is the question of to what extent research and innovation, as undertaken in a region, can be understood in terms of its resource input. Earlier research already indicated that resources inputs differs significantly (European Commission, 2012; 2014). Also it had been observed that the majority (eleven out of the thirty-two) of the most innovative 'Nomenclature of territorial units for statistics' (NUTS) 2 regions[1] are located in the Western part of Germany[2]. This bears the question of *why* Germany, specifically the Midwestern part of it - which is the political-speaking Nordrhein-Westfalen (NRW) - is so innovative and *how* does it differ in regard to other, apparently less innovative, European regions?

Having posed this question, a possible answer to it can be presumably found when using the academic lens of European Economic Governance that is dealing with the intersection of (public sector) economics and European integration. To be specific, this research project will narrow its scope to a specific topic, which is the comparative analysis of the success of the regional dimension of the EU-wide innovation strategy Europe 2020. Hence the aim of this thesis is compare NRW and its European reference regions[3] across the European Union in terms of innovativeness, as outlined in the Europe 2020 Agenda, and consequently learn more why certain regions in Europe are more (or less) innovative than others. The analysis of the implementation of the Europe 2020 Agenda in regional innovation system offers the possibility to use a research tool called territorial benchmarking. Territorial benchmarking seems to be the most applicable methodological and research tool to measure, asses and consequently analyse the given problem because territorial benchmarking allows for the possibility to compare the regional competitiveness between regions as it "measures processes, performances and results of the own region [...] and compares the gathered data with those of other (better) regions [....] by using indicators (benchmarks)" (Iding, 2008: 245). As such, the Euro-

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[1] The 'Nomenclature of territorial units for statistics', abbreviated NUTS, is a geographical nomenclature subdividing the economic territory of the European Union into regions at three different levels (NUTS 1, 2 and 3 respectively, moving from larger to smaller territorial units). Above NUTS 1, there is the 'national' level of the Member States (Eurostat, 2011). This research project will work with the NUTS 2 level as it is has been framed as the level of analysis when regions are analysed in terms of their (regional) policies (Eurostat, 2011).

[2] These German regions are followed by the United Kingdom (six), Sweden (four) and Finland (three), followed by regions in Belgium, France and Austria (two regions each), and finally Denmark and Slovenia (one region each). Altogether these regions were responsible for 44.1 per cent of the EU's total R&D expenditure in 2011 (Europe.eu, 2015)

[3] The concept 'reference region' as understood here, in this research project, refers to an idea along the most-similar case design that one should select regions that are "structural similar" to Nordrhein-Westfalen to benchmark against it. This idea will be more elaborated upon at a later stage of this project. There also the specific dimensions along which "similarity" was decided upon will be discussed.

pean Commission itself explicitly appreciates interregional benchmarking to identify so called 'best practices' and engage subnational authorities from weaker regions to learn from successful ones (Hospers, 2004:7; Hospers et al., 2012:15f).

So putting the single jigsaw pieces together, the research objective of this master thesis research is twofold: On the one hand, it aims to analyse the innovation performance of NRW by taking into account the strategic plan of the region to become an innovative top region by means of the Europe 2020 Agenda. It is therefore an evaluative (and descriptive) report on the performance of NRW—relative to a set of pre-chosen regions on the basis of a predetermined set of benchmarks. While on the other hand, however, this thesis also aims to understand *why* NRW differs from other regions in terms of innovation and in the consequence also an descriptive-explanatory dimension. Due to the fact that the earlier published research already indicated the importance of analysing relationships among the actors in regional innovation systems, this research project takes the earlier used pattern by looking first at the suggested innovation enablers, followed by the analysis of firm activities and intellectual assets, and finally dealing with the innovation outputs. Nevertheless, as this thesis is (also) using an European Economic Governance perspective, this project will also shortly explore the (regional governance) literature on how other governance and policy factors have been theorised to influence innovation. This includes a discussion on how regional innovation may be positively or negatively influenced by political structures, institutions, political climates and the types of policy instruments and rhetorics that are deployed when it comes to economic development.

In addition to that, this research project aims to not only provide the latest 'snap-shot' available—which is the year 2013 as here the the most recent data is available (European Commission, 2014; Eurostat Database, 2015)—but it is also, in the eyes of the researcher, important to analyse how the selected European reference regions develop over time. Especially when one considers that the US financial crisis of 2007-2008, the subprime mortgage crisis of 2007-2009 and the consequent extension of the crises onto the territory of the European Union (with the fall of the Lehmann Brothers bank in 2008) since its 'start' in 2008 resulted in a government debt crisis, a banking crisis and finally, an overall growth and competitiveness crisis. Albeit hit unequal by the crises the EU and its Member States have been increasingly more pressured by cost containment reforms and policies, rationalisation efforts and even outright retrenchment. An environment, which has been by some labelled as 'permanent austerity.' The usage of a bigger time frame (2007-2013) allows to analyse on the notion whether or not the overall global economic recession had an impact on the overall innovation performance of European regions or not. Hence panel data of every two years (2007, 2009, 2011, 2013) will be collected from the Eurostat Database (2015) in order to map the innovation performance of the European regions.

Summarising, the overall mapping exercise of this master thesis, aims to show how regions in Europe score at half time of the Europe 2020—and being somewhat influenced by crises—by looking at the last six years of performance. Especially for the latter one, this study aims to narrow them down by comparing Nordrhein-Westfalen with other reference regions. Thus, the central research question of this master thesis research project therefore reads: ***'Benchmarked with European reference regions, how does the region of Nordrhein-Westfalen perform with re-***

spect to innovation, taking into account the strategic goals of the Europe 2020 flagship initiative Innovation Union throughout the years 2007 till 2013?'

1.2 Literature Review and topic relevance

The research project lies within the research field of European Economic Governance; specifically it investigates the regional dimension of the Europe 2020 Agenda. It is a descriptive benchmarking exercise of European regional innovation systems and their performance with benchmarks predefined by Europe 2020 Agenda. Benchmarking has its origins in the private sector but since then has found its application to the public sector in the meantime. Broadly speaking, this kind of research roots in its initial research form regional policy—of which EU regional innovation policy is an important dimension—and is directed at solving the problems of uneven development between territories in the EU, including regions, localities and cities (Hospers, 2004; Hospers et al., 2012). As such, earlier benchmarking analysis of EU regional innovation policy aimed at understanding how one could improve the situation of the less (economically well) performing regions by catching towards the more (economically well) performing regions (e.g. Engelhardt, 2013; Groenendijk et al., 2013; Navarro et al., 2011; 2014; Iking, 2009).

In that regard the original term 'benchmarking' rooted in the construction sector during the 1990s when engineers used benchmarking as a tool to measure their products against a certain standard that was perceived as the one that should be reached with the help of the products. This idea was quickly adopted in the private sector by the business and enterprise world to compare individual departments within a company that were better performing, in terms of e.g. processes, services or strategies that lead to high performances of these departments. The other departments were urged to get closer to "best performing" departments and to close the gap by identifying their "best-practises", hence use the learned information to improve the "own performance" and implementing them. Achieving efficiencies and increase productivity are the goals with a continuous process-Circle that cumulates in the exceeding of the so-far best performers that in turn now aim to catch up with those that exceeded them (Bessant and Rush, 1998:3f; Iking, 2009:245f; Huggins, 2008). With the rise of the idea of New Public Management in the public sector that introduced the discussion and investigation of economic and political systems that aimed to modernise and render the public sector more efficient, benchmarking has been applied in various settings. As Groenendijk (2011:82) points out, nowadays, the reasons for the implementation of performance or benchmarking studies in the public sector range from its original purpose of the enhancement of performances up to the improvement of the legitimacy of government intervention. As such, there are various types of benchmarking that one needs to distinguish as their application differs from the goal that the researcher (or whoever conducts the benchmarking analysis) tries to achieve. The types of benchmarking are: internal vs. external, functional vs. generic, cooperative vs. competitive benchmarking.

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

Huggins (2008:642) therefore in his work on "Regional Competitive Intelligence: Benchmarking and

Policy-making" suggest to distinguish three different types of territorial benchmarking that one could use:

(1) performance benchmarking that is based on a comparison of metrics portraying the relevant characteristics of the benchmarked against regions;
(2) process benchmarking, which is the comparison of the structures and systems constituting the practices and functioning of benchmarked regions;
(3) policy benchmarking that is to say a comparison of the types of public policy considered to influence the nature of the practices and subsequently the characteristics of benchmarked regions.

Building on this, for the analysis of the public sector, Groenendijk (2011:183ff) distinguishes between three possibilities of benchmarking analysis, which depend in their application on the focus of the researcher:

(1) the benchmarking of public sector organisations, which is a very similar approach to the private sector approach;
(2) the benchmarking of public policies, which has no counterpart in the private sector as policy outcome targets are more relevant for the public sector;
(3) and the benchmarking of policy systems like the studies dealing with national innovation systems, and/or its mutatis mutandis the regional innovation system.

As the research aim of this master thesis is to benchmark the innovation performance of NRW against its European reference regions, process and policy benchmarking as presented by Huggins (2008:642) will be not taken into account in this project due to its limited research frame[4]. So in turn this research project will only specify the nature of international, or in this case interregional, performance benchmarking further by conducting a benchmarking of the policy system i.e. the regional innovation system of NRW and its European reference regions. Hospers (2004:9) points out that the European Commission explicitly appreciates in its policy agenda the idea of this kind interregional performance benchmarking as it can help to identify the earlier mentioned 'best practices' and consequently engage sub-national authorities of weaker regions to learn from their more successful counterparts. Most of the earlier conducted research builds upon the benchmarking of innovation systems and their performance against each other. Most noteworthy of this research is the Innovation Union Scoreboard (IUS), which is an instrument of the European Commission, developed under the Lisbon Strategy and revised after the adoption of the Europe 2020 Agenda to provide a comparative assessment of the innovation performance of EU Member States (European Commission, 2015a). Regional innovation benchmark studies are less frequent and less detailed due to a general lack of innovation data at the regional level (e.g Engelhardt, 2013: ??). As such, the Regional Innovation Scoreboard (RIS) of European Commission tries to address this gap by providing statistical facts and figures on European regions' innovation performance and ranking them (European Commission, 2012; 2014), however, it lacks—and this is where this master thesis adds something to the existing body of knowledge—a comparative studies about how the innovation performance of European regions develops over time. Both, IUS and RIS, only provide a 'snap-shot'

[4] In an ideal case a new (second) research project would aim to combine at least two of the different benchmarking approaches in order to get a more coherent overview of the innovation performance of the benchmarked regions.

view of a single year. Starting from 2013 onward the reference year is given in the title of the report, which is also equal to the year in which the report is published[5]. No comparative analysis (on the basis of territorial benchmarking as research and methodology tool) has been found which took into consideration the European crises and their possible impact on the overall innovation performance of European regions. Hence the collected panel data of every two years (2007, 2009, 2011, 2013) (Eurostat Database, 2015) analyses how in selected European regions innovation performance developed over time, while at the same time facing harsh cost containment reforms and policies, rationalisation efforts and even outright retrenchment. Also the moment of investigating this research problem could not be a better one as at the time point of writing (2015) it is half time for the Europe 2020 Agenda, which calls upon the greater coordination of national and European policy for the advancement of the economy of the European Union.

The analysis that will be performed as part of this research project will be able to contribute to the assessment of the so far progress of the innovation strategy by assessing the strengths and weaknesses of the respective regions. As such, it will aim to clarify whether "smart, sustainable and inclusive growth" (Barroso, 2010) has taken place in European regions and if had been successful or not in those selected regions. Based on this it will be hopefully possible to detect some patterns that contribute to a successful implementation of innovation strategies in general on the one hand, while on the other hand it will be maybe possible to make some concrete recommendations by understanding how a region compares to others in terms of innovativeness. This knowledge could be then used by e.g. policy makers, scholars, academics, and citizens to better understand innovation and governance in regional contexts work. Yet, by focussing, like earlier research projects, on a reference region (NRW) that is located in a Western (read old) Member State this research project follows the established research patterns. Also this research project does not differ from earlier studies in that respect that it acknowledges the governance dimension only as it is not able include it in the analysis. Nevertheless the governance dimension should be given a more central (theoretical) role by shortly discussing how different governance styles and environments have been discussed as having an impact on growth/innovation/economic development. This has been discussed by e.g. Audretsch (2004), Acs and Szerb (2007), and recently Rodríguez-Pose and Di Cataldo (2015). This has academic and societal relevance as it is especially relevant in regard to the regional dimension of the Europe 2020 Agenda. The territorial dimension of Europe 2020 is also at the heart of the Territorial Agenda 2020, adopted in May 2011 (ESPON, 2014) that has already earlier identified regions as the the 'main engines' of the European innovative growth (e.g. European Commission, 1995; 1996; 2000; 2001; 2002; 2010a; 2010b; 2010c; 201d; 2012; 2014; 2015; ESPON, 2014).

1.3 Research Questions and Variables

Being interested how Nordrhein-Westfalen performs with respect to innovation, specifically in comparison with its European reference regions, there are various issues and aspects that need to be

[5] This is why IUS 2013 follows directly the IUS 2011 and IUS 2012 does not exist.
Earlier published reports of the IUS where made publicly available in 2010, 2011, 2013 and 2014, while the RIS was available for the years 2009, 2012, and 2014.

addressed. As such, in order to enhance readability there are several sub-research questions that have to be addressed in the paper in their respective parts in order to respond in the final part more easily to the central research question. These sub-questions are divided into three sub-blocks with each bloc dealing with a different and important part of the overall research project.

The first bloc of four questions is used to create a theoretical base for understanding the topic of regional innovation and its link with the innovation strategy Europe 2020. These sub-questions read:

- Sub-question One: Why and how has the regional level become the focus of European innovation policy?
- Sub-question Two: Why and how does benchmarking as a methodological and research tool can be used to enhance regional innovation and competitiveness in the European Union?
- Sub-questions Three and Four: What is the Europe 2020 flagship initiative 'Innovation Union' and what are the strategic aims of the 'Innovation Union' with regard to regional innovation performances?

The second set of questions deals with the prerequisites that are needed before regional benchmarking analysis can be undertaken. It is important to know, which indicators are available to measure innovation performance of regions before possible European reference regions can to be identified that will be benchmarked against the innovation performance of NRW. The two sub-questions four and five therefore read:

- Sub-question Four: Which possible indicators are suitable and available to measure the innovation performance of EU-regions (over time)?
- Sub-question Five: How can one possibly identify suitable European reference regions in order to compare them with the innovation performance of the reference region Nordrhein-Westfalen?

The third and last block of questions builds on the notion that suitable reference regions for comparison have been obtained and now are benchmarked against each other in respect to innovation performance. After conducting the benchmarking exercise it should be possible to illustrate the possible strengths and weaknesses in regard to innovation performance of NRW in comparison with its reference regions. The last bloc therefore deals with the dimension of possible lessons that can be deducted from the analysis—not only NRW but also for European regions in general.
Hence the sub-questions six and seven read:

- Sub-question Six: How does Nordrhein-Westfalen perform with respect to innovation when compared with its European reference regions over the analysed time and in regard to the given innovation indicators of the Europe 2020 Agenda?
- Sub-question Seven: What does the regional innovation system of NRW (and the system of the other European regions) can learn in regard to the the innovation performance for the further progress of the Europe 2020 Agenda?

The overall aim of all research is to describe and explain possible variance in the phenomena observed in the world. In research methodology, the term 'variable' is used to explain the variance the researcher wants to explain (Babbie, 2009:14ff.). As such, a variable is either a result of some force

or is itself the force that causes a change in another variable. In research (experiments), these are called dependent and independent variables respectively. While the dependent variable, sometimes also labelled as the cause, is thereby expected to undergo a chance as a result of the experimental manipulation of the independent variable(s) as conducted by the researcher in the experiment. Conversely, the independent variable is the condition of an experiment that is (systematically) manipulated by the investigator in order to observe the (desired) outcome/result (all Babbie, 2009: 18). In this master thesis the dependent variable is the expenditure on R&D as a percentage of the GDP, which has been identified in the Lisbon Agenda and later also in the Europe 2020 Agenda as the corresponding indicator to measure innovation (European Commission, 2012; 2014; 2015), while the four independent variables are (1) the percentage population aged 25-64 having completed tertiary education, (2) the R&D expenditure in the business sector, (3) the number of EPO patent applications per million inhabitants, and lastly (4) the employment in knowledge-intensive services (manufacture and services) as per cent of total workforce (all European Commission, 2014: 9), which are all indicators from the 'Innovation Union' scoreboard and are available as innovation indicators[6].

1.4 Outline and Roadmap of the Thesis

This research project is with its 93 pages and more than 17 tables and 2 figures a quite extensive one. Hence it seems imperative to present an outline and roadmap of this research project to the reader in order to facilitate the flow of information as outlined in the master thesis and make it easier to find the relevant information inside the chapters.

Following this introduction, the next chapter sets out the necessary (theoretical) background knowledge for understanding the Europe 2020 Agenda. It presents the regional dimension of the flagship initiative 'Innovation Union' and present Nordrhein-Westfalen and its policy plan on how it wants becomes an innovative regions within the Europe 2020 Agenda.

Next, chapter three is devoted to the theoretical framework by discussing how regions matter as engines for (regional) innovation policies. It starts out by briefly introducing the importance of the regional perspective as well as exploring the dynamic approach of Schumpertian innovation. Both those concepts are combined when the interdicting the analytical frame where innovation and region meet—the Regional Innovation System.

Using the Regional Innovation System. as a starting point chapter four engages with the research materials and research methods by outlining territorial benchmarking as tool to benchmark regions. It explains how the respective European reference regions will have been chosen as well how the necessary data for analysis will be obtained and consequently explained how they will be descriptively analysed.

The actual benchmarking analysis is then performed in chapter five. It benchmarks the innovation

[6] For reasoning. Which indicators had been chosen to capture and measure innovation on the regional level see also the Materials and Methods chapter.

performance of NRW against its earlier established corresponding reference regions. Due to the limited availability of regional data at NUTS 2 level the analysis will be restricted to the investigation of only on a handful number of indicators. It will conclude with an ranking of the overall innovation performance (by using an average of values over a given time instead of illustrating changes in performance over time as original planed) and also highlighting descriptively the individual strengths and weaknesses of the regions

Finally and lastly, chapter six summarises the outcomes of the analysis. The master thesis will also aim to present some policy recommendations for NRW and the other regions as well as providing critical assessment regarding the overall research design and the project in general. As such, also an outlook for future research project will be given.

2. Theory and Background for understanding the Europe 2020 Agenda

2.1 Purpose and Goals of the Europe 2020 Flagship Initiative 'Innovation Union'

Since the year 2007/2008 the European Union has been aggravated to face a economic crises, which since its 'start' resulted in a government debt crisis, a banking crisis and lastly growth and competitiveness crisis. The subsequent economic recession and the tight budgetary tensions, often coupled with austerity measures, has affected all, albeit to a different extent, the economies all of European Member States (and their respective regions).

The ongoing recessions raised severe criticism about the Lisbon Strategy, which was made public by European as well as national politicians. The Lisbon Strategy was not able to bring a common European solution to the problem of reviewing the Member State and European Unions economies that declined during the recession. The European Commission (2010a, 2010b) therefore issued in 2010 the Europe 2020 Agenda, which formulated several essential topics that Europe has to deal with in the nearly future and asked fundamental questions like "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?" (European Commission, 2010a:6). Accordingly these fundamental questions can be only answered by putting more emphasis on certain policy priority with several goals and targets. The European Commission (2010:10a) labelled the five most important headline targets in terms of quantifiable indicators by emphasising that each single Member States, but more importantly the whole EU, must achieve those goals by the year 2020:

1. Raising the employment rate of the population aged 20-64 to at least 75 per cent;
2. Achieving the target of investing 3 per cent of the GDP in R&D by also improving the conditions for R&D investment;
3. Climate change and energy policy—the 20/20/20 goals which is (a) to reduce greenhouse gas emissions by at least 20 per cent (compared to 1990 levels), (b) increase the total share of renewable energy in the total energy consumption to 20 per cent, and (c) increase to 20 per cent

in terms of energy efficiency;

4. Decrease early school leavers up to 10 per cent, while at the same time increase the share of people (aged 30-34) that has completed tertiary education to 40 per cent level;
5. And finally reduce the total number of Europeans living below the national poverty lines by 25 per cent, thus lifting over 20 million people out of poverty.

These overall priorities have been further broken down into seven flagship initiatives of which number one, the 'Innovation Union' is placed at the heart of the overall Europe 2020 Agenda as well as this research project, as Europe's 'policy triad' of "smart, sustainable and inclusive growth" is underlying the importance of a sound innovation policy in Europe. The European Commission (2010a; 2010b) goal is to improve the overall framework for Research & Development and Innovation in the European Union by supporting the knowledge-triangle education, research and innovation to work together more closely, 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 creating on top new ones) and to tackle the major demographic change of post-industrialised societies that will affect Europe in the future. As such, the future living standards of the EU will not only strongly depend on its own innovative capacity of creating new and innovative products but also in terms of its ability to establish innovative services, business and social processes. Furthermore, innovation will have an influence on societal aspects at large, such as climate change, energy and resource scarcity, health and even ageing, which are becoming more and more important as the future is approaching (all European Commission, 2010a:2). Jean-Claude Juncker, President of the European Commission since November 2014, himself confirmed this view in his first 'State of the Union' speech delivered on 9 September 2015 in front of the European Parliament (Juncker, 2015) by underling that innovation is the key in several European projects—stimulating economic growth, dealing with energy politics i.e. Energy Union, copying with the climate change and/or enhance the Digital Single Market of the Union.

2.1.1 The Basic Framework conditions of the 'Innovation Union'

Back in 2010, the European Commission's Communication (2010b) 'Europe 2020 – Flagship Initiative Innovation Union' pointed out the key challenge for the EU in terms of innovation is that it does not succeed in the creation and usage of the generated knowledge in its key areas. This problem is therefore to be addressed in the initiatives that are planed and set out to take place in the future. In order to cope with this 'European problem' the European Commission has identified two major weaknesses that impede the innovation environment and performance.

One the one side of the coin, there are many unfavourable framework conditions in the European Union that hinder the private investment in R&D and innovation, on the other side of the coin it is revealed that these problems are often coupled with high financial restrictions. EU-wide patenting for example, so a European-wide Patent, is considered by some too costly and also it does not offer ultimate intellectual protection throughout the whole European Union (as not all Member States are participating in the creation of it). Albeit EU-wide patents (officially called 'European patent

with unitary effect') would offer a variety of possibilities in terms of economic, intellectual and innovative flow there are also several constrains that one needs to deal with before a European patent with unitary effect could have a real effect in the European Union, when it comes to innovation protection (all Theben, 2014). In addition to patents also the availability of financial resources in order to present ones innovative ideas to the market, is often a big problem for the inventor. But also often outdated and/or complex regulations and procedures and deliberate standard setting of specific actors hamper successful innovation practises (all European Commission, 2010b). Another striking failure seems to be that, although having a single market in the European Union, there are still some sort of barriers that complicate cross-border activities and impede the sharing and using of knowledge from all sources—often in terms of resources but also in terms of human workforce. On top of that the European Commission's Communication (2012b) warns that too much money is often spent for to costly duplications of inventions as there is no general European dimension but rather sparse different national and regional research and innovation systems. In order to avoid this overlap the European Union must be forced to combine those efforts and to enhance the quality of research and Europe's potential for major breakthroughs by increasing the effectiveness of investments that are so desperately needed to get ideas on the market (European Commission, 2010b:7).

In order to tackle the unfavourable framework conditions and to avoid a fragmentation of effort, the Communication calls upon a European strategy that has to be adopted by all Member States and its regions. The to be analysed flagship initiative 'Innovation Union' is one of those straggles as it incorporates three mutually reinforcing priorities by emphasising that first of all it should be focused on innovations that address the major societal challenges as identified in the Europe 2020 Agenda and outlined above. The addressing of this priority stresses the important role that innovation has now taken in the EU's policy design. It is now a key element of (nearly) all EU policies. Next to that a broader definition of the concept is needed as not only research-driven innovation but also innovation in business models must be pursued to the extent that the strength of the creative industries are acknowledged in being able to generate growth and jobs for and in the European Union. At last, the European Communication states in its Communication that it is important to involve all relevant actors in the innovation cycle, including the public sector, the social economy and ultimately citizens themselves. This means that not only major companies and enterprises are ought to be innovative, and also not the few high-tech areas that exist should be a part of the circle, but instead every Member State and all of its regions, with all its actors in Europe shall act together in cooperative innovative partnerships (European Communication, 2010b:7f). To that end, the Communication recognises that the EU's fundament are and remain the strong positioning of its Member States and regions, which are (already) world leader in respect to some (economic) sectors. As such, there are also some European regions that are considered as highly innovative as the Californian 'Silicon Valley' in the United States and can therefore easily compete with it. However, the overall strategy needs to be facilitated further. Therefore, the European Commission (2010b) has determined that the following improvements have to be made at the European level to achieve a more sound innovation on all levels:

(1) delivering the European Research Area and setting out a sound strategic agenda that deals with the challenges identified by Europe 2020;
(2) improving the overall framework conditions for businesses to become innovate e.g. develop a

single EU Patent, improve access to financial capital and make use of possible smart regulation;
(3) initiating 'European Innovation partnerships' between the EU level and the national levels in order to speed up the development of technologies that are needed to deal with the challenges of today and the future;
(4) promoting knowledge partnerships, while at the same time also strengthening links between fields of education, business, research and innovation;
(5) revise and consequently update the existing EU instruments (e.g. structural funds, rural development funds, R&D framework programme, CIP, SET plan) that support innovation.

2.1.2 The Regional Dimension of the 'Innovation Union'

Having discussed the purpose and goals of the flagship initiative 'Innovation Union' and the contribution of the European Commission, the following section will explicitly deal with the regional dimension of EU innovation policy and the corresponding strategic vision. As parallel to the Communication 'Europe 2020 – Flagship Initiative Innovation Union' (European Commission, 2010b), the European Commission (2010c) also launched its fifth report on economic, social and territorial cohesion to support the Europe 2020 Agenda. This supported by the heart of the Territorial Agenda 2020 (ESPON, 2014)—which was adopted in May 2011—and took the 'policy triad' of "smart, sustainable and inclusive growth" (Barroso, 2010) and rephrased it in its sub-title as "[t]owards an inclusive, smart and sustainable Europe of Diverse Regions" (ESPON, 2014:4). In that regard the topic of spatial planning and development of the Member States of the European Union, as expressed by territorial cohesion, is a shared competence of the EU and its Member States as laid down in article four of the Treaty on the Functioning of the European Union (Consolidated Version of the Treaty on European Union, 2010).

The EU argued that the headline targets outline above cannot be reached at the Union or national level alone, but also that the European 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. In terms of innovation the need for more is clearly emphasised in the Europe 2020 target goal of investing 3 per cent of GDP in R&D. However according to the European Commission the average EU spending on R&D in 2010 was only 2,01 per cent, whereby especially the disparities across the EU regions became even more visible. The same phenomena accounts for the set target that at least 40 per cent of the population aged 30-34 in the European Union should have a tertiary degree, but analysis from the European Commission (2010c) in 2010 has shown that—if the then current trends would continue—only half of EU regions would reach the 30 per cent goal by 2020. As such, it was back then only a fifth of the EU regions that had a tertiary educated share among the population aged 25–64 of 30 per cent or more. So national efforts will not be able to avoid this grievance; but a closer cooperation with regions is required to increase the number of (young) people starting and remaining in higher education (all European Commission, 2010c:37).

Based on these conclusions, the earlier failed Lisbon Strategy and other earlier performed innovation studies of the European Commission (2010c; 2010b) concluded that for its new research and innovation strategy the European Union must avoid an "innovation divide" between the weaker and

stronger innovating regions and the others. Therefore in order to maximise the territorial cohesion across the whole European Union and spread the benefits of innovation, regions are now required to zoom in on the relative strength of the particular subnational entity where the chance is given to become an excellent forerunner in the field. Therefore it has been proposed that regions must redirect funding that is based on a smart specialisation 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 (European Commission: 2010b:20). This redirection of the funding shall be supported by the Commission that will establish a 'smart specialisation platform', which should be used to regional/national strategies identify activities where an investment of resources is most likely to stimulate knowledge-driven growth.
In order to help regional policy makers and academies, who aim to perform regional benchmarking studies based on structural similarity (which this master thesis study aims to do) and in the view of initiating a policy learning process, Navarro et al. (2014) have developed a web-based interactive tool that is easily accessible and user-friendly and accessible via the Smart Specialisation Platform webpage[7]. A similar methodology as used by the platform to conduct regional benchmark studies have been performed by Engelhardt (2013), who build her work in turn on the previous work of Navarro et al. (2011). Both scholars have largely influence also this work.

Another aspect of the 'Innovation Union' is that it explicitly addressees the European regions by the new European Innovation Partnership. This initiative is meant to bring all the actors at EU, national and regional level together by generating a so-called "challenge-driven innovative economy" that can act across the whole research and innovation chain and consequently streamline, simplify and co-ordinate the various existing instruments and initiatives in a more effective way (European Commissions, 2010b:23). Regions are explicitly called upon to further reform their research and innovation systems by aiming to improving the overall systems quality but also promoting excellence, foster closer co-operation and pursue smart specialisation. The European Commissions self-assessment tool that points out the features of a well performing national and regional research and innovation system supports those reforms. In line with this idea the regions should therefore measure the progress that they made towards the 'Innovation Union' (European Commissions, 2010b:30f) throughout the following years.
As already outlined earlier the flagship initiative aims to tackle the unfavourable framework conditions within the EU by avoiding a possible fragmentation of its effort by pursuing a broader understanding of the concept 'innovation' that involves all actors and regions in the given innovation cycle (European Commission, 2010b:7f). Yet, the question remains what kind of concrete objectives in terms of measurable indicators regional innovation performances are need to be achieved as for the future it remains unacknowledged in the communication that only instructing regions to develop and support a smart specialisation approach is done. One possible step in this direction has been made in that regard by publishing the communication on '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 (ERDFs) as the latter one is considered to be a "key means of turning priorities of [the] Innovation Union Flag-

[7] For the tool visit: http://s3platform.jrc.ec.europa.eu/regional-benchmarking

ship Initiative into practical action on the ground" (European Commission, 2010b:2).

The 'smart specialisation strategy' is explicitly outlined in the communication by calling upon the regions to identify their individual sectors and technological domains on which the consequent regional policies should be tailored and promoted by the local innovation processes in these areas (European Commission, 2010d:2). Possible examples of those comparative advantages would be according to the European Commission i.e. clusters, cross-sectoral activities, high value-added markets or just specific research areas. Therefore in line with the 'Innovation Union', regions are ultimately requested to make more and efficient use of the existing (financial) instruments to promote regional innovation, particularly the ERDFs. Other possible actions in order to achieve the "smart, sustainable and inclusive growth" objectives of Europe 2020 Agenda are mentioned by the communication in terms of promoting the interregional cooperation and the use of international peer review (European Commission, 2010d:11f).

2.2 Nordrhein-Westfalen and its policy plan concerning Europe 2020

Situated in the (Mid-)West of Germany, Nordrhein-Westfalen is one of the 16 Bundesländer (regions) of the Federal Republic of Germany. Occupying an area that spans over 34,084.13 km^2 with 17,638,098 millions inhibitions it is the most populous state of Germany as well as the fourth largest by size (Information und Technik NRW, 2015). To the north and northeast it is bordering with the German region Niedersachsen, while to the east it borders Hessen while to the south with Rheinland-Pfalz. In its western direction it has international borders with Wallonia in Belgium and the Dutch provinces of Overijssel, Gelderland and Limburg. Important geographical landmarks include the 44 rivers that flow through the federal state, with the Rhine and Ruhr being the most economically important. Especially the Rhine-Ruhr area, one of the European Union's largest conurbations, features various large and medium-sized cities and towns. The most relevant of this area and of whole NRW are the cities of Aachen, Bochum, Bonn, Cologne, Dortmund, Duisburg, Essen, Münster, Wuppertal, and the state's capital Düsseldorf. With two major international airports—Düsseldorf Airport and Cologne-Bonn International Airport—the region is connected to all major destinations within and outside Europe. Additional airports with inner-European connection complete the availability of air transportation in the state. Access to important European seaports is ensured through motorway connections and mainly through the river Rhine that allows for waterway connection with Europort Rotterdam. The port of Duisburg is the world's largest inland port and allows for efficient shipping.

With a total GDP of 624.67 billion Euros in 2014, Nordrhein-Westfalen is the federal state with the largest contribution to the German GDP (Statistikportal.de, n.d.). According to its own regional statistics, NRW's R&D expenditure (as percentage of its GDP) was in 2007, so just at the dawn of the European economic crises, at a value of 1.82 per cent. This value was significantly below the average of Germany, which stood at a value of 2.54 at the same time (all G.I.B.Info, 2010). So there is still a lot of progress and cooperation among the different actors needed in order perform high on the flagship initiative 'Innovation Union'.

The point of departure for Nordrhein-Westfalen to score high on the 'Innovation Union', and consequently the possibilities and chances for a great performance on the Europa 2020 Agenda, seem to be a good one. Next to the presence of twelve state universities as well as various universities of

applied science, which allow for the local development of talent workers and the availability of knowledge and research facilities. There is also a variety of both, traditional and future-oriented, industries that are present in the region as well as clusters that are specifically promoting automotive industry, biotechnology, chemicals, energy, environmental technology, food, healthcare, information and communication technology, logistics, mechanical engineering, media, new materials and plastics the region has a variety of potential sector and fields in order to increase its own economic performance (all Fiolka, 2015).

The 2012 snap election, which confirmed the coalition government of Social Democrats and the Green Party with a majority, emphasised its coalition agreement the attractiveness of NRW as a location for investment and innovation since it is "als industrielles Kernland Europas mit seiner exzellent aufgestellten Wirtschaft und Forschungslandschaft, mit starken Regionen und kultureller Vielfalt verfügt [es] über hervorragende Voraussetzungen, um potenziell weltweit relevante Lösungsbeiträge zur Bewältigung der großen gesellschaftlichen Herausforderungen zu entwickeln"[8] (Forschungsstrategie Fortschritt NRW, 2013:13). This shows that boosting the innovation performance of NRW has also reached already the political corridors of the debate. As such, foreign investors have invested a total of 190 Billion Euros in NRW (till 2012), which accounts roughly to 27.1 per cent of all foreign investment flowing into Germany[9] (Kraft, 2012). Hence the NRW regional government concluded that "[d]ie besonderen Forschungsstärken des Landes liegen auf den Feldern Energie, Klimaschutz, Ressourceneffizienz, nachhaltige Mobilität sowie Lebenswissenschaften/Gesundheit und den Schlüsseltechnologien. Die letzte Runde der Exzellenzinitiative hat gezeigt, dass unser Land hier reüssieren konnte."[10] (Schulze, 2012:11). Building on this NRW has recognised that the solution for all this can be only found within regional innovation systems that bring the research sector and the economic sector closer together (Forschungsstrategie Fortschritt NRW, 2013; Handlungskonzept der Landesregierung Nordrhein-Westfalen, 2014). Ergo, Nordrhein-Westfalen's own research and investment strategy 'Fortschritt NRW'—that lasts from 2013 to 2020—is modelled along the Europe 2020 Agenda and its flagship initiatives—including the 'Innovation Union' (Forschungsstrategie Fortschritt NRW, 2013; Handlungskonzept der Landesregierung Nordrhein-Westfalen, 2014). As outlined in the research and innovation strategy 'Fortschritt NRW' (2013) the region wants to become one of the most innovative regions in Europe by 2020 by putting the focus on:

(1) Research and innovation for sustainable development in the fields that are most likely to be the major challenges that society will be facing in the future, hence attracting a higher number of

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[8] As an industrial heartland of Europe, with its excellent requirements in the economic and research landscape, with strong regional and cultural diversity [it] has an excellent foundation to develop potential relevant solutions and contribute to tackle major societal challenges worldwide. (Translation by the Author)

[9] "[...] Wie attraktiv der Standort Nordrhein-Westfalen ist, zeigt auch das hohe Engagement ausländischer Investoren. Sie haben insgesamt fast 190 Milliarden € bei uns investiert. Das sind 27,1 % aller Auslandsinvestitionen, die nach Deutschland fließen. [...]." (Translation by the Author)

[10] The particular research strengths of the region lie in the fields of energy, climate protection, resource efficiency, sustainable mobility as well as life sciences/health and the key technologies fields. The last round of the Excellence Initiative has shown that our region could succeed here. (Translation by the Author)

innovation that is not only dealing with a technological and economics features but also addresses societal and social topics ("Social Innovation");

(2) Acknowledging the importance and priority of inter- and transdisciplinary research that involves the humanities and social sciences;

(3) Focus oneself on the problem solving relevance, practical implementation, and the potential of dissemination of the issues at stake;

(4) Internationally positioning and profiling NRW as a know-how and innovation hub by (a) further international orientating NRW, especially the international operation of companies, researchers and/or educational institutions and (b) using more extensively and additional to European innovation and research funding policy programmes, also more own and specific regional ones; and

(5) Emphasising European and international networking and as as a learning programme, which should result in more R&D activities to be placed on the market.

3. Theoretical framework: How do regions matter as engines of innovation policies?

3.1 Regional fuzziness—What is meant by a 'region'?

The throughout the last century developed view on competitiveness, innovation and economic development has undergone some major changes. The earlier established academic research conducted, which focussed in its research primarily with the state and national policies as possible units of analysis, has undergone some major changes since the 1990s. This is due to the fact that —as Asheim et al. (2011: 876) argue—that the research focus changed on a more regional scale of innovation. The reason for this focus has been found to be that the concept of 'region' that had been gaining increased attention form policy makers since the 1990s due to the increased intensity of international competition in a globalising economy and the emergence of successful clusters of firms and industries in many regions around the world (Doloreux and Parto, 2004). This caused some academics (e.g. Asheim et al., 2003; Isaksen, 2002; Cooke et al.; 2002) to re-'discover', especially at the beginning of the twenty-first century, this analytical approach and use it in order to understand the earlier detected national innovation processes also on the regional scale. Especially research on regional innovation has grown significantly after the European Commission (1995) published its 'Green Paper on Innovation' as it suggested that the regional scale could contribute a new and also more valid perspective to the study of innovation performances as one of the natures of research and development in the European Union is that it is apparently located in specific geographic areas. Also it has detected that (regional) innovation is not only a source of competitive advantage but also can contribute to design of new policies that address regional inequalities and divergence. Similar to this, also this research project aims to understand how innovation processes on the regional scale function by analysing (and then benchmarking the regions against each other) how the innovation performance of EU regions has developed over time.

In that regard Barry Buzan (1998:68) points at the elephant in the room, which is namely that "[t]he concept of a region is widely used and seldom very clearly defined." Therefore the question of what is meant by the term of 'region' and how one could define it in a European Union context seems imperative. To illustrate this on a simple level—the Baltic Sea is called a region as well as

the region of Twente, or one could name the cities of Bremen or Brussels. All three 'regions' differ significantly from each other and each time it refers to a different notion of the concept 'region' (Schmitt-Egner, 2002: 179). Thus in the EU, a 'region' can refer to a province, country, municipality or even just a city. All have dissimilar meanings in EU-countries and up until now there is no European-wide definition of what constitutes a 'region' (Verboven, 2011: 6). This causes a problem of conceptualisation when dealing with a regional level of analysis as it will be done in this thesis. Consequently there are several approaches on how could define a region e.g defining a natural region, historical region and/or security region. Other studies therefore categorise regions in terms of geographical boundaries, along administrative and/or economic factors. Peter J. Katzenstein (2002) highlights in his work, however, that the key problem when conceptualisation regions: "[A]lthough [they are] often described in geographical terms, regions are political creations and not fixed by geography" (Hemmer and Katzenstein, 2002:575). He then continues his argument by explaining why he can work without any clear-cut definition of a region. Similar already Smouts (1998:30) argued that "[i]t is a characteristic of the region to have neither a definition nor an outline." Hence an investigation (and consequent analysis) of regions in the European Union seems to be confronted by a conceptual dilemma. The concept of 'region' seems to be defined (and what is meant by it) differently by scholars, which is (usually) depending on their academic background. Still Blotevogel (2000) has identified three basic elements that are necessary for any minimal definition of region: (1) spatial relationships, (2) issues of scale and (3) relations between subjects and their territory.

Following, this idea and notion that different meanings of region within EU Member States (a 'region' in France has a very dissimilar constitutional position compared to a 'region' in Belgium, or even a 'Budesland' in Germany) has to be dealt with the EU has developed a regional division primarily for statistical purposes that allows the circumvention of the question of what a 'region' actually is and what subsequently it (must) entail. The 'Nomenclature of Territorial Units for Statistics' (NUTS, for French 'Nomenclature des unités territoriales statistiques') is the geographical nomenclature subdividing the economic territory of the European Union into regions at three different levels (NUTS 1, 2 and 3 respectively, moving from larger to smaller territorial units[11]). This research project will work with the NUTS 2 level that is the regional stage between the local and national one. The purpose of the NUTS is (a) collection, development and harmonisation of the European Union's regional statistics, (b) socio-economic analyses of the regions, and (c) framing of EU regional policies (Eurostat, 2011:6). 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 as it is sometimes regarded as rather viable and often inconsistent. This is especially the case when it comes to the different sizes of the regional levels, which are often rooted in historical modifications on the one hand while on the other hand in some cases they have pure administrative background (Lagendijk, 2005:87; Eurostat 2011). The current NUTS division was put into effect from 1 January 2012 onwards and subdivides the European Union and its territories into 97 regions at NUTS 1 level, 270 regions at NUTS 2 level and over 1.294 regions at the NUTS 3 level (Eurostat, 2011:5f).

[11] Actually, there is still above NUTS 1 also another level, which is the 'national' level of the Member States.

3.2 An ever-changing perspective on the 'Innovation' concept

More than 80 years ago Joseph A. Schumpeter (1934; 1935) started out to conduct his research on competitiveness, innovation and economic development, he—unlike his many contemporary academics—focused, however, on the study of innovation. The Great Depression of the 1930s heavily influenced him in his thinking, which was the longest, deepest, and most widespread depression of the 20th century. Schumpeter's (1934; 1935) key argument was that the major drivers of economic growth are productivity efficiency and adaptive efficiency and these are supported by a number actors, especially individuals (e.g. Entrepreneurs, which Schumpeter thought would be aim for constant improvement of their products via innovation in contrast to Capitalist, who aim to accumulate material gain) but also entire nation states. Thus, the importance of innovation in economies is not a one but already emerged more than 80 years ago.

Hence in a Schumpeterian lens (1934:66) one can speak about 'innovation' when economic activity covers (but not exclusively) one of the following the dimensions:
(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 organisation 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, 1934:66; emphasis added by author).

Similar 'innovation' is defined and understood in this research project, as established by the European Commission in 2010 (2010e; 2010f) when the 'Innovation Union' was introduced. Back then Máire Geoghegan-Quinn, the Commissioner for Research, Innovation and Science and Vice-President Antonio Tajani, also responsible for industry and entrepreneurship said that the first important lesson in relation to innovation is the acknowledgement of the fact that there is no single definition of term innovation. "But innovation as described in the Innovation Union plan broadly means *change that speeds up and improves the way we conceive, develop, produce and access new products, industrial processes and services.* Changes that create more jobs, improve people's lives and build greener and better societies" (European Commission, 2010e; 2010f, emphasis added by author). So to make it short: Innovation is about finding a new way of doing something! This definition also applies to the concept of 'regional innovation', yet here only the scale differs where innovation takes—which in the context of 'regional innovation' is explicitly the regional scale. As the OECD (n.d.) itself pointed out: "Regions matter for innovation, and innovation matters for regions"

Building on these thoughts expressed by Joseph A. Schumpeter various academics have aimed to study innovation throughout the last eighty years by exploring the various factors that contribute to innovation and their causal pathways. As this research project aims to work with the methodological framework used by the EU (for which also the respective data has been collected) the Innovation Union Scoreboard provides a total of 25 different indicators and distinguishing between eight innovation dimensions and three main categories of indicators (European Commission, 2015a: 7ff):
- **Enablers**: Look at the basic features that allow innovation to take place—human resources,

open, excellent and attractive research systems, and finance and support;
- **Firm activities**: Try to capture innovation efforts in European firms—namely firm investments, linkages and entrepreneurship, as well as intellectual assets;
- **Outputs**: Aim to capture how the earlier used indicators translate into benefits for the economy at large—in terms of innovators and economic effects.

While using this existing methodological framework of the European Union, it should be noted that it is not taken for granted that the EU framework in the document is right. Instead this framework is used because the 'smart specialisation strategy' initiated by the European Commission and developed by Navarro et al. (2011; 2014) works along those 25 indicators used by the IUS and also earlier research (see Engelhardt, 2013) used it for their benchmark studies besides its shortcomings. Therefore the in the Annex I (pages 77-78) provided additional chapter introduces a discussion that aims to bolster up the EU-framework to measure 'innovation' by providing some additional discussed 'innovation enablers' in the academic literature.

Parallel to the sketched developments, also the thematic focus of OECD publications during the 1990s (e.g. 1997a, 1997b, 1999, 2002) has been dealing with a topic that been labelled as 'Boosting innovation.' Parallel to it in 1995 the European Commission published the 'Green Paper on Innovation' that until today it is perceived as one of the most influential EU publications on innovation and its governance. It was in this document that for the first time the European Commission acknowledged the fact that innovation is a driver of economic growth. It stated "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 organisation, and the working conditions and skills of the workforce" (European Commission, 1995). Thus innovation is shaped in its characteristics by everything that is related to its policy-making environment and everything that touches upon the subject/topics of innovation. In addition to that the Green Paper has identified—and till today more than 20 years after the original publication of the Green Paper—one of the major obstacles in regard to innovation in the European Union: the 'European paradox'. The 'European paradox' states that although the scientific performance of the European Union has been characterised as excellent (including having a well-educated workforce with strong academia) the transformation process of technological research, which results into innovation and competitive advantages has been a major weakness of the whole European Union (all European Commission, 1995). As such, the key aim of the 'Green Paper on Innovation' was to set up a possible framework for a genuine European strategy that would lead to enhancement of innovation by systematics proposing measures that ought to be taken on a EU-wide and the national and regional levels of the Member States. Shortly afterwards, the 'First Action Plan for Innovation in Europe' (European Commission, 1996) was introduced with the 'Trend Chart on Innovation in Europe' that aimed to enable less favoured territories to learn from 'best practices' (Zabala-Iturriagagoitia et al., 2006:4) of better performing ones. The key milestone was achieved, however, when the EU, through the European Lisbon Council in 2000, approached itself to the topic of innovation policy in a new way. As such, one of the new-set aims was the preparation of the transition to a knowledge-based economy and society by promoting a new kind of policies for the information society and R&D, as well as by stepping up the process of structural reform for competitiveness and innovation (European Commission, 2000). By 2010, however, most of

the goals set in Lisbon were not achieved and the programme phased in 2010 out. Thus, official appraisal of the Lisbon Strategy took place in March 2010 at a European Summit, where also the new Europe 2020 Agenda was introduced (European Commission, 2010a; 2010b; 2010c; 2010d; Barroso, 2010). Some of the earlier established instruments like the European Innovation Scoreboard or the Community Innovations Surveys, where revised and resulted in the Innovation Union Scoreboard and its mutatis mutandis the Regional Innovation Scoreboard to monitor the progress in the European Union in relation to the set aims and goals by the Europe 2020 Agenda (European Commission, 2010a; 2010b; 2010c; 2010d; Barroso, 2010).

In that regard, these new instruments also build on the Oslo Manual, which was jointly developed by Eurostat and the OECD (2005) and undertook a new angle on innovation by claiming that "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organization or external relations is regarded as innovation."
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. Thus, innovation is to be seen now as a non-linear, interactive and evolutionary process in which actors, of the private sector (i.e. the individual firms, research bodies and universities) and public institutions (i.e. the government agencies and/or financing associations) interact with each other in a place with rules to be followed during the process (Edquist and Chaminade, 2006; Klein Woolthuis, et al., 2005; Trippl, 2006). The system of innovation approach thereby requires intensive communication and innovation activities, which are supported by formal and informal institutions (Trippl, 2006:2). This process is also characterised by reciprocity and feedback mechanisms, which determines the success of innovation. By focusing on the interactions between the different actors and institutions, it is possible to detect factors that lead to successful innovation (Edquist and Chaminade, 2006; Klein Woolthuis, et al., 2005; Trippl, 2006).

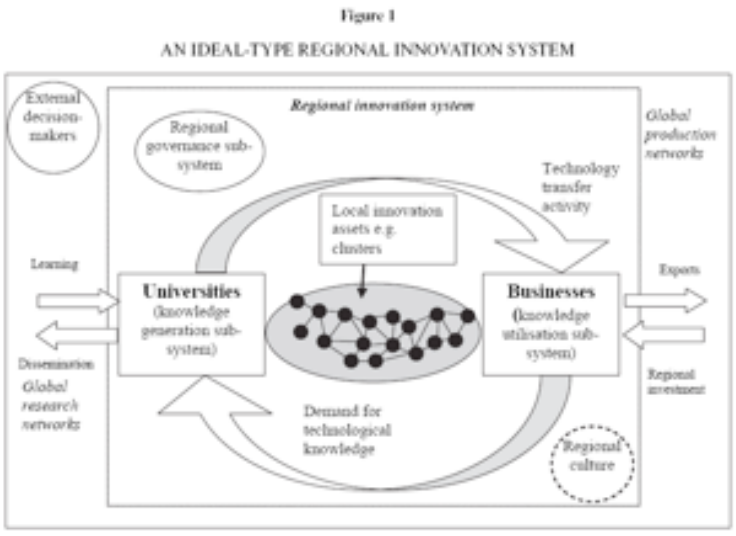
3.3 The Regional Innovation System

Lundvall (1992) was one of the first, who described the phenomenon outlined above and argued that there has been a collective system evolved in which the different actors like the private enterprises, universities and public research institutes produce knowledge and technologies. Those developments were supported by governmental policies that created new institutions in order to increase the strengths. He therefore 'invented' for this phenomenon and analytical frame where place and innovation meet the term 'National Innovation System' (NIS), which he 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 but as Edquist (2001) points out, quickly the literature on national innovation systems had 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.

In that regard already in 1997 Cooke et al. have emphasised the relevance that is important to shift the analytical focus on the subnational or regional level. Cooke (et al., 1997; 1998) 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 defined as "cooperative innovation activities between firms and knowledge-creating and diffusing organisations, such as universities, training organisations, R&D institutes, technology transfer agencies etc., and the innovation-supportive culture that enables both firms and systems to evolve over times" (Doloreux and Parto, 2005:135). In recent years, as regional studies have increased, also the concept of regional innovation systems has evolved into a now widely used analytical framework that builds the empirical foundation for the development of innovation policy. Around the same time also the 'Triple Helix of university–industry–government relations' (Leydesdorff and Etzkowitz, 1996) was introduced as model for explaining the interactions of actors and its social contexts in regard to innovation systems.

It is important to note that these two models (the NIS and RIS on the one hand and the 'Triple Helix' on the other hand) are running parallel to each other and are not mutually exclusive with one another. As Leydesdorff and Zawdie (2010:789) highlight "the Triple Helix of university-industry-government relations was introduced to bring out the depth and complexity of the innovation process as a recursive interaction system underlying the knowledge-based economy, and thus to enhance the exploration and exploitation of this knowledge base on conceptual and empirical grounds" (Abramowitz and David, 1996; David and Foray, 1995; 2002 as cited in Leydesdorff and Zawdie, 2010:789). So while "NIS [and RIS are] ultimately an institutional program[me] focused on wealth creation at the national—or *mutatis mutandis*, regional—level, Triple Helix provides a model of the structure and dynamics underlying the innovation system functioning at various levels. Unlike NIS (or RIS), the Triple Helix model does not presume a geographically delineated system, but it provides a framework for investigating empirical questions at a level of 'systemness,' defined in terms of regimes and trajectories" (Leydesdorff and Zawdie, 2010:789)

Figure 1: The ideal-type of a Regional Innovation System (RIS)



Source: Cooke and Piccaluga (2004) as cited in OECD (2008)

Consequently, Asheim and Isaksen (2002) argue that a regional innovation system, which is characterised by a rich institutional infrastructure (from both private and public side) that cooperates and communications and helps local companies to increase their cooperation and competence building is also likely to be performing high in terms of innovative activity and performance. Figure 1 above outlines this by illustrating an ideal type of a regional innovation system that is characterised by an architecture that contains several sub-systems inside the RIS.
Within its inner circle, educational institutions are the cornerstones for generating knowledge, whereas the businesses and enterprises around it form the dimension of knowledge utilisation and application by fostering the demand for new technologies. The crucial element in this model is the local interaction of the actors and which ultimately facilitates a continuous long-term flow of knowledge, human capital and (financial) resources. The regional governance system, of which public authorities and policy agents are part of, influence the long-term development of a region by establishing and offering a local innovation-friendly environment (with different emphasis depending on the political agenda of the public authorities and policy agents in charge) and 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 (all Trippl, 2006:4f) also arise. Lastly, it is important to note that RIS is—just like the figure of a Matryoshka doll—is part of the national and even international innovation system of the globalised economy and as such it is also driven by the competition between those different layers (national, international) during which the RIS aims to compete and sustain.

3.4 Towards Regional Innovation Policies in the European Union

But how and why has the regional dimension actually become the key player in innovation policies? According to the Organisation for Economic Co-operation and Development (OECD) (2011) this can be explained due to the policy paradigm shift that has been taken place in innovation policies. The increasing importance of regions can be explained by two key distinctive factors. While factor one deals with the issue that more and more national governments are now dealing with the inclusion of a regional dimension, when developing and implanting their national innovation strategies due to the evaluation of its resources (in term of assets) in national innovation policies (OECD, 2011:31), factor two relates to the paradigm shift that has taken place in regional development policies. The paradigm shift in regional development policy is a result of the previous 'old' (read: unsuccessful) strategic approach just to transfer financial resources from wealthier to lagging (read: poorer) regions. The 'new' regional policy applied now focused on the mobilisation of knowledge, assets and capacity of growth by using the existing regional strengths and economic potentials (OECD, 2011:32) to boost its economic and innovative performance. Along this argument, several academic studies have emphasised the importance of the regional level when studying innovation (i.e. Howells, 1999; Cooke et al., 1997; 1998; 2000; Gentler, 2003; Morgan, 2004) and at the same also expressed the statement that the geographical proximity as well as the regional governance sub-system plays an important role in the innovation process. In order to carry out the innovation processes and activities, Trippl (2006:3) emphasised that there is also the need for local exchange of knowledge. Interestingly, the subsequently localised knowledge spillovers are scoring highest in a rather distinctive geography area, yet also in regionally limited places as Audretsch (1998) pointed

out. Hence all in all it is trust among the different involved actors (e.g. business, universities, research centres) that is one of the major prerequisites in regional innovation systems (Trippl, 2006: 3). Trust can be seen as the methodological glue that ties all the people together in regard to the goal as behind each and every single action of all those actors always stand individual people. To that end, Michael E: Porter (1998; 2003) emphasised that every carried out regional policy should always pursue two goals at the same time. Core aim one was labelled by Porter as "strategic positioning" and refereed to the goal that regional governance systems and their policies should aim to develop and strengthen the unique regional strengths in the key areas of innovation and competitiveness at the same time; core aim two was labelled "operational efficiency" and dealt with the perception that regional policies should also have a wider focus on the remaining competitiveness and innovation factors but also at the same time aim at avoiding the development of weaknesses (that in comparison with possible competing regions can become a major obstacle to overcome as they growth larger if not addressed in correctly and in time).

Coming back to the earlier presented argument relating to the governance dimension, which states that public authorities and policy agents influence the long-term development of a region by establishing and offering a local innovation-friendly environment, the (regional) governance literature also suggests that regional innovation may be positively or negatively influenced by political structures, institutions, climates and the types of policy instruments and rhetoric that are deployed when it comes to economic development and innovation (e.g. Audretsch, 2004; Acs and Szerb, 2007; Rodríguez-Pose and Di Cataldo, 2015). Although in this research project it will be not able to include and benchmark for a governance dimension (i.e. see the comments policy benchmarking in the following chapter), this aspect is nevertheless perceived by the author as important as recently Rodríguez-Pose and Di Cataldo (2015) detected in their analysis that the quality of the governmental institutions and its components (i.e. control of corruption, rule of law, government effectiveness and government accountability) shapes the whole innovation capacity of all regions across the European Union (Rodríguez-Pose and Di Cataldo, 2015). Especially, ineffective and corrupt governments seem to represent a fundamental barrier for innovative capacity as Rodríguez-Pose and Di Cataldo (2015) argue, which strongly undermines any potential effect of any other measures aimed at promoting innovation. These results have important implications when defining of innovation strategies in EU regions. Similar already eight years ago, Acs and Szerb (2007), aimed to illustrate the relationships among entrepreneurship, economic growth and public policy, and its interplay and influences according to the stage of economic development. They therefore already emphasised at the beginning of their paper that "an entrepreneurial economy is different from a managed economy because of the way in which it used entrepreneurs to facilitate knowledge spillovers" (Acs and Szerb, 2007: 112). This has important implications for the policy framework, which is used to promote regional innovation. Looking at the global economy, important policies to be consideration are trade policy, immigration policy and the policies regulating the access to foreign technology. On a national scale, policy makers, which aim on the work between long-term economic growth and entrepreneurial activity, the following policies should be taken into consideration: the fiscal challenge, education, science and technology policy, and finally litigation and regulation (Acs and Szerb, 2007: 113ff). The regional level is thereby only recognised by Acs and Szerb (2007) as the key level, where the building and sustaining of economic growth starts as new firms need to start somewhere even

when it is only conducted largely or exclusively on the Internet (Acs and Armington, 2006 as cited in Acs and Szerb, 2007: 115). When taking those policy fields into consideration, Acs and Szerb (2007: 119ff.) therefore deducted the following policy implications on how governance (read: policy makers) should design policies in order to enhance the overall innovation performance were made: First, middle-income countries (to which most EU-countries count) should focus on increasing human capital, upgrading technology availability and promoting the enterprise development. It is thereby important to start these enterprise development policies early because they are identified as the key drivers and they are some perceptual variables that are difficult to change in the short run. Second, for more developed economies, a reducing of entry regulations, in most but not all cases, would not automatically result in a more high-potential of start-ups. Also labour market reforms and deregulation of financial markets may be needed to support growth of high-performance ventures.

These recommendations on policy design for policy makers as presented by Acs and Szerb (2007) are similar to the argument presented earlier in the work of David B. Audretsch (2004) on 'Public Policy support for Entrepreneurship.' Audretsch (2004) not only argued in his work that there is a link between small and medium sized enterprises (SMEs) on the one hand and economic performance (in terms of innovation and growth) on the other hand but also he was creating a theoretical framework for linking SMEs to innovation and growth, and consequently was formulating implications for the public policy design of governance institutions. He starts of his argument by illustrating topic with what kind of questions Western European and North American policy makers and regulators in economics where confronted directly after World War Two. The public policy question of the day was "how to live with this apparent trade-off between concentration and efficiency on the one hand, and decentralization and democracy on the other. [...] The policy response was to constrain the freedom of firms to contract. Such policy restraints typically took the form of public ownership, regulation and competition policy or antitrust" (Audretsch, 2004: 181). Nowadays, however, Audretsch (2004: 182) argued a paradigm shift took place as Governments now focused on the promotion of so-called "entrepreneurship policy" as it had a much broader focus than the traditional SME policies. "The definition introduced by Lundstrom and Stevenson (2001: 19 as cited in Audretsch, 2004: 182) for OECD countries is certainly applicable in the context of the EU: 'Entrepreneurship policy consists of measures taken to stimulate more entrepreneurial behavio[u]r in a region or country [...] We define entrepreneurship policy as those measures intended to directly influence the level of entrepreneurial vitality in a country or a region.'" So while the traditional governance style via SME policies after World War Two aimed to take "the existing enterprises within the appropriate size class as exogenous, or given, and then develops instruments to promote the viability of those enterprises, e.g. almost exclusively targeting towards the existing stock of enterprises and virtually all of the instruments included in the policy portfolio are designed to promote the viability of the SMEs" (Audretsch, 2004: 182). Conversely, the new "entrepreneurship policy" with its much broader focus now should aim at "enabling the creation and commercialization of knowledge" (Audretsch, 2004: 184). As there are too numerous types of entrepreneurship policies that can be identified and implemented in the EU, David Storey (2003 as cited in Audretsch, 2004: 184f.) has identified examples of different types of entrepreneurship policies being undertaken in the EU and the USA. In addition, he provides an assessment of the efficacy of the various types of policies undertaken. An overview of these policies is provided in table 2 in the Appendix II (pp. 81-

82). From this table, it can be deducted that in essence "entrepreneurship policies" should aim at promoting (regional) innovation by creating an environment that is "encouraging R&D, venture capital and new firm start-ups" (Audretsch, 2004: 184).

Besides the governance dimension, innovation has also many other sources, starting with aspects as a cultural diversity and a creative class up to entrepreneurship. As such, since the mid 1990s the European Commission has stimulated the idea of the Regional Innovation Systems by encouraging partnerships within regions to foster the innovation environment within a region. Herby a special role of regions was pointed out by the Committee of the Regions that has pointed out the significant role of the regions within the process of strengthening innovation policy. The communication paper 'The regional dimension of the European Research Area', the European Commission (2001) has published a strategic paper, which for the first time emphasises the role of the regions in the innovation process as key actors ''in training, providing assistance to laboratories, support for researchers and links with the expectations of local populations'' (European Commission, 2001:4). It strengths the view that regions are now considered as one of the major drivers behind the (regional) development of the European knowledge-economy and regions are considered a key factor that contribute to the EU's future growth and competitiveness. In that regard Audretsch and Keilbach (2004) argue that a region must be endowed with entrepreneurship capital that is to say that regions are able to enable the innovation process into the market and contribute to economic growth. Hence for Audretsch and Keilbach (2004) it is the middle class entrepreneur, which is perceived as the backbone of the modern economy, because it is he, who brings upon innovation, new ideas and new markets that in turn fosters economic output, development and employment. However, this process is complex and obstacle-ridden one as some of the barriers are related to those of the market itself, while others are institutional, cultural etc. Only by overcoming the so-called 'knowledge filters' it is possible create value in the market and improve the overall productivity of resources through innovation. Also despite, or because, of the progress in the information and communication technology sector, still the geographical location and proximity is considered a crucial factor when it comes down to innovation. The network of SMEs, spin-offs and Science and Business Parks are often centred around universities campuses (European Commission, 2001:8). Thus, today in the twenty-first century the European Commission aims to promote the development and usage of benchmarking exercises in order to to identify innovative regions across the whole European Union. Thereby the 'Network of Innovating Regions in Europe' was set-up in order to promote inter-regional exchange of best-practises (Benneworth et al., 2007:29f). This is also expressed by the shift of financial resources that is gained towards innovation policy. The EU innovation policy (including its regional dimension) has, with the help of the European Structural Fund, been awarded in the period 1989-1993 merely 4 per cent of its regional policy funds. This percentage has been increased up to approximately 25 per cent for the funding period 2007-2013 (OECD, 2011:31).

4. Materials and Methods: Territorial Benchmarking as the methodological tool

4.1 Research Design

Understanding and comparing how a region (in Europe) compares to others in terms of innovative-

ness might be a useful exercise as it could help to trigger new ways of living by enhancing quality of life along its various dimensions. As explained earlier although the idea of benchmarking has its origins in the private sector it has since then found its application to the public sector.
As the purpose of the paper is to benchmark the innovation performance of NRW with European reference regions an interregional performance benchmarking exercise, also sometimes labelled as a territorial benchmarking exercise, will be specified further as the methodological tool and strategy chosen here. The basic idea of the benchmarking methodology is to ''measure[...] processes, performances and results of the own region [...] and compare[...] the gathered data with those of other (better) regions [...] by using indicators (benchmarks). The goal is to learn from the 'Best'. Therefore benchmarking can be understood as a continuous systematic process to compare the success of organisations, functions, processes, regions, policies or firms with the 'best' aiming at adapting success experiences and improving own procedures in order to exceed the best performers.'' (Iking, 2009: 245). Summarising benchmarking analysis of EU regions is aimed at understanding how could one improve the situation of the less (economically well) performing regions by catching up towards the more (economically well) performing regions (e.g. Engelhardt, 2013; Groenendijk et al., 2013; Navarro et al., 2011; 2014; Iking, 2009).

So the basic idea of this research project is now that NRW and a number of European reference regions are selected and their innovation performance is depicted in reference to the 'Innovation Union' and the Europe 2020 Agenda. After that benchmarking exercise it will be possible to deduce indications of what constitutes successful dimensions and features for regional innovation. The approach is inspired by similar research using the same research methodology (i.e. Engelhardt, 2013; Navarro et al., 2011; 2014) and the European Commission statement that it explicitly appreciates in its policy agenda the idea of interregional benchmarking as it is can help to identify the earlier mentioned 'best practices' and consequently engage sub-national authorities of weaker regions to learn from more their more successful counterparts (Hospers, 2004:3). For the European Union and its agencies the reason to use territorial benchmarking as an analytical tool to compare interregional competes is rooted in the belief that borrowing successful policies can foster the regional competitiveness and at the same time speed up the regional development of regions that are lagging behind without producing to high costs (Iking, 2009; Huggins, 2008; Bessant and Rush, 1998). However, as some academics, e.g. Tödtling and Trippl (2005) as well as Nauwelaers and Reid (2002), have pointed out the conclusions to be drawn from those exercises and analysis should be drawn carefully as there is no universally applicable 'one size fits it all-strategy' in relation to the environments that favour the development of (regional) innovation. Therefore a second stream of research evolved from this, which now aims to identify, characterise and explain the source of innovation by analysing the source of regional innovation systems in its whole complexity (Doloreux and Parto, 2005:138).

Due to the complexity of the nature of regional innovation systems it is not sufficient to simply identify 'best practices' and to 'copy-paste' the whole strategy in the desired region region, but, as outlined by Huggins (2008), systematic regional benchmarking can be only useful to identify relative strengths and weaknesses of a region X and help 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 therefore outlined three options for regional benchmarking exercises: (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 are in-depth analysis of a specific region and present a detailed 'snapshot' of the regional innovation system and illustrate the unique character of the unit of analysis in terms of institutions, governance and policy initiatives (Doloreux and Parto, 2005:138). This research project tries to combine all three options for regional benchmarking exercises as outlined by Edquist (2008) by (1) comparing a region with targets that were set by the 'Innovation Union', (2) analysing the innovation performance of NRW along a longer time frame (2007-2013) and (3) it aims to compare not only one region (NRW) but it in comparison of its several European reference regions.

Although this research project aims to arrive on the question of how generalizable the results (read: patterns) of innovation performance can be found across the EU-Member States, this research project has a mainly evaluative (and descriptive) approach on the performance of the NRW—relative to a set of pre-chosen regions and on the basis of a predetermined set of benchmarks. This thesis in no way accounts for or is able to explain variance in innovation. In relation to the research question, which asks how the region of NRW benchmarked against European reference region is performing with respect to innovation, a case study as the research design has been chosen. Case study research has gained in popularity in recent years and judging "by frequency trends, case study research may be having an increasingly prominent place in everyone's portfolio" (Yin, 2014). Built on case study methodology and using quantitative techniques, this research project aims to investigate the phenomenon of current interest on how regions differ (and how this develops over time) in terms of innovation performance in the wake of the greatest financial and economic crisis since the Great Depression of 1930s. The idea is to construct an picture of the innovation performance within those regions by benchmarking them against the Europe 2020 Agenda and the extend it by benchmarking the regions against each other. But how does one could identify and select reference regions that could be benchmarked against Nordrhein-Westfalen? And where does one could find the relevant data in order to conduct such an analysis? These two questions are going to be answered in the next sub-sections (4.2 Case Selection and Purposive Sampling as well as 4.3 Data Collection and Analysis). Before that, however, an assessment on how valid a case study in the form of a territorial benchmarking exercise is as a methodological tool to evaluate regional innovation should be given.

Several authors (e.g. Groenendijk, 2011; Grozea-Helmenstein et al., 2009; Hospers, 2004) have outlined possible shortcomings of regional benchmarking methodologies. One major pitfall is the appropriate selection of the regions for the 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, 2004:7). But also possible personal preferences of the researcher and/or the purchaser of the research project can play a vital

role, i.e. a regional authority wishes to enhance cooperation with another one, which in turn can lead to an inclusion of irrelevant partners and/or an inappropriate choice of the benchmarked regions. This results in non-objective selection criteria, which have been criticised by academics and scholars alike as a proper diagnosis of successes and failures as it is not desirable of comparing apples and oranges (Navarro, 2011:2). Therefore, in the current academic discourse many scholars plead for when conducting regional benchmarking one should compare 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) or economic specialisation, size of the economy, firms size, culture and social capital (Nauwelaers et al., 2003). Or to say it differently: Regions are selected on a most similar case basis.

As briefly stated above, another failure of regional benchmarking exercises has been the trend of copycat or 'copy-paste' behaviour of policy actors within the EU. Regional policy has been converged in the sense that the objectives, concepts and instruments were more or less equalised and aspire the regions to become ideally a replication of the Californian 'Silicon Valley' in the United States. The European regional policy makers have made efforts to copy the successful approach of the Californian region and to promote their own regions to become what Hospers (2004:3) calls the next 'Silicon Somewhere'. However, recently on the European level a paradigm shift has been taken place towards a more individual approach. As it was outlined earlier, the European Commission wants regions now to focus on their relative strengths where there are chances that the region is more likely to become an excellent forerunner in a particular field of (innovative) specialisation.

With regard to the analysis of regional performance studies, the key criticism focusses around the availability and time lag of the regional data. As Grozea-Helmenstein et al. (2009) underline the fact that most regional data is only usually available with a time lag of at least two or three years, there are disadvantages especially for those regions that are in a process of economic restructuring (i.e. especially the regions of the 'new' EU Member States) albeit their economic positioning within the EU might have been improved significantly in the meantime that the data was collected (Grozea-Helmenstein et al., 2009:288).

Nevertheless despite this criticism, regional benchmarking studies must be seen a useful and valid research tool for the regional policy makers or analysts if it is used as a learning method based on comparisons and rather than simply adopting successful policies trying to imitate and implement a 'Silicon Somewhere' without fulfilling the necessary preconditions. In that regard during the last 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 earlier territorial benchmarking analyses have been labeled as more or less simplistic by pursuing a 'copy-paste' approach, the more recent regional benchmarking studies, to which this thesis tries to count, have evolved towards a more 'intelligent' or 'systematic' analyses.

4.2 Case Selection and Purposive Sampling

A case study design has been selected to obtain practical information on the innovation perform-

ance of NRW. According to Yin (2014), a case study research design is best suited to conduct research with *how* or *why* research questions. This is also the case of the key research question of this research project in a double sense as it asks in both ways the question. *Why* NRW is innovative and *how* does it differ in regard to other European regions? A case study then offers the unique opportunity to study the phenomenon of innovation performance in detail. When setting up a case study, two major decisions have to be made: which and how many cases are going to be studied. Both questions are closely related to each other and play a major role in the design of any case study. Because of the specificity of case selection, several writers have criticised the usage of the word sampling when it come to choosing cases (Yin, 2014; Emmel, 2013). The reasoning behind this is that case studies, in their opinion, do not, or should not, aim to obtain generalizable findings that extent to a whole population the way empirical studies do. Rather Yin (2014) suggests to view the case as "the opportunity to shed empirical light about some theoretical concepts or principles" (Yin, 2014:40). It will be nevertheless used here as the will be comparative reference regions will be collected in here more systematic way. Case selection also confronts the researcher with another choice: how many case to select. Two factors should be given thought to by the researcher: the level of certainty the case study should establish and the strength of rival explanations (Yin, 2014). To account for different approaches of different regions towards the subject, the high number of 35 cases in the frame of a multiple case study design has been chosen in order to account for a greater variance of the innovation performance across the EU. This multiple case study design allows investigating differences within and between the cases.

So how does one can identify and selected the reference regions that could be benchmarked against Nordrhein-Westfalen? This question was also asked by Navarro et al. (2011; 2014), Groenendijk et al. (2013) as well as Engelhardt (2013) that all propose in their research that it might be useful when conducting a benchmark analysis to identify and use those regions that share similar structural conditions with the key region they are compared with it. Ergo, in this analysis, European regions are selected on the basis of a most smilier case design with the selected dimensions along which 'similarity' of the regions was decided upon being indicators like geo-demography, human resources, technology specialisation, economy and industry specialisation, firm structure, openness, and institutions and values (Navarro et al., 2014:8). This strategy of comparison regions that are set-up along the same indicators also usually must deal with similar problems, and—as pointed out by Navarro et al. (2011; 2014)—those kind of regional benchmarking studies are often seen by "the majority of analysts [...] theoretically the most rewarding" (Besant and Rush, 1998; Dunnewijk et al., 2008; Soete and Corpakis, 2003 all as cited in Navarro et al., 2014:8). Another advantage of this strategy is that these characteristics of the regions could not be easily changed in the short term and are usually demonstrated to affect the way innovation and economic evolution take place in a region (Navarro et al., 2014:8). As the cases are chosen based on their value they added to the topic studied, research methodologies speak about 'purposeful sampling'. It is characterised according to Emmel (2013) to mean very different things depending of the context the research is taking. He exposes two deviating approaches: One being the understanding of purposeful sampling as a way of focusing sampling in grounded theory, while the other refers to the selection of information-rich cases in order to best supply central findings (Emmel, 2013). Since the purpose of the study is to determine innovation performance as well as the challenges and factors of success of the promo-

tion process, regions are chosen based on their homogenous and/or share similar structural conditions to mirror NRW and therefore they are selected for their information-richness.

Navarro et al. (2011; 2014) reveal in their work there are two possible options that are mainly used in territorial benchmarking studies to obtain structural similar reference regions. While the first approach is also the more known one, the cluster analysis approach, it is often seen as rewarding for those researchers and politicians, who deal with the entire European regional level since cluster analysis offers a great possibility to compare with the help of a complete overview of the European regions. Cluster analysis has been criticised as method of conducting benchmarking studies especially for its technique to combine different types of variables that may interfere with each other, e.g. mixing up structural conditions or economic and innovation indicators (Navarro et al., 2011:7). Both, Archibugi and Coco (2005) and Edquist (2008), have therefore crucially pointed out that the economic and innovation system are two separate concepts and they must be distinguished as economic performance is affected by innovation performance and also vice versa. As this thesis does not aim to deal with whole of the European regions and only seeks to benchmark a certain number of regions, it has been decided not to apply a cluster analysis to acquire regions. Instead in this research project the second approach will be applied. Engelhardt (2013) also used in this strategy in her analysis on the innovation performance of the Twente region. She used Navarro et al. (2011) mathematical approach to create a distance matrix, which used indicators like (a) Size, demographic and location indicators; (b) Population, Population density, Ageing rate, (c) the Economy‘s industry structure, (d) Distribution of employment, (e) Industrial specialisation, (f) Industrial employment, (e) Technological specialisation and (f) Percentage distribution of EPO patents. Based on the data collected on basis previous used indicators Engelhardt (2013) as well as Navarro et al. (2011) created a distance matrix by using mathematical calculations. This approach, however, usually implies a lot of work as after having defined the aggregated data, several transformations and calculations are required in order to construct the distance matrix that measures the distance between the particular output region (in this case NRW) with its other reference regions. Luckily, however, this complicate step can be now omitted (and with it possible mistakes) as recently Navarro et al. (2014:27) have a developed web-tool “to help regional policy makers performing benchmarking based on structural similarity in the view of initiating a policy learning process.” This tool works on the basis of RIS3 Guide of the European Commission (Foray et. al, 2012) that proposes the design of smart specialisation strategies and is accessible via the Smart Specialisation Platform webpage[12]. The web-tool allows the user to select a region of their interest and specify the number of reference regions they would like to be displayed (from 10 to 35). After pressing the ‘refresh’ button, the list of reference regions will appear in a table on the right side of the screen together with values denoting the distance of the structural similarity. The lower the value given in the distance index the closer is the region to the original output region. Applying this tool for Nordrhein-Westfalen and specifying the number of reference regions to ‘35’ it is easy possibly to identify and rank all regions that are (structural speaking) the closest to NRW. The top 35 identified references regions of NRW, and that will be also analysed in this research project, are listed in the table 3

[12] For the regional benchmarking tool visit: http://s3platform.jrc.ec.europa.eu/regional-benchmarking

found in the Appendix II (pp. 82-83)[13]. The written text analysis, however, will only use the closest use the ten closest regions (see table 4 below).

Table 4: The distance matrix ranking of Nordrhein-Westfalen and its ten closest reference regions

Rank	Region (Country)	NUTS2	Distance Index
	Nordrhein-Westfalen (DE)	DEA	
1	Hessen (DE)	DE7	0.0074
2	Niedersachsen (DE)	DE9	0.0103
3	Baden-Württemberg (DE)	DE1	0.0118
4	Bayern (DE)	DE2	0.0121
5	Schleswig-Holstein (DE)	DEF	0.0174
6	Rheinland-Pfalz (DE)	DEB	0.0180
7	Flemish Region (BE)	BE2	0.0233
8	West Midland, England (UK)	UKG	0.0234
9	Wales (UK)	UKL	0.0238
10	East Midlands, England (UK)	UKF	0.0241

Source: S3Platform, n.d. as given output for the top 10 peer regions of NRW

4.3 Data Collection and Analysis

The Europe 2020 Agenda, particularly the flagship initiative 'Innovation Union' and consequently the Territorial Agenda calls upon a special attention of the territorial dimension of innovation and knowledge creation. As such, the heterogeneity across the European regions in their ability to create knowledge and innovation is supported by the European Union in conducting in-depth analyses of the territorial dimension of the knowledge economy of their Member States and their regions (European Commission, 2010b:9; ESPON, 2014). Both, politicians and policy-makers, alike are very keen and interested in analysing the innovation performance of the regional level as a source of innovation as it is regarded as one of the main drivers behind competitive advantages. Within the European Union special emphasis has been put on the investigation and development of 'best practices' in regional innovation policy. Several instruments i.e. scoreboards, evaluation frameworks and/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, 2004:9; Hospers, 2012). In order to being able to analyse 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 Euro-

[13] Of those original top 35 European reference regions some data for the desired indicators was not available at all (i.e. France and Austria). Hence the analysis restricted to only those countries that collecting information on the regional NUTS 2 level. Therefore, only 31 level regions could be included in the final exercise of the benchmarking.

pean Commission has in line with the recommendations of the 'High-Level Panel on Innovation' developed a Research and Innovation Union scoreboard, which contains a list of indicators to measure an monitor the innovation performance at EU and Member State level. The scoreboard is supposed to enable comparative benchmarking of the EU and Member State performance against a broad set of indicators. While the Science, Technology and Competitiveness Report monitors the progress towards the headline target of investing 3 per cent of GDP on research and innovation for a competitive European economy (European Commission, 2010b:30).

For the national scale the Innovation Union Scoreboard is replacing the former European Innovation Scoreboard. A total list of 25 innovation indicators that are distinguished in three main and eight subgroups (European Commission, 2010b: 36f; 2014; 2015) has been adopted in order to get a better understanding about the development of the national research and innovation systems. The IUS uses for its analysis the most recent statistics from Eurostat and other available internationally recognised sources (e.g. OECD, Scopus, UN) wherever suitable to improve comparability between countries (European Commission, 2015a: 8f). The target group of the IUS is the European Union and its Member States and therefore it does not offer regional data in its analysis. Although the European Commission admits that this lack of statistical sources, including also the limited availability of indicators at the regional level (European Commission, 2010b:30), is not an ideal solution the European Commission also emphasises that efforts will be made to make the data available at the regional level for all Member States (European Commission, 2010b:36). As such, the Regional Innovation Scoreboard seems more appropriate to use as it provides a look at the regional level and there numerical comparative assessment of how European regions perform with regard to innovation (European Commission, 2014). Every two years the Innovation Union Scoreboard is accompanied by RIS thus the most recent regional scoreboard being from 2014[14]. The RIS thereby is based on the same methodology as the IUS.

Taking a closer look at the indicators and their availability at the regional level (for a detailed overview see table 5 beneath), it becomes obvious that the possibilities for a sound regional innovation analysis are limited. Only for 11 out of 25 indicators are identical or similar accessible as regional data regard to the 'Innovation Union' and its applicability to the regional level.

Table 5: Innovation Union Scoreboard and Regional Innovation Scoreboard in comparison in reference to the available data on the regional level (emphasis added by the author)

Innovation dimension/indicators of the Innovation Union Scoreboard	**Data Source, timeframe**	**Data availability on regional level (Regional Innovation Scoreboard)**
1 ENABLERS		
1.1 Human resources		
1.1.1 New Doctorate graduates (ISCED 6) per 1000 population aged 25-34	Eurostat, 2005-2012	Regional data not available

[14] This is why IUS 2013 follows directly the IUS 2011 and IUS 2012 does not exist.
Earlier published reports of the IUS where made publicly available in 2010, 2011, 2013 and 2014, while the RIS was available for the years 2009, 2012, and 2014.

Innovation dimension/indicators of the Innovation Union Scoreboard	Data Source, timeframe	Data availability on regional level (Regional Innovation Scoreboard)
1.1.2 Percentage population aged 30-34 having completed tertiary education	Eurostat, 2006-2013	**Similar (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, 2006-2013	Regional data not available
1.2 Open, excellent and attractive research systems		
1.2.1 International scientific co-publications per million population	Eurostat, 2005-2012	Regional data not available
1.2.2 Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	Science-Metrix using Scopus data	Regional data not available
1.2.3 Non-EU doctorate students as percentage of all doctorate students	Eurostat, 2005-2012	Regional data not available
1.3 Finance and support		
1.3.1 R&D expenditure in the public sector as percentage of GDP	Eurostat, 2006-2013	**Identical**
1.3.2 Venture capital investment as percentage of GDP	Eurostat (CIS) 2006, 2008, 2010, 2012	Regional data not available
2 FIRM ACTIVITIES		
2.1 Firm investments		
2.1.1 R&D expenditure in the business sector as percentage of GDP	Eurostat (CIS) 2006, 2008, 2010, 2012	**Identical**
2.1.2 Non-R&D innovation expenditures as percentage of turnover	Eurostat (CIS) 2006, 2008, 2010, 2012	**Similar (only for SMEs)**
2.2 Linkages & entrepreneurship		
2.2.1 SMEs innovating in-house as percentage of SMEs	Eurostat, 2008-2012	**Identical**
2.2.2 Innovative SMEs collaborating with others as percentage of SMEs	Eurostat (CIS) 2006, 2008, 2010, 2012	**Identical**
2.2.3 Public-private co-publications per million population	Centre for Science and Technology Studies (CWTS) using Thomson Reuters data, 2008-2012	Regional data not available
2.3 Intellectual assets		
2.3.1 PCT patents applications per billion GDP (in Purchasing Power Standard € (PPS€)	OECD, 2004-2011	**Similar (EPO patent applications per billion regional GDP (PPS€))**
2.3.2 PCT patent applications in societal challenges (environment-related technologies; health) per billion GDP (in Purchasing Power Standard €)	OECD, 2004-2011	Regional data not available
2.3.3 Community trademarks per billion GDP (in Purchasing Power Standard €)	Office for Harmonization in the Internal Market, 2006-2013	Regional data not available
2.3.4 Community designs per billion GDP (in Purchasing Power Standard €)	Office for Harmonization in the Internal Market, 2006-2013	Regional data not available
3 OUTPUTS		

Innovation dimension/indicators of the Innovation Union Scoreboard	Data Source, timeframe	Data availability on regional level (Regional Innovation Scoreboard)
3.1 Innovators		
3.1.1 SMEs introducing product or process innovations as percentage of SMEs	Eurostat (CIS) 2006, 2008, 2010, 2012	**Identical**
3.1.2 SMEs introducing marketing or organisational innovations as percentage of SMEs	Eurostat (CIS) 2006, 2008, 2010, 2012	**Identical**
3.1.3 Employment in fast-growing firms of innovative sectors	Eurostat, 2010-2012	Regional data not available
3.2 Economic Effects		
3.2.1 Employment in knowledge-intensive activities (manufacturing and services) as percentage of total employment	Eurostat, 2008-2013	**Identical (data from 2013)** **Similar (Employment in knowledge-intensive services and Employment in medium-high/ high-tech manufacturing as % of total workforce) (data before 2013)**
3.2.2 Medium and high-tech product exports as percentage of total product exports	Eurostat/ United Nations 2006-2013	Regional data not available
3.2.3 Knowledge-intensive services exports as percentage of total service exports	Eurostat, 2005-2012	Regional data not available
3.2.4 Sales of new to market and new to firm innovations as percentage of turnover	Eurostat (CIS) 2006, 2008, 2010, 2012	**Similar (only for SMEs)**
3.2.5 License and patent revenues from abroad as percentage of GDP	Eurostat, 2006-2013	Regional data not available

Source: European Commission 2014:9; 2015:9

The necessary data of the innovation indicators of the IUS/RIS from the European NUTS 2 regions that will be benchmarked against each other will be taken from the official Eurostat database on Innovation (2015). A closer look at the Eurostat database, however, reveals that not the whole data for all available 'innovation indicators' can be accessed publicly and/or is fully available for the whole timeframe via the Eurostat database. Therefore table 5 illustrates those 'innovation indicators' that going to be used in the analysis as they are highlighted in green.

Besides from that, however, at the beginning also the original Europe 2020 headline indicator to measure innovation: 'the expenditure on R&D as percentage of GDP' (GERD) will be included in the analysis.

For the list of 'innovation indicators' that will be analysed in this project this means that from the innovation enablers only one indicator the 'percentage population aged 30-34 having completed tertiary education' (albeit with a different age frame ranging from 25-64) is going to be used for the regional benchmarking analysis. Slightly more regional information is available regarding the indicators for the firm level; here a total number of five out of eight indicators are available but only 'R&D expenditure in the business sector as percentage of GDP' and 'PCT patents applications per billion GDP (in PPS€)' (albeit as regional measure of 'EPO patent applications per billion regional GDP (PPS€)') will be used for the analysis. Lastly, with reference to the outputs only the indica-

tor 'employment in knowledge-intensive activities (manufacturing and services) as percentage of total employment' will be used. Although till the year 2013 there was no direct regional indicator to measure it available, earlier rounds measured it via the both indicators 'employment in knowledge-intensive services' and 'employment in medium-high/high-tech manufacturing as percentage of total workforce.' (all European Commission, 2014:8f). As Eurostat provides one already with all relevant data, no secondary national data needs to be collected from the Member States. Further Eurostat allows a direct selection and systematic comparison of the European reference regions based on their NUTS level.

One of the major obstacles when studying innovation performance across EU regions is the problem that for many regions data are not available for all indicators. Hence for a representative comparison of performance across regions using indicators one should have 100 per cent data availability whereas average regional data availability for RIS regions is only at 70 per which would mean that that 30 per cent of data is missing (European Commission, 2012: 25). The missing data is thereby filled with the help of the imputation procedure, which is implemented entirely in Excel using linear regression and another hierarchical procedure[15]. Another obstacle that had to be taken into consideration is that data should, as much as possible, be standardised and normalised so that the comparisons and conclusions made are fair. All data measuring the innovation dimensions have been normalised using the same procedure as in the IUS, where the normalised value is equal to the difference between the real value and the lowest value across all regions divided by the difference between the highest and lowest value across all regions (European Commission, 2012: 26). They are transformed by first using a power root transformation if the data are not normally distributed. Now most of the indicators are fractional indicators with values between 0 per cent and 100 per cent. Some indicators are unbound indicators, where values are not limited to an upper threshold. These indicators can have skewed data distributions (where most regions show low performance levels and a few regions show exceptionally high performance levels). For all indicators measuring innovation data will be transformed using a square root transformation with power N if the degree of skewness of the raw data exceeds 0.5 such that the skewness of the transformed data is below 0.5 (Note: none of the earlier imputed data are included in this transformation process). At last, the data have then been normalised using the min-max procedure where the transformed score is first subtracted with the minimum score over all regions and then divided by the difference between the maximum and minimum scores over all regions. Thus, now the maximum normalised score is equal to 1 and the minimum normalised score is equal to 0 with all scores rounded to the second decimal place (European Commission, 2012; 2014). Next to this transformed and standardised data, also the absolute values as taken directly from the Eurostat database (2015) will be presented to show the results along the 'innovation indicators.'

The data analysis itself will be conducted by descriptive comparison via cross-tabulation analysis. Cross-tabulation, also known as contingency table analysis, is one of the most useful analytical tools and is a mainstay of research (Babbie, 2009). The cross-tables will allow benchmarking the

[15] For full details on how those calculation and steps are done, check the RIS 2009 Methodology report (Hollanders, Tarantola and Loschky, 2009).

innovation performance of the regions against each other and over time. It will include two types of tables, the one with the absolute values and the one with the normalised and standardised values. For the in text data analysis only the table with absolute values will be used but the reader himself can decide, which one he wants to use for his control of this research study. For the final mapping of the innovation performance, however, there will be the usage of an average value throughout the last six years (2007-2013). Hence it will be using an average of values over a given time instead of illustrating changes in performance over time as originally planned in this project.
The analysis (and its chapter) will be set-up by starting of with a short introduction paragraph about the definition and purpose of the used indicator before benchmarking the performance of the European regions. During the analysis the results of Nordrhein-Westfalen is benchmarked against the outcomes of all 31 reference regions (see Annex III with tables 6 and 7 on page pp.85-89 and pp.89-94 respectively) and subsequently in the text it will be only compared with the ten closest reference regions according to the distant matrix, namely Hessen (DE), Niedersachsen (DE), Baden-Württemberg (DE), Bayern (DE), Schleswig-Holstein (DE), Rheinland-Pfalz (DE), Flemish Region (BE), West Midlands, England (UK), Wales (UK) and East Midlands, England (UK).

5. Data Analysis

Understanding how innovation (also over time) works in the regional context can be a useful learning exercise as understanding how a region compares to others in terms of innovativeness may help policy makers, scholars, and citizens better understand innovation and regional interplay. As such, the aim of the upcoming exercise is not a theoretical one, but a straightforward descriptive analytical one. Throughout this chapter Nordrhein-Westfalen will be benchmarked against its corresponding top 31 reference regions on their innovation performance over time. Due to the limited availability of regional data at the NUTS 2 level the analysis is restricted to the investigation of the few indicators that are available.

The chapter itself will start off by elaborating on the original Europe 2020 headline indicator to measure innovation: 'the expenditure on R&D as percentage of GDP.' Next, and in line with the framework of IUS and RIS, the different innovation enablers will be covered, followed by the analysis of firm activities and intellectual assets, while last but not least the innovation outputs will be looked at. Panel data of every two years (2007, 2009, 2011, 2013) will be collected from the Eurostat Database (2015) for both, the original headline indicator to measure innovation, as well as the different 'innovation indicators.' With exception of the original headline indicator, where missing values have been not imputed and standardised and normalised (as explained above), all subchapter for 'innovation indicators' are presented in two ways: At first, the absolute values as taken directly from the Eurostat database (2015) are presented, next a second table will be displayed that shows the 'innovation indicators' with all missing values to first imputed and then all values have been standardised and normalised so that the comparisons and conclusions made are fair. Therefore in those tables the maximum normalised score is equal to 1 and the minimum normalised score is equal to 0 with all scores rounded to the second decimal place.

Each section will start of by introducing a definition and the purpose of the used 'innovation indi-

cator' in the respective section before moving on towards the actual benchmarking analysis of the regions. During the analysis the results of NRW are benchmarked against all its top 31 reference regions (see Annex III with tables 6 and 7 on page pp.85-89 and pp.89-94 respectively). A particular comparative focus will be on NRW and its top ten closest reference regions in the below written analysis section. Each final column of the tables includes the average of the values over the given time in order to make it easier to (graphically) illustrate an average of values over a given time instead of illustrating changes in performance over time as originally planned. This kind of benchmarking procedure allows for a simple and direct way to assess the position of Nordrhein-Westfalen in the European context with respect to its weaknesses and strengths. All other tables throughout this chapter are produced with the same reasoning in the mind. It is also important to note that this analysis is not able to establish any association or correlation between, or even ultimately causation, that might exist between the different 'innovation indicators.'

5.1 The 'R&D Expenditure'—Headline Indicator of the flagship 'Innovation Union'

5.1.1 Definition of the headline performance indicator

According to the Lisbon Agenda, the corresponding indicator to measure innovation and which is the dependent variable of this thesis, is 'the expenditure on R&D as a percentage of GDP' (GERD) (European Commission, 2014), which by 2020 should be in all European region at the desired benchmark level of three per cent. The 'R&D expenditure' is measured by combing both, private and business, sector in their "work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications." (Frascati Manual, 2002, § 63). Thus, it counts all activities related to the total intramural expenditure on research and development.

Albeit originally to be achieved already in 2000, the subsequent Europe 2020 Agenda maintained that goal due to the lack of any possible substitute or more suitable indicator. This benchmark is, however, not free from criticism. The sole use of using this three per cent benchmark has been criticised by some academics as it only focuses primarily on the manufacturing industry and therefore does neglect to a large extent the service industry, which also promotes innovation activity in the EU (Gros and Roth, 2012:11). Further, Gros and Roth (2012) point out that it is imperative to not only develop a new and better indicator but also maybe find a substitute indicator for the regional level as it is doubted that the indicator is practical and transferrable to the regional scale. Capello (2013) thereby claims that the patterns and pathways of innovation vary among the EU regions due to their different framework conditions (e.g. Governance and policy environments, institutions etc.) and therefore before analysing a regional innovation policy, it (also) requires an appropriate analysis of the regional setting where it takes place. Aside from this discussion, nevertheless, the European Commission emphasises in its policy plans and documents that regions have a capacity to contribute to the defined objectives of regional innovation.

5.1.2 Results on the headline performance indicator

The results of benchmarking the headline innovation performance indicator of NRW and its European reference regions over time have been summarised below in table 8.

Table 8: R&D expenditure (as percentage of GDP) among the top eleven European reference regions (absolute values)

NUTS2	European reference region	R&D expenditure as a percentage of GDP				
		2007	2009	2011	2013	Average value
DEA	Nordrhein-Westfalen (DE)	:	:	1,95	1,94	0,97
DE7	Hessen (DE)	:	:	2,94	2,83	1,44
DE9	Niedersachsen (DE)	:	:	2,73	2,84	1,39
DE1	Baden-Württemberg (DE)	:	:	4,82	4,8	2,41
DE2	Bayern (DE)	:	:	2,99	3,16	1,54
DEF	Schleswig-Holstein (DE)	:	:	1,41	1,47	0,72
DEB	Rheinland-Pfalz (DE)	:	:	2	2,13	1,03
BE2	Flemish Region (BE)	:	2,06	2,3	2,44	1,70
UKG	West Midland, England (UK)	1,25	1,21	1,38	1,67	1,38
UKL	Wales (UK)	1,06	1,29	0,99	1,17	1,13
UKF	East Midland, England (UK)	1,71	1,7	1,64	1,77	1,71
Average of the top 31 European refrence regions		0,69	0,84	1,86	1,91	1,48

Explanation of flags: data not avaible = :

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by author

The benchmarking reveals that the overall 'R&D expenditure' (as percentage of GDP) of all reference regions (albeit with a different magnitude) increased their performance throughout the analysed timeframe. While some regions are close, in terms of their overall 'R&D expenditure', to the desired benchmarked goal of three per cent—namely the regions Hessen (DE), Niedersachsen (DE) and Flemish Region (BE), there are also some regions that are exceeding the goal already. In the top ten reference regions these are Baden-Württemberg (DE) that scored 4,82 per cent in 2011 and 4,8 per cent in 2013 respectively, and Bayern (DE) which scored 2,99 in 2011 and 3,16 in 2013. Besides those exceedingly well performing ones there are also those regions that are not even close to the desired benchmark like West Midland, England (UK) and Wales (UK). NRW ranks in the middle as it achieved 1,95 per cent in 2011 and 1,94 per cent in 2013 (EU data is missing for 2007 and 2009) for the 'expenditure on R&D' but still has a lot to do (read: to invest more) in order to come closer to the desired Europe 2020 target of three per cent. Since only data for two years of NRW are available this results in a rather low average value of only 0,97. This is significantly below the mean of the Top 31 reference group but still on the overall innovation performance of NRW this is

a good result.

The benchmarking of the original Europe 2020 headline indicator to measure innovation 'the expenditure on R&D as percentage of GDP' revealed already one important feature in regard 'innovation performance' in the European Union: There are big discrepancies across the EU regions with very few successful ones that are able to come pretty close or even exceed the benchmarked targets, and those regions with almost none progress towards the overall goals. These discrepancies should be minimised to reach (or even just come close) to the overall Europe 2020 targets. Also the analysis showed that the alleged economic crises that the EU is facing had a positive effect in terms of increased 'R&D expenditure' by all European regions in each single analysed year, as well as on average, of all the top 31 European reference regions. It seems that regions have invested more into R&D as a possible innovation motor albeit financial constrains and tight economic budgets.

5.2 Innovation Enablers

The innovation enablers', as a topic covered in the IUS/RIS framework, aim to capture the innovation performances that are located outside the traditional firm actives. As such, it covers three separate dimensions that are meant to portray a different angle on the same issue. Thus, the three dimensions are (1) Human resources, which is supposed to measure the availability of a high-skilled and educated workforce, (2) Open, excellent and attractive research systems that aim to focus on the international competitiveness of the science base, and (3) Finance and support, which is supposed to measure the accessibility of investments for innovation projects through e.g. governmental support for R&D are ought to be covered in this dimension section (Hollanders and Tarantola, 2011:2). As emphasised at a different part of this thesis, the availability of regional data is extremely limited and therefore only indicator to measure the human resources dimension—the 'percentage population having completed tertiary education'—will be taken into account. The finance and support dimension as measured by 'the governmental support for R&D' is partially covered by original Europe 2020 headline indicator to measure innovation as it looks at both, the private and public, sector. It will be therefore not included in this regional benchmark analysis.

5.2.1 Explanation of the 'Human Resources' indicator

The IUS indicator 'percentage population aged 30-34 having completed tertiary education' is supposed to measure the supply of skilled workers in a particular region. This variable does not only look at people working in science and technology as innovation fields but also covers the service sector. As such, the indicators distinguish regions in respect to the employment opportunities that it offers its (young) university graduates. On the European level, the Europe 2020 Agenda set the benchmark at the number of 40 per cent that the population aged 30-34 should have at least 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 ultimately easily lead to more tertiary graduates to be observed (Hollanders and Tarantola, 2011:3; European Commission, 2012:38ff). Due to the fact that regional data is, however, not available for the age group 30-34 the RIS framework analysis is restricted to the old and broader classification 'percentage population aged 25-64 having completed tertiary education'. Yet, the downside of this broader allocation is clear. Changes in the outcomes of this indicator will not become so visible in the short run given the size of the age group. None-

theless having a young and well-educated workforce is an important asset in the knowledge economy of the twenty-first century as 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 for economic growth. As Hollanders and Tarantola (2011:3; European Commission, 2012:38ff)) explain the value of the indicator is calculated 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, which results into the total share of people with completed tertiary education. On a final note one should remember that comparisons and interpretations across (national) borders of regions in relation to education need to be done with great caution as (national) educational systems including their access and the level of attainment that is required to receive a tertiary degree differs usually across countries. This could also have an influence on those numbers.

5.2.2 Results of the 'Human Resources' indicator

The analysis of the data displaying the 'percentage of population aged 25-64 with higher education' as obtained from the Eurostat database and transformed can be found in the tables below.

Table 9: Percentage of population aged 25-64 with a higher education degree among the top ten European reference regions (absolute values)

NUTS2	European reference region	Population with tertiary education				
		2007	2009	2011	2013	Average value
DEA	Nordrhein-Westfalen (DE)	17,2	18,5	20,0	20,8	19,13
DE7	Hessen (DE)	20,9	21,7	23,5	25,7	22,95
DE9	Niedersachsen (DE)	16,1	17,6	20,1	20,5	18,58
DE1	Baden-Württemberg (DE)	22,1	24,3	24,8	26,1	24,33
DE2	Bayern (DE)	19,9	21,5	22,8	25,2	22,35
DEF	Schleswig-Holstein (DE)	18,7	15,9	20,3	20,5	18,85
DEB	Rheinland-Pfalz (DE)	18,0	21,1	21,5	21,9	20,63
BE2	Flemish Region (BE)	26,3	28,0	28,8	30,3	28,35
UKG	West Midland, England (UK)	21,5	21,3	22,6	25,0	22,60
UKL	Wales (UK)	20,5	25,6	26,1	27,3	24,88
UKF	East Midland, England (UK)	21,2	23,0	23,4	27,2	23,70
Average of the top 31 European refrence regions		21,87	23,65	25,11	26,46	24,27

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by author

Table 10: Percentage of population aged 25-64 with a higher education degree among the top ten European

reference regions (normalised and standardised)

NUTS2	European reference region	Population with tertiary education				
		2007	2009	2011	2013	Average value
DEA	Nordrhein-Westfalen (DE)	0,44	0,48	0,50	0,38	0,45
DE7	Hessen (DE)	0,56	0,56	0,60	0,50	0,56
DE9	Niedersachsen (DE)	0,44	0,44	0,48	0,36	0,43
DE1	Baden-Württemberg (DE)	0,54	0,57	0,60	0,53	0,56
DE2	Bayern (DE)	0,51	0,56	0,59	0,53	0,55
DEF	Schleswig-Holstein (DE)	0,43	0,47	0,47	0,33	0,43
DEB	Rheinland-Pfalz (DE)	0,46	0,49	0,51	0,42	0,47
BE2	Flemish Region (BE)	0,71	0,72	0,77	0,68	0,72
UKG	West Midland, England (UK)	0,57	0,61	0,63	0,52	0,58
UKL	Wales (UK)	0,49	0,65	0,73	0,61	0,62
UKF	East Midland, England (UK)	0,59	0,59	0,67	0,57	0,60
Average of the top 31 European refrence regions		0,56	0,59	0,63	0,54	0,58

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by author

The overall analysed share of 'population aged 25-64 with higher education' increased from 2007-2011 in all European regions—in Nordrhein-Westfalen as well as the top 10 European reference regions—till it dropped in all regions for the year 2013. The drop in numbers of the 'percentage of population aged 25-64 with higher education' between 2011-2013 can be most likely explained that 2012 is seen by some scholars as high-point of the crises, which the EU is supposedly facing since the year 2009 (Carfuny and Schwartz, 2013). As such, better educational attainment increases employability and reduces the risk of being unemployed but due to tight budgets and financial limits companies do not hire the people with primary or lower secondary education or they leave education early. This results in a lower share of people with tertiary education as the indicator is calculated by calculating 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. This results into the total the share to decrease as the number of those people with no tertiary education increases. So increasing educational attainment and equipping people with skills for the knowledge society is therefore also one of the major concerns for European employment policies and is addressed in the Europe 2020 headline targets on

both employment and education[16]. When it comes, however, to the actual (absolute) performance each of the regions is performing exceedingly with all regions close or even above the 0,50 normalised and standardised value or speaking in concrete values above the 20,0 per cent level. This implies that the regions are close to catch up to the Europe 2020 Agenda set benchmark level that 30 per cent 'of the population aged 25-64 with higher education' should be reached but still further progress has to be done in the next seven years (2013 to 2020). NRW performance is below the mean of the top 31 European reference regions and the set benchmark of 30,0 per cent but still increased its performance increased in terms of absolute values 17,2 (2007); 18,5 (2009); 20,0 (2011); 20,8 (2013) throughout the last years. Nevertheless the numbers speak for them themselves and apparently NRW does not have a significant amount of high skilled graduated and consequently potentially employees for the knowledge economy. As the End of the crisis has been, however, reached according to Cafruny and Schwartz (2013) the number of NRW as well as the other European regions should increase in the upcoming years if e.g. education policies are designed correctly in order to increase the share of (young) people with a tertiary degree.

5.3 Innovative 'Firm Activities'

Having discussed the number of skilled workers available on the regional level, the IUS/RIS framework has also incorporated three dimensions that aim to assess the innovation activities in the business sector. While the first dimension 'firm investments' includes two measures, both regarding R&D and non-R&D investments that firms make in order to generate innovations; the second dimension 'linkages and entrepreneurship' aims to assess the entrepreneurial and collaboration efforts among innovating firms. Lastly, there is the dimension labelled as 'intellectual assets' and it measures various forms of Intellectual Property Rights that are generated as a throughput of the innovation process (Hollanders and Tarantola, 2011:2; European Commission, 2012:38ff). Sufficient regional information is only available regarding 5 out of 8 indicators but double checking with the Eurostat database reveals that the initial optimism is constrained by the fact that not all selected NUTS 2 regions were covered in the data collection at all. Therefore again limitations have been made with respect to the analysed indicators with only 2 out of 8 indicators ('business R&D expenditure' and the 'number of EPO patent applications') will be used in the benchmarking process.

5.3.1 Explanation of the 'Firm Investment' indicator

The first used indicator for 'Firm Investment' is the 'R&D expenditure in the business sector (BERD)', which aims to capture the creation and production of new knowledge within firms that be can ultimately result in new innovative assets such as patents or other forms of innovation outputs. It should be already noted here, that also the public sector can be innovative[17] but it had

[16] Goals one and four of the Europe 2020 Agenda are: 75 per cent of the 20-64 year-olds to be employed (Employment) and Reducing the rates of early school leaving below 10 per cent and at least 40 per cent of 30-34–year-olds completing third level education (Education)

[17] In 2013, the European Commission launched a pilot European Public Sector Innovation Scoreboard in order to improve the ability to benchmark the innovation performance of the public sector. The results show that the public sector in Europe is on the move to become innovate but it still faces a number of obstacles on its road.

been skipped here, as well as the science-based sector (i.e. electronics, pharmacy, transportation and chemistry) as no proper indictors exist yet to measure the performance. R&D investments of businesses are a requisite for the improvement of production methods and the generation of new products. Therefore an increased R&D provides enterprises in general with the capability of gaining greater market shares as R&D can increase a firms competitiveness. In the research-intensive economies, the business sector is the main funder and performer of R&D expenditures. It is calculated when dividing all R&D expenditures in the business sector (according to the Frascati-Manual) in national currency and current prices through the GDP of the national currency and current prices (Hollanders and Tarantola, 2011:9; European Commission, 2012:38ff). The desired benchmarking target at the European level is that 2/3rd of all R&D expenditures should be created by business R&D expenditure, which as percentage of GDP composes 2 percent of all R&D expenditures, and was set by the predecessor of the Europea 2020 Agenda, the Barcelona Council in 2002.

5.3.2 Results of the 'Firm Investment' indicator

The benchmarking analysis on the 'R&D expenditure in the business sector' is summarised in the table 11 and 12.

Table 11: Business R&D expenditure (as percentage of GDP) between Nordrhein-Westfalen (DE) and its reference regions (absolute values)

NUTS2	**European reference region**	**Business R&D expenditures**				
		2007	**2009**	**2011**	**2013**	**Average value**
DEA	Nordrhein-Westfalen (DE)	:	:	1,18	1,11	0,57
DE7	Hessen (DE)	:	:	2,29	2,18	1,12
DE9	Niedersachsen (DE)	:	:	1,87	1,92	0,95
DE1	Baden-Württemberg (DE)	:	:	3,89	3,87	1,94
DE2	Bayern (DE)	:	:	2,29	2,41	1,18
DEF	Schleswig-Holstein (DE)	:	:	0,68	0,75	0,36
DEB	Rheinland-Pfalz (DE)	:	:	1,41	1,54	0,74
BE2	Flemish Region (BE)	:	1,35	1,56	1,75	1,17
UKG	West Midland, England (UK)	0,93	0,87	1,07	1,37	1,06
UKL	Wales (UK)	0,45	0,65	0,46	0,63	0,55
UKF	East Midland, England (UK)	1,25	1,19	1,2	1,37	1,25
Average of the top 31 European refrence regions		0,50	0,59	1,27	1,32	0,92
Explanation of flags: data not avaible = :						

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by author

Table 12: Business R&D expenditure (as percentage of GDP) among Nordrhein-Westfalen (DE) and its reference regions (normalised and standardised)

NUTS2	European reference region	Business R&D expenditures				
		2007	2009	2011	2013	Average value
DEA	Nordrhein-Westfalen (DE)	0,55	0,56	0,56	0,47	0,53
DE7	Hessen (DE)	0,72	0,73	0,73	0,67	0,71
DE9	Niedersachsen (DE)	0,63	0,67	0,67	0,58	0,64
DE1	Baden-Württemberg (DE)	0,87	0,89	0,89	0,86	0,88
DE2	Bayern (DE)	0,75	0,74	0,74	0,68	0,73
DEF	Schleswig-Holstein (DE)	0,40	0,40	0,41	0,31	0,38
DEB	Rheinland-Pfalz (DE)	0,58	0,61	0,61	0,52	0,58
BE2	Flemish Region (BE)	0,62	0,61	0,62	0,51	0,59
UKG	West Midland, England (UK)	0,48	0,52	0,50	0,39	0,47
UKL	Wales (UK)	0,40	0,38	0,39	0,28	0,36
UKF	East Midland, England (UK)	0,60	0,58	0,56	0,45	0,55
Average of the top 31 European refrence regions		0,54	0,55	0,55	0,46	0,52

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by author

The results of the benchmarking analysis show a phenomenon that already become evident when analysing the original Europe 2020 headline indicator to measure innovation 'the expenditure on R&D as percentage of GDP.' Looking at the beginning only at the absolute values there are big discrepancies across the EU regions with very few successful ones that are able to come pretty close or even exceed the benchmarked target (i.e. Hessen (DE); Niedersachsen (DE); Baden-Württemberg (DE), Bayern (DE), and Flemish Region (BE)), and those regions with little or almost none progress towards the overall goal (i.e. Schleswig-Holstein (DE) and Wales (UK)). NRW is again in centre of the regional performance and still has a lot to do in order to reach (or come even close) to the Europe 2020 target of 2 per cent (as it now stands at 1 per cent) of R&D expenditures as financed by business enterprises.

Interestingly to observe is that 5 out of 6 of the better performing regions and 1 of the less well performing one, so a total of six regions are located within the same country. To illustrate this: The business R&D performance of Baden-Württemberg (DE) was in 2011 at a value of 3,89 and 3,87 in 2014 (and with that nearly twice the value of the set EU benchmark) whereas Schleswig-Holstein (DE) achieved in the same time only values of 0,68 (2011) and 0,75 (2013). The normalised and standardised values tend to confirm these innovation performance patterns of all regions throughout. This table is especially valuable as for regions located in Germany data from the pre-crises

moments (2007, 2009) is missed and no possible effect could be detected but from this event. However, with the usage of normalised and standardised values over the absolute values it can be detected that the crises had positive effect in terms of an increase in numbers of 'R&D expenditure in the business sector.' Overall, however, most regions—especially the ones of the top 31 European reference regions—still need to invest a lot more throughout the next seven years in order to achieve the 2 per cent goal by 2020.

5.3.3 Explanation of the 'Intellectual Assets' indicator

The diffusion of new products, processes and ideas is often regarded as a major driving force of economic growth. The legal protection of 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 seem to be inter alia an important criterion an inventor takes into account in deciding where to develop and market his inventions (Theben, 2014). Obtaining a patent usually does the protection of ones industrial property. The protection of ones industrial property is usually done by obtaining a patent. Whereas on the national (state) level a 'simple count' of patents is used to assess the inventive and innovation performance of Member States, for regional statistics the 'Number of EPO patent applications per million inhabitants' is to be used. It measures the capacity of firms to develop and launch new products and consequently it also used to assess the competitiveness of businesses. EPO—the European Patent Office—is able to asses through the number of patent applications the inventive activity of a country, a region or even just a firm. This measure is meant to highlight the 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, however, with big caution as the regional statistics are usually built upon the address of the inventor, which is not automatically also the place where the invention took place (Hollanders and Tarantola, 2011:12f; European Commission, 2012:38ff). In addition, patents are not compulsory for inventors and therefore not all inventions end up being patented, as the attitude towards patenting is different across activities and businesses. Also the fact that one would apply in all 28 Member States of the European Union for a patent in order to have full coverage over ones invention is hardly feasible due time, money and language constrains (all Theben, 2014)[18].

Up to 2009 the indicator to measure intellectual assets was the number of EPO patent applications per million inhabitants that was altered in the 2010 edition of the IUS when a switch in the denominator from million population to GDP in Purchasing Power Parity Euros (PPP€) has taken place (and kept this way ever since, however, still the number of patent applications is still also measured). Within the EU this change has only a small effect on the relative performance. The replacement has its origin to simplify international comparisons for benchmarking analysis between the countries outside of the EU such as the United States, Japan and the BRIC countries (Hollanders and Tarantola, 2011:11; European Commission, 2012:38ff). As in this analysis interregional

[18] Although a European-wide patent, whose official name is 'patent with unitary effect', is on its way, not all 28 Member States are participating in it. Besides that also the question whether or not patent numbers will rise a EU-wide patent it is still very doubtful (Theben, 2014).

benchmarking within EU Member States is applied the 'old' indicator will be kept. Also a bigger time frame is analysed with two years data also originally using the 'old approach' (2007 and 2009).

5.3.4 Results of the 'Intellectual Assets' indicator

A bundled and comparative overview about the number of EPO patents and high-technology EPO patents and its relative weight in terms of patents per million inhabitants from 2007 till 2013 is given in the tables 13 and 14 below. Next to the number of patent applications that were made to the European Patent Office and how much this accounts per million inhabitants, also the number of High-tech patents and how much this accounts per million inhabitants, will be presented in absolute values. However only for the EPO patens also the normalised and standardised values will be given, not for the High-tech patents. The reasoning behind this is the fact that High-tech patents are only included to show that not nearly all patent applications are related to the High-tech sector but they hail from different fields and it is a much more diverse picture.

Eurostat provided the data with a mean (among the top 31) of 716,07 EPO patents, which translates into 102,60 patent applications per million inhabitants. Of those EPO patens only a small fraction, 103,55, was related to the application of high-technology patents, which accounts for 14,96 patent applications per million inhabitants. When analysing NRWs performance it scores (extremely) higher than the values of the European mean as well as through the analysed years. On average in NRW roughly 3202,21 patents, which corresponds to 178,49 patent applications per million inhabitants, can be observed. The same observance holds true (although not same magnitude) for the number of high-technology patents as here Nordrhein-Westfalen outscores the other regions by an average over the years (2007-2011) of 293,63 that is 16,37 high-tech patents per million inhabitants. When using the normalised and standardised values for the analysed 2013 round (as here for all European regions the data is missing) a more (drastic) decrease in the numbers of EPO patents can be observed.

Table 13: Overview of the number of EPO patents and high-technology EPO patents and their relative weight in terms of patents per million inhabitants (absolute values)

NUTS2	European reference region	EPO patents										High-tech patents									
		Number of EPO patents					EPO patents per million inhabitants					Number of High-tech patents					High-tech patents per million inhabitants				
		2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value
DEA	Nordrhein-Westfalen (DE)	4438,61	4655,21	3715,02	:	3202,21	246,20	259,59	208,18	:	178,49	391,72	422,07	360,73	:	293,63	21,73	23,54	20,21	:	16,37
DE7	Hessen (DE)	2025,86	1745,35	1511,88	:	1320,77	333,46	287,78	249,20	:	217,61	232,04	211,11	181,97	:	156,28	38,19	34,81	29,99	:	25,75
DE9	Niedersachsen (DE)	1398,12	1320,60	1229,81	:	987,13	175,14	166,17	155,31	:	124,16	196,53	185,45	149,12	:	132,78	24,62	23,34	18,83	:	16,70
DE1	Baden-Württemberg (DE)	6136,51	5807,54	4647,39	:	4147,86	571,44	540,26	432,16	:	385,96	666,57	623,01	569,24	:	464,71	62,1	58	59,2	:	44,80
DE2	Bayern (DE)	5854,87	5381,08	4688,33	:	3981,07	469,47	429,81	373,92	:	318,30	1193,60	948,37	741,82	:	720,95	95,54	75,75	59,16	:	57,61

NUTS2	European reference region	EPO patents										High-tech patents									
		Number of EPO patents					EPO patents per million inhabitants					Number of High-tech patents					High-tech patents per million inhabitants				
		2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value
DEF	Schleswig-Holstein (DE)	437,28	437,47	428,04	:	325,70	154,28	154,35	151,02	:	114,91	39,01	33,04	34,94	:	26,75	13,76	11,66	12,33	:	9,44
DEB	Rheinland-Pfalz (DE)	1242,33	1159,50	878,03	:	819,97	306,53	287,84	219,30	:	203,42	84,93	103,20	67,65	:	63,95	20,96	25,62	16,90	:	15,87
BE2	Flemish Region (BE)	1053,40	942,72	811,59	:	701,93	172,20	151,83	128,30	:	113,08	265,56	213,95	205,44	:	171,24	43,41	34,46	32,48	:	27,59
UKG	West Midland, England (UK)	283,89	340,74	288,37	:	228,25	52,25	61,82	51,61	:	41,42	38,68	35,01	23,02	:	24,18	7,12	6,35	4,12	:	4,40
UKL	Wales (UK)	125,58	129,20	110,78	:	91,39	41,92	42,61	36,24	:	30,19	20,68	24,38	18,12	:	15,80	6,90	8,04	5,93	:	5,22
UKF	East Midland, England (UK)	375,73	370,38	399,07	:	286,30	85,67	83,11	88,25	:	64,26	44,09	42,72	45,20	:	33,00	10,05	9,59	10,00	:	7,41
Average of the top 31 European refrence regions		1049,02	995,90	819,37	0,00	716,07	151,02	142,90	116,45	0,00	102,60	156,63	141,29	115,49	0,00	103,35	22,82	20,44	16,57	0,00	14,96

Explanation of flags: data not avaible = :

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by author

Table 14: Overview of the number of EPO patents in terms of patents per million inhabitants (normalised and standardised)

NUTS2	European reference region	EPO patents per million inhabitants				
		2007	2009	2011	2013	Average value
DEA	Nordrhein-Westfalen (DE)	0,72	0,69	0,67	0,51	0,65
DE7	Hessen (DE)	0,72	0,70	0,70	0,50	0,66
DE9	Niedersachsen (DE)	0,66	0,63	0,63	0,48	0,60
DE1	Baden-Württemberg (DE)	0,90	0,88	0,85	0,72	0,84
DE2	Bayern (DE)	0,80	0,80	0,79	0,65	0,76
DEF	Schleswig-Holstein (DE)	0,62	0,61	0,61	0,45	0,57
DEB	Rheinland-Pfalz (DE)	0,78	0,75	0,75	0,59	0,72
BE2	Flemish Region (BE)	0,61	0,59	0,59	0,40	0,55
UKG	West Midland, England (UK)	0,48	0,45	0,43	0,27	0,41
UKL	Wales (UK)	0,42	0,42	0,41	0,23	0,37
UKF	East Midland, England (UK)	0,49	0,51	0,50	0,34	0,46

NUTS2	European reference region	EPO patents per million inhabitants				
		2007	2009	2011	2013	Average value
Average of the top 31 European refrence regions		0,56	0,55	0,38	0,51	0,51

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by author

Already with the absolute values it can be observed that from 2007-2011 the number of EPO and High-tech patents (and their respective share in their population) deceases. This leads to the speculation that the since to 2009 allegedly faced economic recension is lowering the innovative assets of a firm to crate and produce new products, knowledge, processes and ideas. They are often regarded as a major driving force of economic growth and therefore obtaining a patent usually does the legal protection of ones industrial property. So in terms of patent numbers it seems like innovation is currently slowing down in Europe. Looking first only at the EPO patents it can be detected that every single region has a three or even four digit score. Of those regions, especially the performance of Baden-Württemberg (DE), Bayern (DE), Hessen (DE) and NRW (DE) is noteworthy. But also the other top ten reference regions are performing (innovatively speaking) extremely well in terms of patent applications (and its translation per million inhabitants) with the big exception of Wales (UK), which has rather small numbers (on average 91,39 patents that is only 30,19 patents per million inhabitants) in comparison to the other regions. These kind of observations also hold true for the number of High-tech patents although here no reference due to the lack of normalised and standardised values for the year 2013 can be made. The discrepancy between the (exceedingly) well performing regions and the less performing ones prevails with the regions of Bayern (DE), Baden-Württemberg (DE) and NRW (DE) leading the field whereas at the lower end there is Schleswig-Holstein (DE) with (average) values of 26,75 high-tech patents (equal to 9,44 high-tech patents per million), West Midland, England (UK) with 24,18 high-tech patents (4,40 per million), Wales (UK) 15,80 high-tech patents (5,22 per million), and finally East Midland, England (UK) with 33 high-tech patents (7,41 per million). These kind of results are not so much extreme (in terms of numbers) as those of the top-performing ones.

These numbers become even more dramatic when considering the fact that for all regions the numbers, just like for the EPO patents, decreased. Especially for the low performing regions a low innovation (in terms of patent counts) causes a low R&D intensity that is even more constrained by the tight economic budgets of the regions policy makers and low economic growth in general. This in turn leads to even less innovation as no or only little financial means are used in order to increase the innovation performance. Hence regional policy-makers should address this vicious circle in their policies in order attract more innovation in their region.

5.4 Innovation Outputs

Every input into a system also results into a certain output. In that perspective, this sub-chapter on innovation outputs aims to capture the picture in terms of efforts and/or of the enablers and firms activities. The IUS/RIS framework distinguishes between two dimensions. While the first dimension of 'Innovators' covers three indicators, namely (1) the number of firms that have intro-

duced innovations either onto the market or within their organisations, (2) the technological and non-technological innovations and (3) the presence of high-growth firms. The second dimension is labelled 'Economic Effects' and aims to capture the economic success of innovation in employment, exports and sales due to innovation activities and covers five different indicators (Hollanders and Tarantola, 2011:2f; European Commission, 2012:38ff). The indicators are (1) the employment in knowledge-intensive activities (looking at both manufacturing and services) as percentage of total employment; (2) looking at medium and high-tech product exports as percentage of total product exports; (3) checking for knowledge-intensive services exports as percentage of total service exports; (4) controlling for the sales of new to market and new to firm innovations as percentage of turnover; (5) and finally the license and patent revenues from abroad as percentage of GDP. This subchapter is only able to cover the second, 'Economic Effects', dimension, due to the restricted data availability in the Eurostat database (2015), specifically one indicator—'employment in knowledge-intensive activities'— in order to benchmark the innovation outputs of NRW and all top 31 European reference regions besides the importance of counting the number of 'SMEs introducing product or process innovations' as research, in its nature, is about the enlargement and the diffusion of scientific and technological knowledge.

5.4.1 Explanation of the 'Economic Effects' indicator

One of the key components of an innovative society is the availability of a high-skilled workforce, which has been analysed already through the earlier used indictor 'percentage of population aged 25-64 with higher education.' In terms of output, so actual numbers, however, the number of people that are employed in science and technology-related activities is also an important aspect when measuring 'innovative performance' The IUS/RIS therefore aims to the chunk of highly qualified people by looking at the degree of human resources employed in science and technology. Therefore the corresponding indicator is the 'employment in knowledge-intensive activities (manufacturing and services) as percentage of total employment.' This direct indicator, however, only exists since the analysed year 2013 as for the earlier rounds of the Scoreboard had the indicator separated in indicators measuring the 'employment in knowledge-intensive services' on the one hand and 'employment in medium-high/high-tech manufacturing as percentage of total workforce' on the other hand (all European Commission, 2014:8f). Besides this division of the indicator in earlier rounds, it will be still used here. It fails, however, to capture the fact that next to researchers and academics also other people are working in science and technology e.g. technicians, clerks and support staff. OECD (2011) therefore calls upon to extend the measure by analysing all persons employed in science and technology. This objection is taken into consideration and therefore the table containing the absolute values of the Eurostat database (2015) also includes as a proxy the indicator 'persons employed in science and technology as percentage of total employment'.

5.4.2 Results of the 'Economic Effects' indicator

Tables 14 and 15 below summarise the important findings regarding the indicators 'employment in knowledge-intensive activities (manufacturing and services)' throughout the years 2009-2013 as no data for the year 2007 was available. To get broader perspective of the issue also a measure for all 'persons employed in science and technology as percentage of total employment' for the same timeframe is included.

Table 15: The persons 'employment in knowledge-intensive activities (manufacturing and services)' as well as those 'employed in science and technology' both as a percentage share of total employment among the top ten European reference regions (absolute values)

NUTS2	European reference region	Employment in knowledge-intensive activities (manufacturing and services)					Persons employed in Science and Technology				
		2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value
DEA	Nordrhein-Westfalen (DE)	:	3,70	4,0(b)	3,60	1,83	20,70	21,40	23,2(b)	23,50	16,40
DE7	Hessen (DE)	:	5,60	5,1(b)	5,00	2,65	21,90	23,10	24,0(b)	26,00	17,75
DE9	Niedersachsen (DE)	:	2,60	2,6(b)	2,50	1,28	20,10	19,90	22,4(b)	23,70	15,93
DE1	Baden-Württemberg (DE)	:	5,50	5,2(b)	5,20	2,68	23,40	24,10	26,0(b)	26,70	18,55
DE2	Bayern (DE)	:	5,20	5,2(b)	5,10	2,58	23,10	22,70	24,6(b)	26,60	18,10
DEF	Schleswig-Holstein (DE)	:	:(u)	:(bu)	3,40	0,85	23,30	21,40	23,4(b)	23,70	17,10
DEB	Rheinland-Pfalz (DE)	:	3,60	3,7(b)	3,60	1,80	20,80	23,00	24,2(b)	25,20	17,25
BE2	Flemish Region (BE)	:	4,30	4,4(b)	4,50	2,20	18,40	18,80	21,2(b)	21,00	14,55
UKG	West Midland, England (UK)	:	2,90	3,20	3,80	2,48	15,8(b)	15,60	19,5(b)	20,00	8,90
UKL	Wales (UK)	:	2,60	2,80	3,10	2,13	14,9(b)	15,30	20,6(b)	21,30	9,15
UKF	East Midland, England (UK)	:	2,70	3,50	3,50	2,43	15,0(b)	15,40	20,1(b)	21,00	9,10
Average of the top 31 European refrence regions		:	3,58	3,68	4,14	2,85	19,01	19,22	21,56	22,17	20,49
Explanation of flags: data not avaible = : ; break in time series = b ; u = low reliablity											

Source: Source: European Commission 2012; 2014; Eurostat, 2015; calculations by author

The benchmarking analysis with respect to the first dimension 'employment in knowledge-intensive activities (manufacturing and services)' reveals that the employment numbers remained rather stable throughout the timeframe. In some regions the employment numbers slightly decreased (like in NRW), while in some other regions the numbers went slightly up. Ultimately it seems like the economic crises had no or only a small influence in regard to the people being employed in the manufacturing and science sector of knowledge-intensive sector. On average 2,85 per cent of the population in the top 31 European reference regions was employed in knowledge-intensive activities with NRW performing below the reference group with a value of one per cent point and a mean of 1,83 per cent. Thus, it scores in the centre for this indicator. A high performance for the single years can be observed in Baden-Württemberg (DE), Hessen (DE), Bayern (DE). Far behind are Niedersachsen (DE) and Wales (UK) that score both rather low.

Table 16: The persons 'employment in knowledge-intensive activities (manufacturing and services)' as a percentage share of total employment among the top ten European reference regions (normalised and standardised)

NUTS2	European reference region	Employment in knowledge-intensive activities (manufacturing and services)				
		2007	2009	2011	2013	Average value
DEA	Nordrhein-Westfalen (DE)	0,64	0,68	0,64	0,64	0,65
DE7	Hessen (DE)	0,82	0,77	0,81	0,76	0,79
DE9	Niedersachsen (DE)	0,67	0,67	0,70	0,56	0,65
DE1	Baden-Württemberg (DE)	0,93	1,00	0,96	1,00	0,97
DE2	Bayern (DE)	0,82	0,85	0,84	0,85	0,84
DEF	Schleswig-Holstein (DE)	0,50	0,59	0,59	0,50	0,54
DEB	Rheinland-Pfalz (DE)	0,58	0,69	0,77	0,69	0,68
BE2	Flemish Region (BE)	0,58	0,55	0,54	0,56	0,56
UKG	West Midland, England (UK)	0,63	0,58	0,52	0,56	0,57
UKL	Wales (UK)	0,45	0,43	0,43	0,43	0,43
UKF	East Midland, England (UK)	0,55	0,51	0,44	0,52	0,51
Average of the top 31 European refrence regions		0,61	0,63	0,63	0,60	0,62

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by author

Taking the second indicator 'persons employed in science and technology' the same observational patterns can be detected. Although, the absolute values increased from 2007-2013 it has to been stated that the data is not very reliable as in 2011 there was break in the time series (as indicated by the 'b' in the table). NRW remains in the centre of the top ten reference regions. Interestingly to note here, is the fact that most regions have values slightly above the 20,00 per cent value which suggested an overall good performance in regard to the 'Economic Effects' indicator. Hence it seems that the European crises had no or only small influence on the employed people working in the R&D sector as measured and analysed for by this indicator.

5.5 Mapping 'Innovation Performance' of NRW and European reference regions

5.5.1 Calculating Ranks of 'Innovation Performance'

The last four sub-chapters aimed in a first step to capture and descriptively illustrate the level of regional innovation performance of Nordrhein-Westfalen and then in a second step to benchmark this regions performance against its top 31 European reference regions. For this benchmarking ex-

ercise it used the European research and innovation strategy 'Innovation Union' as a reference framework as it had done by other scholars (i.e. Engelhardt, 2013) in the past. For the analysis three type of indicators had been used: One linked to human resources (percentage of population aged 25-64 having completed tertiary education), one linked to firms activities (R&D expenditure in the business sector), one to intellectual assets (patent applications at EPO per million inhabitants), and finally one indicator regarding the economic effects (employment in knowledge-intensive activities).

Therefore after having analysed each single innovation dimension in detail, the purpose of this section is to provide a comprehensive overview about the overall innovation performance of Nordrhein-Westfalen and its the top ten reference regions in the light of the Europe 2020 Agenda by ranking it. By using for the ranks the average of the absolute values over a given time instead of illustrating changes in performance over time as original the original research strategy in terms time series analysis is not applicable anymore, however, the graphical illustration still enables the identification of the (relative and descriptive) strengths and weaknesses of NRW in terms of its innovation performance. In addition to that by comparing (and graphically illustrating) NRW with its top ten reference regions it can be seen whether NRW is alone with its strengths and weaknesses in this inter-regional benchmarking analysis.

In order to bring NRW and the reference regions into proportion with one another, the average value throughout the years 2007 till 2013 has been used in order to calculate the rank by using the min-max-method (De Vaux et al., 2012). The formula for this is:

$$X_{i0\text{-}10} = \frac{(Xi\text{-}Xmin)}{(Xmax\text{-}Xmin)} \times 10$$

The overall innovation performance of all analysed regions is now ranging from 0 to 10, where 0 is the lowest share and 10 represents the highest.
For instance, with respect to the EU 2020 headline indicator R&D expenditure, from the top 31 reference regions the East of England (UK) achieved the highest share with 3,81 per cent (Xmax), whereas Lombardia (IT) reported only 0,63 per cent (Xmin) while NRW achieved a share of 0,97 per cent (Xi) on this dimension. Filling in data for the given values, the model for the calculation (being rounded up two decimal places) therefore reads as the following:

$$X_{i0\text{-}10} = \frac{(0{,}97\text{-}0{,}63)}{(3{,}81\text{-}0{,}63)} \times 10 = 0{,}9119 = 1$$

Thus the ultimate ranking place of Nordrhein-Westfalen would be a rank of one (1) as fractioned numbers are usually not applied in ranking calculations (De Vaux et al., 2012). Consequently, this procedure and calculation has been done for each and single region from within the whole group of the top 31 reference regions. The results of this standardisation are outlined in the big table 7 on pp. 89-94 in the Appendix III. On top of that, and also in line with the previous established approach of this chapter, also the average value of the top 31 reference group will be assigned a rank. Also for some indicators the European Commission has proposed target values that should be

achieved by 2020; if available, those are also included in the standardisation procedure. As it could be that some regions even score higher than the proposed European target (see i.e. East of England (UK) with respect to the headline indicator). The Europe 2020 target therefore does not automatically and necessarily gets a 10 in the ranking.

5.5.2 Discussing Ranks of 'Innovation Performance'

The below given table 17 summarises the ranking of the top ten regions and their innovation performance. Highlighted in green is the best (or in some cases "are the best") region(s), while red denotes the worst performing one(s). Starting point of the analysis is NRW as it had been the original key region whose innovation performance had been studied.

Table 17: Ranked performance of the top eleven European reference regions along their achieved averaged values between 2007 and 2013 on the analysed indicators dimension

NUTS 2 Refer cep Region	R&D expenditure (Europe 2020 Headline indicator)	Human Resources	Firm Activities		Economics Effects
			Firm Investment	Intellectual Assets	
Nordrhein-Westfalen (DE)	1	3	1	8	4
Hessen (DE)	3	4	3	3	6
Niedersachsen (DE)	2	3	3	2	3
Baden-Württemberg (DE)	6	5	6	10	6
Bayern (DE)	3	4	3	10	6
Schleswig-Holstein (DE)	0	3	1	1	1
Rheinland-Pfalz (DE)	1	3	2	2	2
Flemish Region (BE)	3	6	3	2	5
West Midland, England (UK)	2	4	3	0	4
Wales (UK)	2	5	1	0	3
East Midland, England (UK)	1	5	4	1	3
Average of the top 31 European refrence regions	3	5	3	2	4
EU 2020 target	**8**	**7**	**6**	**n.a.**	**n.a.**

Source: Based on the information established by the previous chapters; calculations by author

Starting off with the Europe 2020 headline indicator, Nordrhein-Westfalen had (on average) an expenditure on R&D of 0,97 due to data missing for the years 2007 and 2009. This results to the

value, which is far below the set benchmark target of 3 per cent causing the region to be nearly at the bottom of the field with a rank of 1. Only Schleswig-Holstein (DE) scored worse with a 0. Rank 3 represent the centre of the field as many regions scored it. At the other end of the ranking is Baden-Württemberg (DE) that stands out with a value of 6. Yet, still no region came close to Europe 2020 target that ranks a 8. Summarising, for the Europe 2020 headline indicator it can be summarised that all European regions need to promote more effort in achieving innovation. There are big discrepancies across the EU regions with very few successful ones that are able to come close or even exceed the benchmarked level on the one hand, while on the other hand there are also those regions with almost none or just small progress toward the overall Europe 2020 target. R&D investment needs to be increased in order to allow especially the less performing regions to minimise their performance value (or even just come close to it) and to reach the set benchmark of three percent.

Taking a look at the first 'innovation indicator' to assess the innovation performance, 'Human Resources', the Europe 2020 benchmark target was set so that at least 40 per cent of the population aged 30-34 in the European Union should have at least a tertiary degree, which correlates to a share of 30 per cent for the analysed age class of 25-64 years having completed tertiary education. Amongst the top ten reference regions[19] there seems to be one region (comparably speaking) well-performing, four middle performing, and six low-performing region(s) that can be distinguished. Top (and holding rank 6, which is one below the EU target) is the Flemish Region (BE). At the lower end is (again) NRW sharing the third rank with Niedersachsen (DE), Schleswig-Holstein (DE), and Rheinland-Pfalz (DE). The majority of regions is located in the centre and performing well with ranks 4 or 5. When speaking in absolute values the average value of all 31 European reference regions across the analysed time frame was equal to 24,27 per cent. This is pretty close to European target value of 30 per cent that the population aged 25-64 should have 'completed tertiary education'. European regions are on a good way to achieve the set benchmark by 2020 if trends continue and all relevant actors keep the effort.

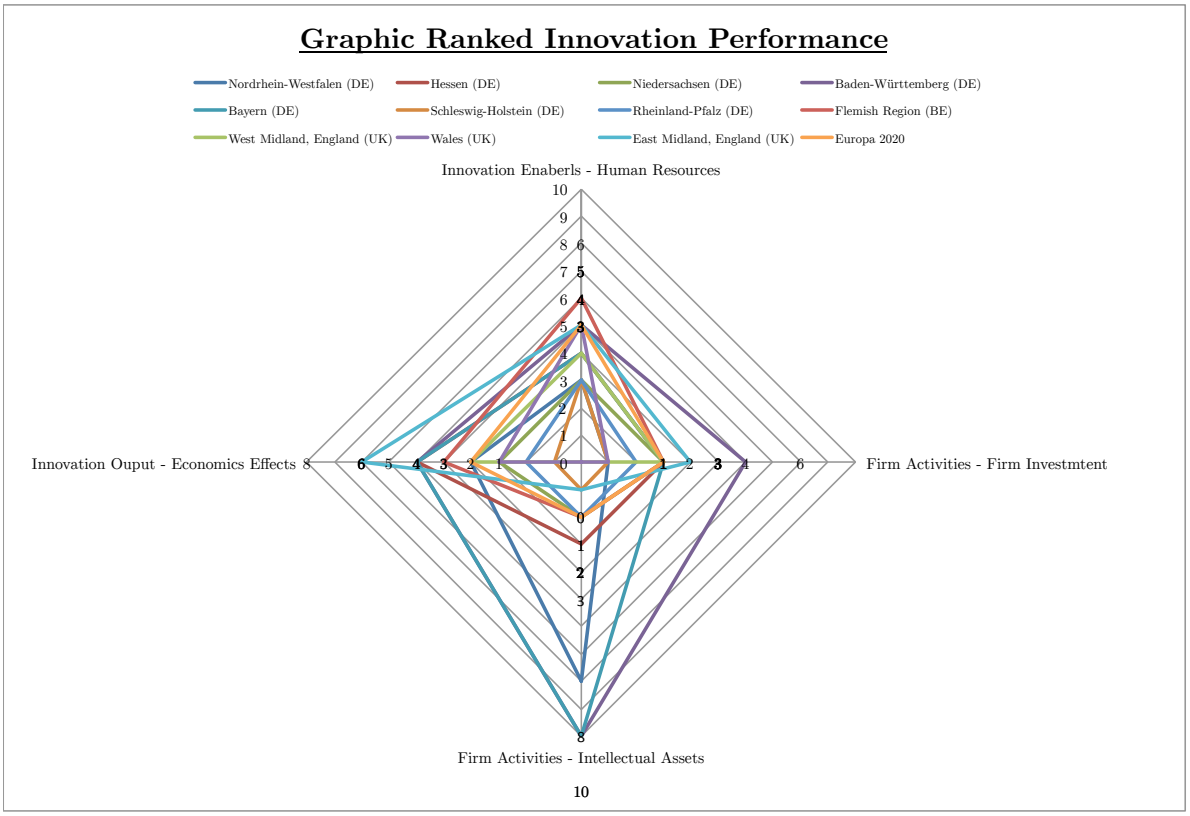
Next in line is the 'Firm Activates' indicator with its sub-indicators 'Firm Investment' and 'Intellectual Assets'. Looking first at the 'Firm Investment' that captures 'R&D expenditure in the business sector' the desired benchmark was set that it should be at least two per cent of all R&D expenditures of the GDP. Similar to the Europe 2020 headline target there is again a split between the regions with a larger share of the low-performing regions. Leading the field is Baden-Württemberg with the rank 6 (which is equal to the Europe 2020 goal) while the bottom place (and ranking 1) is shared by Nordrhein-Westfalen (DE), Schleswig-Holstein (DE) and Wales (UK). The majority of the regions is scoring a 3, which means that nearly all European regions are significantly lagging behind in terms of 'R&D expenditure in the business sector.' Hence European regions need to strengthen their performance as R&D provides enterprises with the capability of gaining greater market shares and can also increase the overall competitiveness of firms.
Also included in the 'Firm Activates' indicators is the 'number of EPO patent applications per mil-

[19] The number ten refers to the ten closest European reference regions of NRW. Adding NRW to it (10 + 1) this comparison as outlined here assess the innovation of eleven regions.

lion inhabitants' dimension, which measures the capacity of firms to develop new products. Albeit the European Commission has not formulated a concrete target for the 'number of EPO patent applications per million inhabitants' it can, however, generally be assumed that a higher share of patents corresponds with a higher degree of innovation activity as intellectual property rights provide a link between inventions, innovations and the market. Here for the first time, Nordrhein-Westfalen, does rank good (8) (Average value of 3.202,21 million patent applications) and only being exceeded by the performance of Baden-Württemberg (DE) and Bayern (DE) as both score 10. The rest of the top ten European reference regions is alarming far below those values. The left regions rank 0 (twice), 1 (three), and 2 (four). The average of the top 31 European reference regions ranks 2, which shows the European regions crucially lack a form capacity to exploit knowledge and translate it into economic gains in terms of patents. A possible explanation for the exceeding well performance of Nordrhein-Westfalen (DE), Baden-Württemberg (DE) and Bayern (DE) might be the presence and close-proximity of excellent universities, research institutes as well as science and business parks.

Last but not least, taking the economic effects dimension into consideration that captures the economic success of innovation to create the knowledge-based economy 'employment in knowledge-intensive activities (manufacturing and services).' Also here no specific benchmark was defined by the Europa 2020 Agenda. However with a rank of 4, NRW is closely behind the top-performing regions Hessen (DE), Baden-Württemberg (DE), and Bayern (DE) that all ranked a 6. The Flemish Region (BE) ranks 5 and five other regions are ranking below NRW. So all in all, NRW is performing well since it ranks with majority of regions the same value that is equal to the top 31 European reference regions mean.

Figure 2: Illustrated averaged Ranked Innovation Performance of Nordrhein-Westfalen and its top ten European reference regions as well as the Europe 2020 targets



Source: Own graphical representation based on calculations of the information established in the previous chapter

Summarising, the graphic representation of the regional benchmarking analysis revealed NRW is performing pretty very well in respect to 'Intellectual Assets' and 'Economics Effects' by being close to the top for the latter one and clearly above the average of the top 31 European reference regions for the first one. Not so well, however, NRW is ranking for the two other dimensions 'Human Resources' and 'Firm Investment'. It ranks in the middle-lower class of the regions therefore more effort is required by regional (policy) actors in or to close gap and achieve, or just come close, to the set benchmark targets of the Europe 2020 Agenda for those indicators. Looking at the whole, broader European, picture out of the top ten regions Baden-Württemberg (DE) scores nearly always on top or close to the level performers and could therefore be classified as a 'top-leader' in light of the 'Innovation Union' performance. At the other end of the ranking scale is Schleswig-Holstein (DE), which ranked in three out of four indicators on the last rank (although not always alone. Hence it could be seen as an 'innovation lagger' as for higher innovation performance NRW needs to put more than just a lot of effort in the performance in order to reach, or just even come close, to other European reference regions. NRW is close to the centre and is therefore classed as an 'innovation follower' in light of its innovation performance of the 'Innovation Union' and the Europe 2020 Agenda in general.

6. Conclusions and Outlook

The research project started out with the objective to benchmark the innovation performance how EU-regions perform in terms of innovation (as measured by Europe 2020 'Innovation Union') and how this developed over time. By using panel on the last six years of performance (2007-2013) it

was able to derive at some descriptive conclusions, as one is currently (speaking from the time pint of writing) close at the half time of the Europe 2020. The study thereby narrowed its focus by benchmarking Nordrhein-Westfalen against, according to a synthetic index of structural distance, 31 homogenous reference regions across the entire EU. With this exercise, the project tried to contribute descriptively to the ambitions laid down in the regions own innovation and research strategy 'Fortschritt NRW' (2013) and locate NRW in the wider picture of its aims to become one of the most innovative regions in the European Union. The final conclusion starts by briefly reiterating the key objective of the thesis, presenting the main findings and subsequently outlining some recommendations for regional innovation (policies) in the future. However, as this thesis was not able to cover all (possible) aspects and themes of regional innovation due to the limited space and goal of the thesis, also a discussion of limitations and a critical analysis regarding the research design complete this sub-chapter. An outlook for a possible future research project and therefore ending this final and important chapter of the research project follows this.

6.1 Main findings of the research project

This thesis has argued extensively in favour of using the regional level as the level of analysis as it is today seen as one of the major drivers of innovation policy. This idea is also translated as a territorial dimension of Europe 2020 Agenda, especially the Territorial Agenda 2020 (ESPON, 2014). The Territorial Agenda 2020 was adopted in May 2011 along the Europe 2020 Agenda by taking its self-set 'policy triad' of "smart, sustainable and inclusive growth" (Barroso, 2010) and subsequently rephrased it in its sub-title as "[t]owards an inclusive, smart and sustainable Europe of Diverse Regions" (ESPON, 2014:4). As such the topic of spatial planning and development of the Member States of the European Union, as expressed as a territorial cohesion, has now even become a shared competence of the EU and its Member States as laid down in article four of the Treaty on the Functioning of the European Union (Consolidated Version of the Treaty on European Union, 2010). This Territorial Agenda 2020 is important as it already in its sub-title ("Towards an inclusive, smart and sustainable Europe of Diverse Regions" (ESPON, 2014:4)) hints also the key finding of this research project and master thesis: Every region is influenced by its own shape of characteristics and therefore also the results of the regions are individual. However one general pattern can be detected for innovation performance, which is that there are big discrepancies across the EU regions with very few successful ones that are able to be close or even exceed the target values, and then there are those regions with almost none or only small progress at the overall goals. Especially those regions have to put a lot effort forward in order to reach (or even just come close) to the overall Europe 2020 targets. As such the European Commission demands its regions to focus on their relative strength by focusing in a particular field of specialisation ('speciality niche') and consequently become an excellent forerunner in this area instead of simply 'copy-paste' the successes strategies of other regions.

This observation also holds true for the benchmarked analysis conducted in this research project. First, the benchmarking of 32 European regions (NRW plus its top 31 European reference regions) was narrowed to down to a reference group of only ten regions that consisted next to Nordrhein-Westfalen (DE) out of (1) Hessen (DE), (2) Niedersachsen (DE), (3) Baden-Württemberg (DE), (4) Bayern (DE), (5) Schleswig-Holstein (DE), (6) Rheinland-Pfalz (DE), (7) Flemish Region (BE), (8)

West Midland, England (UK), (9) Wales (UK), and (10) East Midland, England (UK) As one can already see there is high proximity of regions located within the same country (Germany). After having conceptualised, operationalized, and explained the measurement of the innovation indicators the regional benchmark analysis has generated the following results in regard to NRWs innovation performance:

- Albeit being criticised by the academic site for being to narrow to measure all (possible) defined objectives, the corresponding headline indicator to measure innovation revealed that NRW is performing relative good. Although NRW scored (on average) only a value 0,97 per cent this low value can be explained the fact that data missing for the years 2007 and 2009. In 2011 and 2013, where data for NRW is available, those values stood 1,95 per cent and 1,94 per cent respectively. Although still below the Europe 2020 benchmark target of three per cent, still further intense progress would make it possible to achieve the set out benchmark till 2020.

- Taking the first 'innovation indicator' to assess the innovation performance, 'Human Resources', the target value is that a share of 30 per cent of the analysed age class of 25-64 years should completed tertiary education. For the analysed time frame NRW scores rather weak with only (on average) 19,13 per cent of the population aged 25-64 having completed tertiary education. Hence, NRW is clearly lagging behind and intensified progress is needed by all regional innovation (policy) actors in NRW in order to achieve the desired goal.

- Next in line is the 'Firm Activates' indicator with its sub-indicators 'Firm Investment' and 'Intellectual Assets'. While for the first dimension 'Firm Investment', which captures 'R&D expenditure in the business sector', the desired benchmark was set that at least two per cent of all R&D expenditures of the GDP should originate from the business sector. Similar to the Europe 2020 headline target there is again split between the regions as there those regions who are close or even exceeding the benchmark value, while there also some regions will little or no progress towards the value. NRW achieved 1,18 per cent (2011) and 1,11 per cent (2013) resulting an call for strengthening of the R&D performance in order increase the overall competitiveness of firms.
- Also included in the 'Firm Activates' indicator is the 'Intellectual Assets' dimension, which measures the 'number of EPO patent applications per million inhabitants' and it measures the capacity of firms to develop new products. The European Commission did not explicit set a target value but it can be argued that a higher share of patents equals a higher capacity to exploit its present knowledge and therefore translate it into potential economic gains as intellectual property rights (i.e. patents) provide a link between inventions, innovations and the market. NRW achieved an average value of 3202,21 million patent applications in belong with this to the top performers of this indicator and only exceeded by the performance of Baden-Württemberg (DE) and Bayern (DE). At the other end is the Mazowiecke region in Poland (42,32). A possible explanation for the exceeding well performance might be the presence and close-proximity of excellent universities, research institutes as well as science and business parks.

- Last but least, the 'Economic Effects' as an innovation output indicator was taken into consideration. It captures the economic success of innovation to create the knowledge-based economy by

measuring 'employment in knowledge-intensive activities (manufacturing and services)' Also here no specific benchmark was defined by the Europa 2020 Agenda, however NRW is closely behind the top-scoring regions and with an average value 2,83 on the 'employment in knowledge-intensive activities' the region is 0,01 per cent values above the average of the top 31 European reference region (2,82 per cent). So all in all NRW is performing well as it ranks with majority of regions.

So what does that all mean for the key research question, which has been asked at the beginning of the research project? The questions asked how, benchmarked against its European reference regions, Nordrhein-Westfalen was performing with respect to innovation during the last six years (2007-2013)? Taking the descriptive results as outlined above it can stated in a nutshell that the regional benchmarking analysis has exposed that NRW shows to be performing exceedingly well in terms of 'Intellectual Assets' (EPO patents) and 'Economics Effects' (Employment in knowledge-intensive activities) by being close to the top, however, it lacks behind in terms of the 'Human Resources' (People aged 25-64 years completed tertiary education) and the 'Firm Investment' dimensions (R&D expenditure in the business sector). Hence more effort is required by the regional (policy) actors of NRW in or to close gap and achieve, or just come close, to the set benchmark targets of the Europe 2020 Agenda for those indicators. It can be therefore classified as an 'innovation follower' in light of its innovation performance throughout 2007-2013.

6.2 Recommendations for regional innovation (policy) actors

As presented in earlier in this research project NRW is ambitious in becoming an innovative top region and a forerunner in the European Union by 2020 by extending its innovative capacities in various directions and fields (Fortschritt NRW, 2013). On the basis of the earlier outlined results of the descriptive benchmarking analysis it can be deducted on which fields it should concentrate it efforts. These are the 'Human Resources' indicator (people aged 25-64 years completed tertiary education) and the 'Firm Investment' indicator (R&D expenditure in the business sector) for which also concrete recommendations, specifically for the regional innovation (policy) actor, will be given. New ways and strategies need to be found in order to attract a higher business R&D performance and funding. This is especially important during harsh economic times (as Europe is facing it since 2009) with tight budgets and austerity measures in place. Possible, predominantly financial and investing, means need to be found in order revitalise the (regional) market(s) that in turn can lead to higher innovation performance. Next to that, however, also having a strong foundation from the business sector when promoting innovation is also the availability of well-educated workforce. H ere NRW scored only in the centre with an average value of 19,13 per cent, which is not only below the desired EU-set benchmark but also requires more efforts to increase the actual share of the population having completed tertiary education.

In light of the financial and economic crisis, which is coupled with an investment downturn from the public/policy sector, it seems like the economic (and with it innovative) performance of the regions is decreasing. As Camagni and Capello (2015) suggest in their paper a solution could be found for regional actors within (EU) cohesion policy as it could be more appropriate than one might think in boosting R&D expenditure of the business sector throughout the European regions. A (economic) reasoned question, however, might be of "how can cohesion policies be justified in a

period of crisis when short-term, anti-cyclical policies intended to boost internal demand may seem more appropriate than structural and supply-side ones?" (Camagni and Capello, 2015:27). It seems that cohesion policy is seen as less urgent and appropriate than the short-term demand policies to deal with the immediate effects and causes that the regions are facing as a result of the crises. However the role of business has to be extended as public resources are limited and therefore attracting higher business R&D investment seems even more essential. Therefore regional innovation (policy) actors, as Camagni and Capello (2015) start of their argument, need first to realise that besides the considerable pressure that the crises is putting on several EU countries and regions it is now even more important to use the EU cohesion policy as the appropriate tool of solution since otherwise, or even in the worst case, the pressures of the regions caused by the crises could jeopardise the last two decades of efforts made towards EU enlargement and cohesion. EU cohesion policy could increase R&D business expenditure by increasing a larger number of fiscal incentives e.g. grants for business and/or increasing the support for public-private partnerships. Further concrete examples of possible financing instruments for promoting innovation through R&D business expenditure can be found in table 18 in the Appendix II (pp. 83-84). They are based on the existing conclusions of the EU Industrial R&D Investment Scoreboard (2015c), which found that most of the European business tended to increase their R&D spending despite (or maybe because of) the crisis. These practices as outlined in the table could be promoted by the (regional) policy actors of regions and their national governments (so in the case of NRW, the regional government seated in Düsseldorf and the Federal Government of Germany). EU and its cohesion policy complement these tools as it has higher financial means. It is therefore, as Camagni and Capello (2015) highlight, important to use cohesion policy to allow regional policies to rebalance their spatial effects that the on-going crises is determining on interregional convergence trends, in strict relationship with some new monetary and fiscal policy tools agreed at the EU level this could also lift some of the pressure that existing austerity measures are exerting on many.

Another shortcoming of NRW was the 'Human Resources' indicator performance. It was not alone in not performing so well on this indicator and as such, also here possible (EU-wide) solutions need to be found. A starting point for this would be adjustment of the education policy in order to increase the share of those people attending university and if they are studying, also assist them in finalising their degree. The role and importance of (regional) university and third-level educational facilities for a knowledge society of the twenty-first century needs to be emphasised by regional innovation (policy) actors. As such NRW showed a high capacity to develop new products (as measured by the high number of patent applications), which is supposedly explained by high presence of excellent universities that contain research institutes as well as science and business parks. The number of people being trained and consequently working in those fields needs to be increased to boost the innovation performance. Possible programmes and strategies that could increase the number of people attending and finishing tertiary education would be according to the European Commission (2015b) e.g. the regulation and revision criteria of access to higher education like offering also offering work-experienced to access university besides their lack of holding the initial school matriculation diploma. Other strategies are the introduction of matching students and programmes with regard to motivation, competencies and expectations that they hold and could potentially lead to higher completion rates. Also an increased facilitation of the transition to tertiary education and investing in high--school collaboration thorough i.e. outreach programmes or supporting students

from less-fortunate families to finance their studies. Governments can also use competitive funding incentives to enhance transition from secondary to tertiary education of (special) groups. To that end, governments should promote a comprehensive and transparent human capital development system that is stretching from primary to tertiary education and including lifelong learning (all European Commission, 2015b). These outlined practises and strategies in their majority try to reduce the drop out numbers, while aiming to increase the completion rates of higher education at same time. These two strategies are seen as the major solution on how the Europe 2020 strategy of having at least 40 per cent of 30-34 year olds complete higher education could be completed. As such all these practises are, in one way or another, already incorporated by a number of European Member States but not yet EU-wide as European Commission (2015b) explains.

So summarising, instead on focussing the R&D intensity alone, Nordrhein-Westfalen should focus on its local strengths by strengthening its policies in the above mentioned field. The 'Innovation Union' framework is the foundation. So NRW should follow the advice given by the European Commission and use the knowledge-triangle of education, research and innovation and facilitate development in all three corner of the knowledge-triangle. In that regard, Nordrhein-Westfalen needs to find policies to further reform its research and innovation systems aiming to improve its quality, promote excellence, foster closer co-operation and pursue smart specialisation. In that regard, the Ruhr Metropolitan Region (Metropolregion Ruhr) that is an urban area in NRW and with a population density of 2.800 km^2 and a population of roughly eight and a half million, it is the largest urban agglomeration in Germany, this region offers a great start to boost NRWs innovation performance. The region has a number of excellent universities with which there are a number of closely associated research institutes. Three Max Planck Institutes have their headquarters in the Ruhr region: the Max Planck Institute of Molecular Physiology in Dortmund, the Max Planck Institute for Coal Research in Mülheim an der Ruhr and the Max Planck Institute for Chemical Energy Conversion also in Mülheim, in addition Four Fraunhofer Institutes are located in the Ruhr region: the UMSICHT called the Oberhausen Fraunhofer Institute for Environmental, Safety and Energy Technology, the Fraunhofer Institute for Material Flow and Logistics and the Fraunhofer Institute for Software and Systems Engineering in Dortmund and the Fraunhofer Institute for Microelectronic Circuits and Systems, Duisburg. Among the (more) well-known research institutes are also included institutions related to social sciences and humanities as the Rhine-Westphalia Institute for Economic Research, the Center for Turkish Studies and the Cultural Studies Institute, all of which have their headquarters in Essen; further the regions Sozialforschungsstelle Dortmund and the Institute for Work and Technology in Gelsenkirchen, the Landesspracheninstitut NRW in Bochum and the DMT-Research Institute of mining history in Bochum can be seen as the cornerstones of Nordrhein-Westfalen innovation economy. In that vein technology and science parks work as incubators and create a link between universities and the business community. A link, however, as the analysis has shown that must be strengthened. A successful example of this would be Technologie Zentrum Dortmund where since 1988 settled more than 225 companies with over 8,500 employees. Here micro technology industry has a particularly high proportion. Rather recently, a science park was created in Gelsenkirchen with companies specialising in renewable energy as function as a possible business incubator. The knowledge transfer between SMEs that do not conduct their own research is provided by the Mülheim Center for Innovation and Technology (all Fiolka, 2015).

Those are just a few examples of areas and places in the Ruhrgebiet, which shows that NRW has a good starting pointing if it wants become an innovative forerunner in particular sectors by 2020 if applying regional innovation polices correctly. But Nordrhein-Westfalen is even bigger and more possibility and chancres are open. The presence of a high number of (existing) people working in the science and technology sector as well as a good knowledge-dissemination through patents, NRW can be an attractive destination for R&D investment. But in order to keep up with European as well as global competitors it needs to boost investments as building a knowledge economy requires strong foundation. Therefore it can be doubted if the region becomes innovative forerunner when looking only at quantitative achievements to be reached till 2020 but it can catch up to those well performing ones. It shall be not discussed here in detail here whether or not purely quantitative measurements are the right tool to judge if a region is innovative or not, nor should one debate here about the appropriateness of the actual headline indicator but NRW will be most likely not one of the regions that will report an R&D intensity of exceeding 3 per cent by 2020 but it is on a good way to come close to it The average value of 0,97 per cent to 3 per cent is just too big to close within the next seven years.

6.3 Limitations and Outlook for the research project

Every research project has to take certain limitations and adjustments in regard to its research project as there is no possibility for a jack-of-all-trades. However being aware as a researcher of ones limitations this allows for a critical assessment of the research project in terms of its validity and reliability of the found results—in that case the innovation performance of NRW over the last six years.

With respect to the chosen research design, a most-similar case study approach has been chosen; there are alternative options to assess the innovation performance at the regional level. As argued earlier, there is the possibility to execute a cluster analysis to identify the groups of reference regions with similar structural conditions. An analysis obtaining by this typology is likely to result a different outcome and also different reference regions would have to be chosen. The same logic is true, if one would decide to use exclusively the assigned weights for the variables when calculating the performance.

Along this line is also the public policy argument. It has been argued that there are three types of territorial benchmarking: (1) performance benchmarking that is based on a comparison of metrics portraying the relevant characteristics of the benchmarked against regions, (2) process benchmarking, which is the comparison of the structures and systems constituting the practices and functioning of benchmarked regions, and (3) policy benchmarking that is to say a comparison of the types of public policy considered to influence the nature of the practices and subsequently the characteristics of benchmarked regions. As the aim of this thesis was to benchmark the innovation performance of NRW against its European reference regions, process and policy benchmarking have been not taken into account in this project due to the limited research frame. Still policy and governance structures matters for innovation and therefore a (possible second) more inclusive research project should aim at combing at least two (out of the three) of the different benchmarking ap-

proaches in order to get a more coherent and complete overview of the benchmarked against regions. The shortly presented literature on governance and public policy has show that both aspects must be seen as important determinants of economic growth. Especially in the EU where all levels of government (from the EU to the municipality level) are involved in a 'multi-governance system' this aspect is a crucial one. As regions become key players in the promotion of the entrepreneurial economy and innovation, while at the same time entrepreneurship policies are implemented at all those governance levels, this combined perspective needs to be considered more in upcoming benchmarking excises.

Another limit in that regard is the in this analysis (as well as in earlier conducted ones) is the predominant research focus of benchmarking analysis on the innovation of regions that are predominately located in the Western European Member States that is to say the "old" Member States, which are (usually already) characterised by (comparatively speaking) already a higher number of performance on the indicators as they have long-established research and science institutions that have, inter alia, received numerous years of support via the EU the and its cohesion policy. This results R&D performance in regions to develop around strong and established academic institutions and/or specific high-technology industrial activities and/or knowledge-based services that is attracting (further) highly qualified personnel. This fosters a favourable environment in which R&D is intensified and as such the competitive advantage of these regions is further intensified.
On the other side of the coin this results that Eastern European Member States that is to say the "new" Member States have problems in catching up or just to increase their innovation performance. They therefore continue to lag behind as they are not given (enough) financial means from the cohesion policy funds and therefore neither established academic institutions and/or specific high-technology industrial activities and/or knowledge-based services, which are attracting (highly) qualified personnel, are available. The possible downsides are evident: A negative-spinning spiral of the competitive advantage of these regions is intensified and no progress towards the innovation-performance is possible. If this, however, also true in reality and how (possible) innovation performance should be analysed in another research project. Thus to sum up, a look to the East might be more useful exercise for understanding innovation performance of EU regions then a look to the West.

Finally, and this is arguably the most crucial restriction of this thesis, even though the most comprehensive and recent data available have been used from the Eurostat database it was still limited, slightly outdated and sometimes not reliable (e.g. interruption of data-collection in time or low readability when collecting the data). Also by using panel data of every two years (2007, 2009, 2011, 2013) and consequently using for the final analysis an average of values over a given time instead of illustrating changes in performance over time, the original set out objective of conducting a time series analysis was not possible anymore.
Although the European Commission is aware of the problem with the data, it has promised that it would enhance the collection as well as quality of the availability of region data. Therefore the current state of art and the possibilities to conduct a sound and overreaching regional innovation analysis with the used indicators was the best that one could conduct on the NUTS 2 level for a benchmarking analysis Also the possibility to include all original top 35 European reference regions

was restricted due some countries not offering or collecting information for the regional level (i.e. France and Austria). Therefore, only 31 NUTS 2 level regions could be included in this exercise of the benchmarking analysis As such, next to the limited availability of regional innovation statistics, is the correctness and currentness of the data is the second major point of criticism. Most of the statistics for the regional level are available at Eurostat with a delay of two up to three years, which results that the year 2013 was not always possible to include fully in the analysis. Not even speaking about the year 2015, which is the year of writing this thesis. Also, and in particularly, with respect to the time series analysis of economic recession in the European Union it would have been interesting to investigate whether this aspect did have any consequences on the innovation performance of the regions over time, however, no proper conclusions could be made due to missing data. This resulted for the average values, a skewed picture of the indicators, as for some years the data missing.

Nevertheless, this comparative time series analysis on the innovation performance of Nordrhein-Westfalen and its top 31 European reference regions over the last six years (2007-2013) can be seen as valuable as provided descriptive insights of the innovation performance at the regional level. Although there is more research needed to address the full scope of the individual regional innovation systems of Nordrhein-Westfalen and other European regions since regional innovation systems are embedded in the national, supranational and international system of a globalised economy. Especially the institutional infrastructure with public authorities and policy agents would be interesting to observe and how it involves/interacts with the research and higher education institutions, technology transfer agencies, organisations. But also its fostering of firm's innovation capacity as well as business associations and finance institutions is deemed interesting. All these aspects have not been addressed within this project, but could be easily done within a second work. As smart, sustainable and inclusive growth—the 'policy triad' of the European Union—of regions remains in tact till the Europe 2020 Agenda ends in 2020.

7. List of References

Books and Chapters

Babbie, E.R. (2009). *The Practice of Social Research* (12 Ed., International Student Ed.). Belmont, CA.: Thomson Wadsworth.

Barnett, V. (1998). *Kondratiev and the Dynamics of Economic Development: Long Cycles and Industrial Growth in Historical Context.* London: Macmillan.

Cafruny, A. W. and Schwartz, H. M. (2013). (Eds.) *Exploring the Global Financial Crisis.* Boulder, Co: Lynne Rienner Publishers.

Cooke, P. (1998). Introduction: origins of the concept. In Braczyk, H-J., Cooke, P., Heidenreich, M. (Eds.) *Regional Innovation Systems: The role of governances in a globalized world* (pp. 2-25). UCL Press: London.

Cooke, P., Boekholt, P., Tödtling, F. (2000). *The Governance of Innovation in Europe: Regional Perspectives on Global Competitiveness (Science, Technology, and the International Political Economy).* Pinter: London.

Cooke, P. and Piccaluga A. (Eds) (2004). *Regional Economies as Knowledge Laboratories.* Edward Elgar: Cheltenham.

Buzan, B. (1998). The Asia-Pacific: what sort of region in what sort of world? In McGrew, A. And Brook, C. (Eds.) *Asia-Pacific in the New World Order* (pp. 67-87). London: Routledge.

Chaminade, C. & Edquist, C. (2010). Rationales for Public Policy Innovation Process: Systems of Innovation Approach. Smits. In R.E., Kuhlmann, S. and Shapira, P. (Eds.). *The theory and practice of innovation policy – An international Research Handbook* (pp. 95-115). Cheltenham (UK) and Northampton, MA (USA).

De Vaux, R.D., Velleman, P. F. and D.E. Bock. (2012). *Stats: Data and Models (3 Ed., International Ed.).* Boston: Pearson Education Inc.

Engelhardt, A.-K. (2013). Benchmarking regional innovation in the light of the Europe 2020 agenda: the case of Twente. M.Sc. & M.A. Thesis. Enschede: University of Twente.

Fiolka, T.A. (2015). A Red Carpet Welcome - Investment Promotion as a Tool to Attract FDI to European Regions. M.Sc. & M.A. Thesis. Enschede: University of Twente.

Florida, R. (2002). *The Rise of the Creative Class. And How It's Transforming Work, Leisure and Everyday Life.* Basic Books.

Florida, R. (2005). *Cities and the Creative Class.* Routledge.

Florida, R. (2008). *Who's Your City?: How the Creative Economy Is Making Where You Live the Most Important Decision of Your Life.* Basic Books.

Florida, R. (2010). *The Great Reset: How New Ways of Living and Working Drive Post-Crash Prosperity.* New York: HarperCollins.

Gordon, D., Adelman, L., Ashworth, K., Bradshaw, J., Levitas, R., Middleton, S., Pantazis, C., Patsios, D., Payne, S., Townsend, P. and Williams, J. (2000). *Poverty and social exclusion in Britain.* York: Joseph Rowntree Foundation.

Groenendijk, N. (2011). EU and OECD Benchmarking and Peer Review Compared. In F. Laursen (Ed.). *The EU and Federalism – Polities and Policies Compared* (pp. 181-202). Surrey: Ashgate Publishing Limited.

Hospers, G.-J. (2004). Innovation by Imitation? Territorial Benchmarking in EU Regional Policy. *CES Working paper no. 7/04,* University of Twente, Netherlands.

Hospers, G.J., Tuijl, E. van, Benneworth, P. (2012), Innovation by imitation? Benchmarking success stories of regional innovation, In: Bas, T. and Zhao, J. (Eds.), *Comparing High-Technology Firms in Developed and Developing Countries: Cluster Growth Initiatives* (pp. 14-25), IGI Global, Hershey PA.

Howells, J. (1999). Regional systems of Innovation?. In: Archibugi, D., Howells, J. and J. Michie (Eds). *Innovation Policy in a Global Economy* (pp. 67-93). Cambridge University Press, Cambridge.

Lagendijk, A. (2005). Regionalization in Europe. Stories, institutions and boundaries. In Houtum, H. van, Kramsch, O., Zierhofer, W. (Eds.). B/ordering Space (pp. 77-92). Ashgate: Aldershot.

Iking, B. (2009). Benchmarking Innovation Performance on the Regional Level: Approach and Policy Implications of the European Innovation Scoreboard for Countries and Regions. In P.J.J. Welfens and J T. Addison (Eds.), *Innovation, Employment and Growth Policy Issues in the EU and the US* (pp. 245-271). Berlin, Heidelberg: Springer.

Keating, M. (1998). The New Regionalism in Western Europe, Territorial Restructuring and Political Change. Edward Elgar: Cheltenham.

Lundvall, B. (Ed.) (1992). National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning. London: Pinter.

Naskell, P. and Törnqvist, G. (1999). *Building a Cross-border Learning Region: The Emergence of the Northern European Öresund Region.* Copenhagen Business School Press: Copenhagen.

Porter, M. E. (1998). *On competition.* Boston: Harvard Business School.

Schumpeter, J. A. (1934). *The Theory of Economic Development. An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle.* Transaction Books: New Brunswick, N.J. and London.

Smouts, M.C. (1998). The region as a new imagined community? In: Le Galés, P. and Lequesne, C. (Eds.). *Regions in Europe* (22-28). Routledge: London

Storey, D.J. (2003): Entrepreneurship, small and medium sized enterprises and public policy, in Z.J. Acs and D.B. Audretsch (Eds.), *International Handbook of Entrepreneurship Research* (pp. 473-511), Dordrecht: Kluwer Academic.

Theben, A. D. D. (2014). Unitary Patent Protection under Enhanced Cooperation: Is an EU patent feasible in the future? M.Sc. Thesis. Enschede: University of Twente.

Yin, R. K. (2014): Case Study Research: Design and Methods (5th Edition). London: Sage Publications.

Journal Articles, Newsletters and Working Papers

Acs, Z.J. and Szerb, L. (2007). Entrepreneurship, Economic Growth and Public Policy. *Small Business Economics, 28*(2-3), 109-122

Archibugi, D. and Coco, A. (2004). A New Indicator of Technological Capabilities for Developed and Developing Countries. *World Development, 32*(4), 629-654.

Asheim B. and Isaksen, A. (2002). Regional innovation Systems; The Integration of Local "Sticky" and Global "Ubiquitous" Knowledge. *The Journal of Technology Transfer, 27*(1), 77-86.

Audretsch, D.B. (2004). Sustaning Innovation and Growth: Public Policy Support for Entrepneuership. *Industry and Innovation, 11*(3),167-191.

Audretsch, D.B. and Keilbach, M. (2004). Entrepreneurship Capital and Economic Performance,*Regional Studies, 38*(8), 949-959.

Audretsch, D.B. and Belitski, M. (2015). Is Happiness Conducive to Entrepreneurship? Exploring Subjective Well-Being – Entrepreneurship Relationship across Major European Cities. Discussion Paper CFE-2015-01, Retrieved December 13, 2015 from henley.ac.uk: https://www.henley.ac.uk/files/pdf/research/papers-publications/CFE-2015-01_Audretsch_and_Belitski.pdf

Barroso, J.M. (2010). *Let's give Europe a vision.* Centre for European Studies. European View, 5-10.

Benneworth, P., Charles D., Hodgson, C. and Humphrey, L. (2007). Leadership and the 'regional innovation journey' in ordinary regions. A review of the literature. *A report prepared for Places & Innovation Research programme, National Endowment for Science, Technology & the Arts*, Third draft, March 2007.

Bessant, J. and Rush, H. (1998). Approaches to benchmarking: the case of 'framework conditions' and ICT-Os. Centre for Research in Innovation Management, University of Brighton. *Paper prepared for the European Commission Joint Research Centre,* 1-30.

Blotevogel, H.H. (2000). Zur Konjunktur der Regionsdiskurse. Informationen zur Raumentwicklung (*IzR 9/10.2000 - Die neue Konjunktur von Region und Regionalisierung*), 491-506.

Camagni, R. and Capello, R. (2015). Rationale and design of EU cohesion policies in a period of crisis. *Rgional Science Policy & Practice, 7*(1), 25-49.

Capello, R. (2013). Knowledge, Innovation, and Regional Performance: Towards Smart Innovation Policies. Introductory remarks to the Special Issue. *Growth and Change, 44*(2), 185-194.

Coenen, L., Moodysson, J., Asheim, B. (2004). Proximities in a Cross-border Regional Innovation System: On the Knowledge Dynamics of Medicon Valley (DK/SE). *Paper presented at the 4th Congress on Proximity Economics: Proximity, Networks and Co-ordination*, Marseille, 2004.

Cooke, P., Urangab, M. G., Etxebarriab G. (1997). Regional innovation systems: Institutional and organizational dimensions. *Research Policy, 26*(4-5), 475-491.

DiMaggio, P.J. and Powell, W.W. (1983). The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. *American Sociological Review, 48*(2), 147-160.

Doloreux, D. and Parto, S. (2005). Regional innovation systems: Current discourse and unresolved issues. *Technology in Science, 27*(2) pp. 133-153

Edquist, C. (2001). The Systems of Innovation Approach and Innovation Policy: An account of the state of theart. *Lead paper presented at the DRUID Conference*, June 2001, Aalborg.

Edquist, C. and Chaminade, C. (2006). Industrial policy from a systems-of-innovation perspective. EIB Papers, *11*(1), 108-132.

Edquist, C. (2008). Design of Innovation Policy through Diagnostic Analysis: Identification of Systemic Problems (or Failures). *CIRCLE, Lund University paper No 2008/06.*

Feser, E.J. And Bergman, E.M. (2000) National Industry Cluster Templates: A Framework for Applied Regional Cluster Analysis, *Regional Studies, 34*(1), 1-19.

Florida, R., Mellander, C. and Rentfrow, P.J. (2013). The happiness of cities. *Regional Studies , 47*(4), 613-627.

Gertler, M.S. (2003). Tacit knowledge and the economic geography of context or The undefinable tacitness of being (there). *Journal of Economic Geography, 3*(1), 75-99.

Groenendijk, N. (2015) *The rise of regionalism in Europe.* AER newsletter, 2015(4), 20-23.

Gros, D. and Roth, F. (2012). The Europe 2020 Strategy. Can it maintain the EU's competitiveness in the world? *Centre for European Policy Studies*, Brussels.

Grozea-Helmenstein, D., Helmenstein , C. and T. Slavov (2009). Who is the best? Insights from the benchmarking of border regions. TRAMES, *13(63/58),* 3, 285-302.

Hemmer, C. And Katzenstein, P. (2002). Why is There No NATO in Asia? Collective Identity, Regionalism, and the Origins of Multilateralism. International Organization, 56(3), 575-607.

Hollanders, H. and Tarantola, S. (2011). Innovation Union Scoreboard 2010 – Methodology report.

Hollanders, H., Tarantola, S. and Loschky, A. (2009). Regional Innovation Scoreboard 2009 Methodlgiy report. Prop Inno Europe, Inno Metrics.

Huggins, R. (2008). Regional Competitive Intelligence: Benchmarking and Policy-making. *Regional Studies, 44*(5), 639-658.

Klein Woolthuis, R., Lankhuizen, M. and Gilsing, V. (2005). A system failure framework for innovation policy design. *Technovation, 25*(6), 609–619.

Leydesdorff, L. and Etzkowitz, H. (1996). Emergence of a Triple Helix of university—industry—government relations. *Science and Public Policy, 23*(5), 279-286.

Leydesdorff, L. and Zawdie, G. (2010) The triple helix perspective of innovation systems, *Technology Analysis & Strategic Management, 22*(7), 789-804.

Lundquist, K. and Trippl, M. (2009). Towards Cross-Border Innovation Spaces. A theoretical analysis and empirical comparison of the Öresund region and the Centrope area. *SRE - Discussion Papers, 2009/05*. Institut für Regional- und Umweltwirtschaft, WU Vienna University of Economics and Business.

Maré, D. C., Fabling, R., and Stillman, S. (2014). Innovation and the local workforce. *Papers in Regional Science*, *93*(1), 183-201.

Natali, D. (2010). The Lisbon Strategy, Europe 2020 and the crisis in between. *European Social Observatory, 4*, 1-26.

Navarro, M., Gibaja, J., Franco, S., Murciego, A. (2011). Territorial benchmarking methodology: The need to identify reference regions. *DRUID Conference Paper,* Copenhagen Business School, Denmark, June 2011.

Navarro, M., Gibaja, J.J., Franco, S., Murciego, A., Gianelle, C. Hegyi, F.B. and Kleibrink, A. (2014). Regional benchmarking in the smart specialisation process: Identification of reference regions based on structural similarity, *S3 Working Paper Series No. 03/2014*.

Porter, M.E. (2003). The Economic Performance of Region. *Regional Studies, 37*(6-7), 549-578

Rodríguez-Pose, A. and Di Cataldo, M. (2015). Quality of government and innovative performance in the regions of Europe. *Journal of Economic Geography, 15*(5), 673-706.

Schmitt-Egner, P. (2002). The Concept of 'Region': Theoretical and Methodological Notes on its Reconstruction. *European Integration, 24(*3), 179-200.

Schumpeter, J.A. (1935) The Analysis of Economic Change. *The Review of Economics and Statistics, 17*(4),2-10.

Šmihula, D. (2009). The waves of the technological innovations of the modern age and the present crisis as the end of the wave of the informational technological revolution. *Studia politica Slovaca, 1*, 32-47.

Šmihula, D. (2011): Long waves of technological innovations, *Studia politica Slovaca, 2*, 50-69.

Tödtling, F. and Trippl, M. (2005). One size fits all? Towards a differentiated regional innovation policy approach. *Research Policy, 34*(8), 1203-1219.

Trippl, M. (2006). Cross-Border Regional Innovation Systems. *SRE – Discussion Papers 2006/05.* Institut für Regional- und Umweltwirtschaft, WU Vienna University of Economics and Business.

Verboven, T. (2011). The organizationa format of territorial lobbying in Brussels. Conference paper. University of Antwerp, March 2011.

Zabala-Iturriagagoitia, J., Gutiérrez-Gracia, A., Jiménez-Sáez, F. (2006). Benchmarking Innovation in the Valencian Community. SRE - Discussion Papers. Institut für Regional- und Umweltwirtschaft, WU Vienna University of Economics and Business

Legal Documents and Official Publications

Consolidated Version of the Treaty on European Union [2010] OJ C83/13.

European Commission (1995). Green Paper on Innovation. European Commission Publications, Luxembourg and Brussels.

European Commission (1996). The First Action Plan for Innovation in Europe – Innovation for growth and employment. European Commission Publications, Luxembourg and Brussels.

European Commission (2000). Presidency Conclusions. European Commission Publications, Luxembourg and Brussels.

European Commission (2001). The Regional Dimension of the European Research Area. European Commission, Brussels.

European Commission (2002). 2002 European Innovation Scoreboard: Technical Paper No. 3, EU Regions. European Commission Publications, Luxembourg and Brussels.

European Commission. (2010a). Europe 2020. A strategy for smart, sustainable and inclusive growth. European Commission Publications, Luxembourg and Brussels.

European Commission (2010b). Europe 2020 Flagship Initiative Innovation Union. European Commission Publications, Luxembourg and Brussels.

European Commission. (2010c). The fifth report on economic, social and territorial cohesion – Investing in Europe's future. European Commission, Brussels

European Commission. (2010d). Regional Policy contributing to smart growth in Europe 2020. European Commission Publications, Luxembourg and Brussels.

European Commission (2010e). The "Innovation Union" - turning ideas into jobs, green growth and social progress. IP/10/1288. European Commission Publications, Luxembourg and Brussels.

European Commission (2010f). Turning Europe into a true Innovation Union. MEMO/10/473. European Commission Publications, Luxembourg and Brussels.

European Commission (2012). Regional Innovation Scoreboard 2012. European Commission Publications, Luxembourg and Brussels.

European Commission (2014). Regional Innovation Scoreboard 2014. European Commission Publications, Luxembourg and Brussels.

European Commission (2015a). Innovation Union Scoreboard 2015. European Commission Publications, Luxembourg and Brussels.

European Commission (2015b). Dropout and Completion in Higher Education in Europe. Main Report. European Commission Publications, Luxembourg and Brussels.

European Commission (2015c). 2015 EU Industrial R&D Investment Scoreboard. European Commission Publications, Luxembourg and Brussels.

Eurostat (2011). Regions in the European Union. Nomenclature of territorial units for statistics NUTS 2010/EU27. European Commission Publications, Luxembourg and Brussels.

ESPON (2014). Progress towards the Territorial Agenda of the European Union 2020 [Territorial Monitoring Report], ESPON Programme, Luxmebourg.

Foray, D., Goddard, J., Goenaga, X., Landabaso, M., McCann, P., Morgan, K., Nauwelaers, C. & Ortega-Argilés, R. (2012). Guide to Research and Innovation Strategies for Smart Specialisation (RIS3). May 2012. European Commission, Regional Policy.

Forschungsstrategie Fortschritt NRW (2013): Forschung und Innovation für nachhaltige Entwicklung 2013 – 2020, Stand: Kabinettbefassung 5. Juli 2013, sprachlich redigiert, Düsseldorf: Ministerium für Innovation, Wissenschaft und Forschung des Landes Nordrhein-Westfalen.

Groenendijk, N. Engelhardt, A. and Geerdink, C. (2013) *Twente index 2013.* Enschede: Stichting Twente Index [Report].

Juncker, J.-C. (2015). Authorised State of the Union Address 2015: Time for Honesty, Unity and Solidarity. Strasbourg, 9 September 2015. Retrieved October 25, 2015 from europa.eu: http://europa.eu/rapid/press-release_SPEECH-15-5614_en.htm

Landtag Nordrhein-Westfalen (2012): Plenarprotokoll 16/7 v. 12.09.2012, Regierungserklärung Hannelore Kraft, S. 240-252.

Organization for Economic Co-operation and Development. (1997a). National Innovation Systems. OECD, Paris.

Organization for Economic Co-operation and Development. (1997b). Policy Evaluation in Innovation and Technology: Towards Best Practices. OECD, Paris.

Organization for Economic Co-operation and Development. (1999). Managing National Innovation Systems. OECD, Paris.

Organization for Economic Co-operation and Development. (2002). Dynamising National Innovation Systems. OECD, Paris.

Organization for Economic Co-operation and Development. (2002). Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development. OECD, Paris.

OECD and Eurostat. (2005). Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd edition. OECD, Paris.

Organization for Economic Co-operation and Development. (2011). Why regions matter for innovation policy today. In Regions and Innovation Policy (2011). OECD, Paris.

Schulze, S. (2012): Bericht der Ministerin für Innovation, Wissenschaft und Forschung des Landes Nordrhein-Westfalen, Svenja Schulze, in der zweiten Sitzung des Ausschusses für Innovation, Wissenschaft und Forschung am 26. September 2012 zur Innovations- Wissenschafts- und Forschungspolitik in der 16. Legislaturperiode. Retrieved November 25, 2015 from wissesenfschaft.nrw.de: http://www.wissenschaft.nrw.de/fileadmin/Medien/Dokumente/Reden_Ministerin/rede_2012_09_26.pdf

Websites and Datasets

Barnett, V. "Kondratiev, Nikolai Dmitrievich." Encyclopedia of Russian History. 2004. Retrieved November 25, 2015 from Encyclopedia.com: http://www.encyclopedia.com/doc/1G2-3404100667.html

Eurostat Database (2015). Science, technology and innovation. Retrieved October 12,, 2015 from http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database

Eurostat. Statictics Explained. (n.d.) "Europe 2020 indicators - research and development" Retrieved September 26, 2015 from http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_research_and_development

G.I.B.Info (2010). "Eine indikatorbezogene Betrachtung: Bedeutung der Strategie Europa 2020 für Nordrhein-Westfalen" (= Heft 3/2010) Retrieved September 26, 2015 from http://www.gibinfo.de/gibinfo/2010/3_10/bedeutung-der-strategie-europa-2020-fuer-nordrhein-Westfalen

Information und Technik NRW (2015). "Statistiken Nordrhein-Westfalen" Retrieved September 26, 2015 from https://www.it.nrw.de/statistik/a/index.html

Organization for Economic Co-operation and Development (n.d). "Regional Innovation." Retrieved December 16, 2015 from http://www.oecd.org/gov/regional-policy/regionalinnovation.htm

S3Platform (2015). Benchmarking Regional Structure. Retrieved October 12, 2015 from s3platform.jrc.ec.europa.eu: http://s3platform.jrc.ec.europa.eu/regional-benchmarking-tool

8. Appendix I

Bolstering up the EU methodological framework to measure innovation

During the 1990s the debate about innovation (and its causal pathways) heated up again as the rise of the Information and telecommunications technology was seen as a new and innovative 'Kondratiev wave' (Barnett, 1998; 2004). Kondratiev waves are, according to technological innovation theory, economics cycles that arise from the bundling of basic innovations that lead to the launch of technological revolutions, which in turn create leading industrial and/or commercial sectors (Barnett, 1998; 2004; Šmihula, 2009; 2011). These ideas were taken up by the earlier mentioned Joseph A. Schumpeter in the 1930s, who suggested to name those 'long waves of innovation' after the Soviet economist Nikolai Kondratiev, who was the first to bring these observations to international attention in his book 'The Major Economic Cycles' (1925) alongside other works written in the same decade (Barnett, 1998; 2004)[20].

Also the EU has been influence its existing methodological framework to measure innovation and as such uses several 'innovation indicators.' These are also used in this research report because they work along the 'smart specialisation strategy' as initiated by the European Commission and developed by Navarro et al. (2014). It is not said this indicator are correct per se and therefore the below given table 1 provides a short non-exhaustive list of additional possible 'innovation enablers' that have been found to also have a positive influence on innovation process on the (sub-) national level. These indicators are meant to bolster up the EU selection to measure innovation.

Table 1: Overview of Innovation Enablers

Variable	Valence or relationship and theoretical justification	Academics
Innovation clusters	Innovation clusters are, according to Feser and Bergman (2000), to the groupings of independent undertakings—innovative start-ups, small, medium and large enterprises as well as undertakings in research organisations—that operating in a particular sector and/or region. This cluster is designed to stimulate increased innovative activity by promoting an interaction and sharing of the facilities. It finally contributes to higher innovation outputs by all actors inside the cluster exchanging their knowledge and expertise and by contributing effectively to technology transfer, networking and information dissemination among the participating actors.	Fesser and Bergman, 2000

[20] Most recently, Daniel Šmihula (2009; 2011)—albeit with some modifications—brought up the theory of Kondratieff cycles up again, when he identified in his work six long-waves with each of which was initiated by a specific technological revolution. As such, he sees the current wave of the Information and as such the since 2007 ongoing economic crises is for him, and for some scholar believes that the economic crises as a result of the technological stagnation, a result a result of the coming end of the "wave of the Information and telecommunications technological revolution."

Variable	Valence or relationship and theoretical justification	Academics
Social Networks	Generally perceived, as the driving force behind any growth in a modern western economy is the entrepreneur, traditionally belonging to the middle-class of society. As such, Gordon et al. (2000) argue it is the entrepreneurs‘ social network, the social structure made up by the social actors (such as individuals and/or organisations) he encounters that drive and influences the innovation capacity of regions. People are in the driver seat of innovation process and dyadic ties and social interactions influences the innovation capacity of the people.	Gordon et al., 2000
Life Satisfaction	In their work Florida et al. (2013:614) find that people tend to actively select “their place of residence on the light of job opportunities, public goods, and services they provide [...] and derive both satisfaction with their community and emotional attachment from the city in which they live.” This results people‘s ‘life-satisfaction’ (as measured by the subjective well-being) to be apparently conducive to higher Entrepreneurship actives across various major European regions and cities (Audretsch and Belitski, 2015).	Florida et al., 2013 Audretsch and Belitski, 2015
Human Capital	For ‘life-satisfaction’ indicator Florida et al. (2013) find ‘human capital’ agglomeration to be the strongest predictor of it. ‘Human capital’ thereby tends to closely linked the educational background of the labour force as a higher educated working class is thereby associated also with a higher innovation rate since a higher educated society is also more likely to cover more skills, knowledge, and experience possessed by an individual (or population at large) viewed in terms of their value or cost to an organisation (or region in the context of this specific analysis).	Florida et al., 2013
Quality of Life	Earlier to ‘life-satisfaction’ and ‘human capital’ agglomeration, Richard Florida (2002; 2005; 2008; 2010) also emphasised in earlier studies that a concept that he labelled as ‘quality of life’ is important when trying to understand entrepreneurship and innovation performance. It does not only asses the general ‘quality of life’ by observing the wealth and employment context but it also adds that environment, physical and mental health, education, recreation and leisure time, as well as social belonging need to be asset when a populations well-being. As such, Florida‘s concepts of ‘life-satisfaction’ and ‘quality of life’ are often used interchangeably albeit they are not. With increased performance on the ‘quality of life’ scale, Florida (2002; 2005; 2008; 2010) also assumes the entrepreneurial (so innovation) spirt raises as several outlined factors are theoretically discussed to be the driving forces behind innovation, business creation and transformation of regions. Also entrepreneurs are also those, who bring upon innovation, new ideas and new markets and in turn foster economic output and employment	Richard Florida, 2002; 2005; 2008; 2010

Variable	Valence or relationship and theoretical justification	Academics
Entrepreneurship Capital	Entrepreneurial activity is one of the major contributes to economic growth. As such, Audretsch and Keilbach (2004), argue that 'entrepreneurship capital' is one of the major assets that a region can have. Entrepreneurship capital is defined as "a region's endowment with factors conducive to the creation of new businesses" and it exerts a positive impact on the region's economic (and therefore innovative) output. (Regional) Policy therefore should focus to mobilise and increase this 'entrepreneurship capital' as here lays the sources of innovation performance. However, this process is complex and obstacle-ridden one as some of innovation barriers might hinder the performance. Some of those barriers are related to that of the market itself, while others are institutional, cultural etc. Only by overcoming these 'knowledge filters' the 'entrepreneurship capital' can create a real value in the market and improve the overall productivity of resources through innovation.	Audretsch and Keilbach, 2004
Learning processes	DiMaggio and Powell (1983) argue that albeit institutions are shapes in their behaviour with their respective agents (i.e. people, organisations, governments) it has been observed that insertions throughout the globe have evolved in the same direction. As such, however, this kind of copy (isomorphism) behaviour does pose a constraint rather than an enabler of innovation, which is why they call the institutions to be in an "iron cage." Hence governments (or regional actors), who copy (isomorphism) rather than learn will be not able to contribute to the innovation diffusion.	DiMaggio and Powell, 1983
Workforce development	According to Maré, Fabling, and Stillman (2014) recent empirical studies that have identified a link between the presence of immigrants or skilled workers in an area and the innovative outcomes of firms in the area. Combing firm-level innovation data with area-level census data from New Zeeland the researchers tried to examine the relationship between local workforce characteristics, especially the presence of immigrants and local skills, and the likelihood of innovation by firms. After examining a range of innovation outcomes, and test the relationship their results, however, indicate that there is indeed a positive relationship between local workforce characteristics and average innovation outcomes in labour market areas, but this is accounted for by variation in firm characteristics such as firm size, industry, and research and development expenditure. Controlling for these influences, however, one finds for the New Zeelandian case, no systematic evidence of an independent link between local workforce characteristics and innovation.	Maré, Fabling, and Stillman, 2014

Source: Self-created by the author

9. Appendix II

Table 2: Overview of public programmes to assist SMEs and enhance entrepreneurship

Problem	Programme	Description	Country	Success
Access to loan finance	Loan Guarantee Scheme	SMEs without access to own collateral obtain access to bank loans by state acting as guarantor	UK, USA, Canada, France, Netherlands	Yes, generally viewed as helpful, but small-scale impact on the overall financing of SMEs in most countries
Access to equity capital	Enterprise Investment Scheme	Tax breaks for wealthy individuals to become business angels	UK	Unknown
Access to markets	Europartenariat	Organisation of trade fairs to encourage cross- border trade between SMEs	EU	General satisfaction amongst firms that participated
Administrative burdens	Units established within government to seek to minimise administrative burdens on smaller firms	Sunsetting legislation deregulation units	Netherlands, Portugal, UK	The view of small firms themselves is that bureaucratic burdens have increased markedly in recent years
Science parks	Property-based developments adjacent to universities	Seek to promote clusters of new technology-based firms	UK, France, Italy, Sweden	Conflicting findings on Impact of Science parks on performance of firms
Managed workspace	Property provision to assist new and very small firms	Often called business incubators, these provide premises for new and small firms on ‘‘easy terms’’	Worldwide	General recognition that such initiatives are of value
Stimulating innovation and R&D in small firms	Small Business Innovation Research Program (SBIR)	$1 billion per year is allocated via a competition to small firms to stimulate additional R&D activity	USA	Lerner implies SBIR enhances small firm performance, but Wallsten is unable to show it leads to additional R&D
Stimulating training in small firms	Japan Small Business Corporation (JSBC)	JSBC and local governments provide training for owners and managers of small firms. The training program began in 1963	Japan	Unknown

Problem	Programme	Description	Country	Success
Entrepreneurial skills	Small Business Development Corporations (SBDCs)	Counselling is provided by SBDC mentors to small business clients who may be starting a business or be already trading	USA	This study finds SBDC clients have higher rates of survival and growth than might be expected. Reservations over these findings are found in the text
Entrepreneurial awareness	Entrepreneurship Education	To develop an awareness of enterprise and/or an entrepreneurial spirit in society by incorporating enterprise into the school and college curriculum	Australia, Netherlands, but leading area was Atlantic Canada	Conventional assessments are particularly difficult here because of the long ''lead times''
Special groups	Law 44	Provides finance and mentoring advice to young people in Southern Italy, where enterprise creation rates were very low	Southern Italy	This is an expensive program, but most studies show the survival rates of assisted firms to be well above those of ''spontaneous'' firms

Source: Audretsch (2004:185f as modified in the original) from Storey (2003)

Table 6: Distance Matrix of Nordrhein-Westfalen and its top 31 European reference region
This synthetic index of structural distance denotes a lower value of structural closeness to Nordrhein-Westfalen whereas a higher value denotes structural diverseness.

Score	NUTS 2	European reference region	Distance index
	DEA	Nordrhein-Westfalen (DE)	
1	DE7	Hessen (DE)	0.0074
2	DE9	Niedersachsen (DE)	0.0103
3	DE1	Baden-Württemberg (DE)	0.0118
4	DE2	Bayern (DE)	0.0121
5	DEF	Schleswig-Holstein (DE)	0.0174
6	DEB	Rheinland-Pfalz (DE)	0.0180
7	BE2	Flemish Region (BE)	0.0233
8	UKG	West Midland, England (UK)	0.0234
9	UKL	Wales (UK)	0.0238
10	UKF	East Midland, England (UK)	0.0241
11	DE3	Berlin (DE)	0.0263

Score	NUTS 2	European reference region	Distance index
11	UKJ	South East, England (UK)	0.0263
12	ES21	País Vasco (ES)	0.0265
13	DE4	Brandenburg (DE)	0.0269
14	UKD	North West, England (UK)	0.0270
15	UKE	Yorkshire and The Humber (UK)	0.0276
16	BE3	Walloon Region (BE)	0.0295
17	UKH	East of England (UK)	0.0298
18	ITC4	Lombardia (IT)	0.0304
19	UKC	North East, England (UK)	0.0319
20	UKM	Scotland (UK)	0.0331
21	ES51	Cataluña (ES)	0.0334
22	DEE	Sachsen-Anhalt (DE)	0.0363
23	UKK	South West, England (UK)	0.0377
24	ES30	Comunidad de Madrid (ES)	0.0378
25	ITC	Piemonte (IT)	0.0387
26	DEC	Saarland (DE)	0.0397
27	PL12	Mazowieckie (PL)	0.0401
28	DEG	Thüringen (DE)	0.0412
29	DED	Sachsen (DE)	0.0412
30	ITH5	Emilia-Romagna (IT)	0.0413

Source: S3Platform, 2015

Table 18: Overview of some financing instruments for promoting innovation in terms of higher business R&D investment

Financing instrument	Key features of the financing instruments	Remarks
Bank loan	One one of the classic and most common tools for access to finance. It needs collateral or guarantees in exchange for financial loans.	Obligation to repay as debt
Grant, subsidy	Usually used as seed funding for innovative start-ups and SMEs at the seed and early stage	Complements market failures, financing at seed and initial stage
Business angel	Financing source at an early riskier stage and provides financing, advice and mentoring on business management.	Financing in start-up and/or early stage

Financing instrument	Key features of the financing instruments	Remarks
Venture capital	Tends increasingly to invest at later, less risky growth stage. Usually referred to as patient capital owing to the lengthy time span (10-12 years) for investing, maturing and finally exiting.	Financing at later expansion stage
Crowd funding	Collective funding tool via the Internet that makes it easier for small businesses to raise capital at the seed and early stages.	Easily potential for fraud
Tax incentive(s)	A broad range of tax incentives for R&D and entrepreneurial investments exists in most countries	Indirect, preferably non-discriminatory

Source: Self-created by the author on the basis of the findings of the 2015 EU Industrial R&D Investment Scoreboard (European Commission, 2015c)

10. Appendix III

Table 06: Absolute Ranking of the Innovation Performance of Nordrhein-Westfalen and its top 35 European reference regions over time (2007, 2009, 2011, 2013)
The table shows the innovation performance of each analysed European region and for each chosen 'innovation indicators' in absolute values as taken from the Eurostat database. All values have been rounded to the second decimal place as well as the average value. The consequent ranking is based on the average value and using of the min-max-method.

NUTS code	European reference region	R&D expenditure as percentage of GDP						Population with tertiary education						Business R&D expenditures					
		2007	2009	2011	2013	Average value	Ranking	2007	2009	2011	2013	Average value	Ranking	2007	2009	2011	2013	Average value	Ranking
DE9	Nordrhein-Westfalen - Germany	:	:	1,95	1,94	0,97	**1**	17,2	18,5	20,0	20,8	19,13	**3**	:	:	1,18	1,11	0,57	**1**
DE7	Hessen - Germany	:	:	2,94	2,83	1,44	**3**	20,9	21,7	23,5	25,7	22,95	**4**	:	:	2,29	2,18	1,12	**3**
DE9	Niedersachsen - Germany	:	:	2,73	2,84	1,39	**2**	16,1	17,6	20,1	20,5	18,58	**3**	:	:	1,87	1,92	0,95	**3**
DE1	Baden-Württemberg - Germany	:	:	4,82	4,8	2,41	**6**	22,1	24,3	24,8	26,1	24,33	**5**	:	:	3,89	3,87	1,94	**6**
DE2	Bayern - Germany	:	:	2,99	3,16	1,54	**3**	19,9	21,5	22,8	25,2	22,35	**4**	:	:	2,29	2,41	1,18	**3**
DEF	Schleswig-Holstein - Germany	:	:	1,41	1,47	0,72	**0**	18,7	15,9	20,3	20,5	18,85	**3**	:	:	0,68	0,75	0,36	**1**
DEB	Rheinland-Pfalz - Germany	:	:	2	2,13	1,03	**1**	18,0	21,1	21,5	21,9	20,63	**3**	:	:	1,41	1,54	0,74	**2**
BE2	Flemish Region - Belgium	:	2,06	2,3	2,44	1,70	**3**	26,3	28,0	28,8	30,3	28,35	**6**	:	1,35	1,56	1,75	1,17	**3**
UKG	West Midland, England - United Kingdom	1,25	1,21	1,38	1,67	1,38	**2**	21,5	21,3	22,6	25,0	22,60	**4**	0,93	0,87	1,07	1,37	1,06	**3**
UKL	Wales - United Kingdom	1,06	1,29	0,99	1,17	1,13	**2**	20,5	25,6	26,1	27,3	24,88	**5**	0,45	0,65	0,46	0,63	0,55	**1**
UKF	East Midland, England - United Kingdom	1,71	1,7	1,64	1,77	1,71	**1**	21,2	23,0	23,4	27,2	23,70	**5**	1,25	1,19	1,2	1,37	1,25	**4**

NUTS code	European reference region	R&D expenditure as percentage of GDP						Population with tertiary education						Business R&D expenditures					
		2007	2009	2011	2013	Average value	Ranking	2007	2009	2011	2013	Average value	Ranking	2007	2009	2011	2013	Average value	Ranking
DE3	Berlin - Germany	:	:	3,32	3,57	1,72	**3**	28,4	29,1	32,8	31,9	30,55	**7**	:	:	1,3	1,5	0,70	**2**
UKJ	South East, England - United Kingdom	2,43	2,5	2,73	2,42	2,52	**6**	25,7	30,4	33,3	35,4	31,20	**7**	1,74	1,74	1,91	1,64	1,76	**6**
ES21	País Vasco - Spain	1,87	2,07	2,13	2,09	2,04	**4**	37,0	36,2	38,3	41,7	38,30	**10**	1,52	1,6	1,63	1,57	1,58	**5**
DE4	Brandenburg - Germany	:	:	1,64	1,55	0,80	**1**	25,5	27,3	27,7	28,0	27,13	**6**	:	:	0,53	0,45	0,25	**0**
UKD	North West, England - United Kingdom	2,04	2,01	1,94	1,56	1,89	**4**	22,0	24,5	25,3	27,2	24,75	**5**	1,55	1,48	1,5	1,12	1,41	**4**
UKE	Yorkshire and The Humber - United Kingdom	0,88	1	1,01	1,09	1,00	**1**	19,7	23,9	24,5	25,5	23,40	**4**	0,41	0,46	0,5	0,56	0,48	**1**
BE3	Walloon Region - Belgium	:	2,13	2,41	2,78	1,83	**4**	24,7	25,2	27,1	27,8	26,20	**5**	:	1,61	1,89	2,34	1,46	**4**
UKH	East of England - United Kingdom	4,24	3,97	3,42	3,61	3,81	**10**	22,2	25,2	26,3	29,3	25,75	**5**	3,49	3,16	2,63	2,78	3,02	**10**
ITC4	Lombardia - Italy	:	:	1,25	1,27	0,63	**0**	11,8	12,7	13,1	14,2	12,95	**1**	:	:	0,86	0,88	0,44	**1**
UKC	North East, England - United Kingdom	1,16	1,24	1,01	1,1	1,13	**2**	19,3	20,1	23,5	23,7	21,65	**4**	0,7	0,72	0,53	0,61	0,64	**5**
UKM	Scotland - United Kingdom	1,47	1,58	1,56	1,59	1,55	**3**	26,7	28,3	32,7	34,7	30,60	**7**	0,46	0,56	0,55	0,61	0,55	**1**
ES51	Cataluña - Spain	1,43	1,63	1,54	1,5	1,53	**3**	24,1	25,6	28,0	27,8	26,38	**6**	0,9	0,94	0,86	0,85	0,89	**2**
DEE	Sachsen-Anhalt - Germany	:	:	1,47	1,42	0,72	**0**	20,2	23,8	25,4	24,0	23,35	**4**	:	:	0,42	0,42	0,21	**0**
UKK	South West, England - United Kingdom	1,68	1,78	1,73	1,7	1,72	**3**	23,8	27,3	29,3	30,2	27,65	**6**	1,17	1,17	1,12	1,14	1,15	**3**

NUTS code	European reference region	R&D expenditure as percentage of GDP						Population with tertiary education						Business R&D expenditures					
		2007	2009	2011	2013	Average value	Ranking	2007	2009	2011	2013	Average value	Ranking	2007	2009	2011	2013	Average value	Ranking
ES30	Comunidad de Madrid - Spain	1,84	1,95	1,89	1,75	1,86	**4**	32,7	36,5	38,1	39,5	36,70	**9**	1,09	1,07	1,04	0,99	1,05	**3**
ITC1	Piemonte - Italy	:	:	1,84	1,98	0,96	**1**	10,6	11,2	11,4	13,1	11,58	**0**	:	:	1,44	1,55	0,75	**2**
DEC	Saarland - Germany	:	:	1,48	1,42	0,73	**0**	17,5	17,0	15,8	19,0	17,33	**2**	:	:	0,53	0,55	0,27	**0**
PL12	Mazowieckie - Poland	1,1	1,21	1,39	1,56	1,32	**2**	22,3	24,6	27,0	29,3	25,80	**5**	0,32	0,33	0,36	0,66	0,42	**1**
DEG	Thüringen - Germany	:	:	2,12	2,2	1,08	**1**	22,8	26,4	26,3	28,4	25,98	**5**	:	:	0,98	1,05	0,51	**1**
DED	Sachsen - Germany	:	:	2,78	2,74	1,38	**2**	28,1	29,5	29,7	30,5	29,45	**7**	:	:	1,2	1,11	0,58	**1**
ITH5	Emilia-Romagna - Italy	:	:	1,41	1,65	0,77	**0**	12,2	13,4	14,1	14,9	13,65	**1**	:	:	0,93	1,1	0,51	**1**
Average of the top 31 European refrence regions		0,69	0,84	1,86	1,91	1,32	**3**	21,87	23,65	25,11	26,46	24,27	**5**	0,50	0,59	1,27	1,32	0,92	**3**
Explanation of flags: data not avaible = :																			

Source: European Commission 2012; 2014; Eurostat, 2015

NUTS2	European reference region	EPO patent applications						Employment in knowledge-intensive activities (manufacturing and services)					
		2007	2009	2011	2013	Average value	Rank	2007	2009	2011	2013	Average value	Rank
DEA	Nordrhein-Westfalen (DE)	4438,61	4655,21	3715,02	:	3202,21	**8**	:	3,7	4,0	3,6	2,83	**4**
DE7	Hessen (DE)	2025,86	1745,35	1511,88	:	1320,77	**3**	:	5,6	5,1	5,0	3,93	**6**
DE9	Niedersachsen (DE)	1398,12	1320,6	1229,81	:	987,13	**2**	:	2,6	2,6	2,5	1,93	**3**
DE1	Baden-Württemberg (DE)	6136,51	5807,54	4647,39	:	4147,86	**10**	:	5,5	5,2	5,2	3,98	**6**

NUTS2	European reference region	EPO patent applications						Employment in knowledge-intensive activities (manufacturing and services)					
		2007	2009	2011	2013	Average value	Rank	2007	2009	2011	2013	Average value	Rank
DE2	Bayern (DE)	5864,87	5381,08	4688,43	:	3983,60	**10**	:	5,2	5,2	5,1	3,88	**6**
DEF	Schleswig-Holstein (DE)	437,28	437,47	428,04	:	325,70	**1**	:	:	:(bu)	3,4	0,85	**1**
DEB	Rheinland-Pfalz (DE)	1242,33	1159,5	878,03	:	819,97	**2**	:	3,60	3,7(b)	3,60	1,80	**2**
BE2	Flemish Region (BE)	1053,4	942,72	811,59	:	701,93	**2**	:	4,3	4,4	4,5	3,30	**5**
UKG	West Midland, England (UK)	283,89	340,74	288,37	:	228,25	**0**	:	2,9	3,2	3,8	2,48	**4**
UKL	Wales (UK)	125,58	129,2	110,78	:	91,39	**0**	:	2,6	2,8	3,1	2,13	**3**
UKF	East Midland, England (UK)	375,73	370,38	399,07	:	286,30	**1**	:	2,7	3,5	3,5	2,43	**3**
DE3	Berlin (DE)	753,63	686,83	556,33	:	499,20	**1**	:	6,9	7,2	7,0	5,28	**9**
UKJ	South East, England (UK)	1294,15	1279,21	917,74	:	872,78	**2**	:	6,6	6,6	6,7	4,98	**8**
ES21	País Vasco (ES)	134,41	141,65	140,07	:	104,03	**0**	:	3,6	3,8	3,4	2,70	**4**
DE4	Brandenburg (DE)	308,37	291,09	205,9	:	201,34	**0**	:	:(u)	:(bu)	2,9	0,73	**0**
UKD	North West, England (UK)	393,16	382,81	309,34	:	271,33	**1**	:	3,5	3,7	4,1	2,83	**4**
UKE	Yorkshire and The Humber (UK)	323,53	222,53	207,41	:	188,37	**0**	:	2,4	2,6	3,0	2,00	**3**
BE3	Walloon Region (BE)	376,04	306,52	291,94	:	243,63	**0**	:	4,3	4,5	3,9	3,18	**5**
UKH	East of England (UK)	891,58	687,16	482,54	:	515,32	**1**	:	5,0	5,1	5,5	3,90	**6**
ITC4	Lombardia (IT)	1394,83	1331,48	1028,14	:	938,61	**2**	:	5,0	4,7	4,9	3,65	**6**
UKC	North East, England (UK)	129,36	180,4	145,79	:	113,89	**0**	:	3,5	3,4	3,4	2,58	**4**
UKM	Scotland (UK)	400,47	392,54	236,37	:	257,35	**1**	:	3,0	3,4	3,5	2,48	**4**

NUTS2	European reference region	EPO patent applications						Employment in knowledge-intensive activities (manufacturing and services)					
		2007	2009	2011	2013	Average value	Rank	2007	2009	2011	2013	Average value	Rank
ES51	Cataluña (ES)	519,18	482,27	410,63	:	353,02	**1**	:	4,4	4,9	4,9	3,55	**6**
DEE	Sachsen-Anhalt (DE)	129,09	110,30	80,27	:	79,92	**0**	:	:(u)	:(bu)	2,1	0,53	**0**
UKK	South West, England (UK)	510,92	539,36	464,91	:	378,80	**1**	:	3,8	4,1	4,0	2,98	**4**
ES30	Comunidad de Madrid (ES)	264,01	350,23	260,29	:	218,63	**0**	:	7,3	7,9	8,8	6,00	**10**
ITC1	Piemonte (IT)	614,97	473,3	443,89	:	383,04	**1**	:	3,4	3,8	3,7	2,73	**4**
DEC	Saarland (DE)	163,77	193,14	117,42	:	118,58	**0**	:	:(u)	:(u)	2,1	0,53	**0**
PL12	Mazowieckie (PL)	43,19	55,34	70,76	:	42,32	**0**	:	5,9	5,2	5,5	4,15	**7**
DEG	Thüringen (DE)	282,79	298,53	220,1	:	200,36	**0**	:	:(u)	:(bu)	3,3	0,83	**1**
DED	Sachsen (DE)	461,19	496,65	369,08	:	331,73	**1**	:	4,1	4,1	3,7	2,98	**4**
ITH5	Emilia-Romagna (IT)	797,85	677,7	552,37	:	506,98	**1**	:	3,0	3,1	2,7	2,20	**3**
Average of the top 31 European refrence regions		1049,02	995,90	819,37	:	716,07	**2**	:	3,58	3,57	4,14	2,82	**4**
Explanation of flags: data not avaible = : ; break in time series = b ; u = low reliablity													

Source: European Commission 2012; 2014; Eurostat, 2015; informations from previous chapters; calculations by the author

Table 07: Normalised and Standardised Innovation Performance of Nordrhein-Westfalen and its European reference regions over time (2007, 2009, 2011, 2013)
The table shows the performance of each region and for each chosen indicator to measure innovation performance where data was available. In order to perform a sound analysis and to avoid results being influenced by scores of regions over-/under-performing, the dataset has been normalised for outlier's scores with the next best values. Thus, the values of the indicators has been rescaled from a minimum value of 0 for the lowest performing region to a maximum value of 1.0 for the best performing region. All values have been rounded to the second decimal place as well as the average value.

NUTS code	European reference region	Population with tertiary education					Business R&D expenditures				
		2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value
DE9	Nordrhein-Westfalen - Germany	0,44	0,48	0,50	0,38	0,45	0,55	0,56	0,56	0,47	0,53
DE7	Hessen - Germany	0,56	0,56	0,60	0,50	0,56	0,72	0,73	0,73	0,67	0,71
DE9	Niedersachsen - Germany	0,44	0,44	0,48	0,36	0,43	0,63	0,67	0,67	0,58	0,64
DE1	Baden-Württemberg - Germany	0,54	0,57	0,60	0,53	0,56	0,87	0,89	0,89	0,86	0,88
DE2	Bayern - Germany	0,51	0,56	0,59	0,53	0,55	0,75	0,74	0,74	0,68	0,73
DEF	Schleswig-Holstein - Germany	0,43	0,47	0,47	0,33	0,43	0,40	0,40	0,41	0,31	0,38
DEB	Rheinland-Pfalz - Germany	0,46	0,49	0,51	0,42	0,47	0,58	0,61	0,61	0,52	0,58
BE2	Flemish Region - Belgium	0,71	0,72	0,77	0,68	0,72	0,62	0,61	0,62	0,51	0,59
UKG	West Midland, England - United Kingdom	0,57	0,61	0,63	0,52	0,58	0,48	0,52	0,50	0,39	0,47
UKL	Wales - United Kingdom	0,49	0,65	0,73	0,61	0,62	0,40	0,38	0,39	0,28	0,36
UKF	East Midland, England - United Kingdom	0,59	0,59	0,67	0,57	0,60	0,60	0,58	0,56	0,45	0,55
DE3	Berlin - Germany	0,72	0,72	0,75	0,64	0,71	0,69	0,61	0,61	0,51	0,60
UKJ	South East, England - United Kingdom	0,68	0,71	0,79	0,71	0,72	0,59	0,57	0,59	0,56	0,58
ES21	País Vasco - Spain	0,93	0,92	0,96	0,97	0,94	0,56	0,63	0,65	0,53	0,59
DE4	Brandenburg - Germany	0,58	0,61	0,61	0,30	0,52	0,30	0,32	0,33	0,24	0,30

NUTS code	European reference region	Population with tertiary education					Business R&D expenditures				
		2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value
UKD	North West, England - United Kingdom	0,60	0,63	0,70	0,61	0,63	0,65	0,66	0,67	0,57	0,64
UKE	Yorkshire and The Humber - United Kingdom	0,55	0,61	0,64	0,65	0,61	0,35	0,37	0,37	0,27	0,34
BE3	Walloon Region - Belgium	0,67	0,68	0,75	0,59	0,67	0,61	0,65	0,64	0,53	0,61
UKH	East of England - United Kingdom	0,57	0,59	0,68	0,62	0,61	0,85	0,90	0,87	0,81	0,86
ITC4	Lombardia - Italy	0,30	0,34	0,35	0,30	0,32	0,48	0,49	0,49	0,40	0,46
UKC	North East, England - United Kingdom	0,57	0,56	0,64	0,56	0,58	0,35	0,46	0,46	0,36	0,41
UKM	Scotland - United Kingdom	0,73	0,77	0,79	0,81	0,78	0,43	0,38	0,39	0,28	0,37
ES51	Cataluña - Spain	0,64	0,64	0,66	0,62	0,64	0,50	0,52	0,53	0,41	0,49
DEE	Sachsen-Anhalt - Germany	0,46	0,49	0,51	0,24	0,43	0,33	0,33	0,34	0,26	0,32
UKK	South West, England - United Kingdom	0,65	0,65	0,73	0,70	0,68	0,59	0,57	0,59	0,49	0,56
ES30	Comunidad de Madrid - Spain	0,77	0,81	0,85	0,75	0,80	0,54	0,56	0,57	0,45	0,53
ITC1	Piemonte - Italy	0,27	0,31	0,31	0,28	0,29	0,61	0,61	0,61	0,50	0,58
DEC	Saarland - Germany	0,35	0,40	0,47	0,37	0,40	0,32	0,37	0,38	0,29	0,34
PL12	Mazowieckie - Poland	0,57	0,61	0,72	0,73	0,66	0,31	0,31	0,35	0,28	0,31
DEG	Thüringen - Germany	0,55	0,56	0,58	0,40	0,52	0,52	0,51	0,52	0,43	0,50
DED	Sachsen - Germany	0,64	0,65	0,65	0,48	0,61	0,55	0,60	0,60	0,47	0,55

NUTS code	European reference region	Population with tertiary education					Business R&D expenditures				
		2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value
ITH5	Emilia-Romagna - Italy	0,31	0,34	0,34	0,39	0,34	0,40	0,44	0,44	0,39	0,42
Average of the top 35 European refrence regions		0,56	0,59	0,63	0,54	0,58	0,54	0,55	0,55	0,46	0,52

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by the author

NUTS code	European reference region	EPO patent applications					Employment in knowledge-intensive activities (manufacturing and services)				
		2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value
DE9	Nordrhein-Westfalen - Germany	0,72	0,69	0,67	0,51	0,65	0,64	0,68	0,64	0,64	0,65
DE7	Hessen - Germany	0,72	0,70	0,70	0,50	0,66	0,82	0,77	0,81	0,76	0,79
DE9	Niedersachsen - Germany	0,66	0,63	0,63	0,48	0,60	0,67	0,67	0,70	0,56	0,65
DE1	Baden-Württemberg - Germany	0,90	0,88	0,85	0,72	0,84	0,93	1,00	0,96	1,00	0,97
DE2	Bayern - Germany	0,80	0,80	0,79	0,65	0,76	0,82	0,85	0,84	0,85	0,84
DEF	Schleswig-Holstein - Germany	0,62	0,61	0,61	0,45	0,57	0,50	0,59	0,59	0,50	0,54
DEB	Rheinland-Pfalz - Germany	0,78	0,75	0,75	0,59	0,72	0,58	0,69	0,77	0,69	0,68
BE2	Flemish Region - Belgium	0,61	0,59	0,59	0,40	0,55	0,58	0,55	0,54	0,56	0,56
UKG	West Midland, England - United Kingdom	0,48	0,45	0,43	0,27	0,41	0,63	0,58	0,52	0,56	0,57
UKL	Wales - United Kingdom	0,42	0,42	0,41	0,23	0,37	0,45	0,43	0,43	0,43	0,43

NUTS code	European reference region	EPO patent applications					Employment in knowledge-intensive activities (manufacturing and services)				
		2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value
UKF	East Midland, England - United Kingdom	0,49	0,51	0,50	0,34	0,46	0,55	0,51	0,44	0,52	0,51
DE3	Berlin - Germany	0,67	0,69	0,68	0,51	0,64	0,88	0,84	0,82	0,70	0,81
UKJ	South East, England - United Kingdom	0,60	0,58	0,57	0,40	0,54	0,73	0,75	0,88	0,70	0,77
ES21	País Vasco - Spain	0,41	0,42	0,41	0,24	0,37	0,64	0,71	0,73	0,65	0,68
DE4	Brandenburg - Germany	0,56	0,59	0,60	0,42	0,54	0,45	0,51	0,45	0,52	0,48
UKD	North West, England - United Kingdom	0,47	0,46	0,43	0,28	0,41	0,56	0,50	0,45	0,53	0,51
UKE	Yorkshire and The Humber - United Kingdom	0,44	0,43	0,45	0,26	0,40	0,41	0,45	0,47	0,41	0,43
BE3	Walloon Region - Belgium	0,61	0,59	0,57	0,41	0,54	0,39	0,42	0,39	0,48	0,42
UKH	East of England - United Kingdom	0,62	0,60	0,59	0,40	0,55	0,62	0,61	0,60	0,60	0,61
ITC4	Lombardia - Italy	0,54	0,53	0,54	0,36	0,49	0,82	0,82	0,84	0,78	0,81
UKC	North East, England - United Kingdom	0,47	0,47	0,43	0,31	0,42	0,54	0,49	0,48	0,45	0,49
UKM	Scotland - United Kingdom	0,45	0,46	0,46	0,28	0,41	0,42	0,43	0,48	0,44	0,44
ES51	Cataluña - Spain	0,46	0,45	0,44	0,26	0,40	0,63	0,71	0,70	0,65	0,67
DEE	Sachsen-Anhalt - Germany	0,41	0,45	0,44	0,24	0,39	0,36	0,43	0,43	0,40	0,40

NUTS code	European reference region	EPO patent applications					Employment in knowledge-intensive activities (manufacturing and services)				
		2007	2009	2011	2013	Average value	2007	2009	2011	2013	Average value
UKK	South West, England - United Kingdom	0,52	0,52	0,51	0,34	0,47	0,55	0,51	0,37	0,55	0,49
ES30	Comunidad de Madrid - Spain	0,36	0,36	0,35	0,20	0,32	0,71	0,82	0,82	0,79	0,79
ITC1	Piemonte - Italy	0,53	0,52	0,56	0,38	0,50	0,80	0,78	0,76	0,77	0,78
DEC	Saarland - Germany	0,61	0,59	0,58	0,37	0,54	0,55	0,78	0,76	0,40	0,62
PL12	Mazowieckie - Poland	0,26	0,22	0,24	0,09	0,20	0,38	0,51	0,51	0,53	0,48
DEG	Thüringen - Germany	0,62	0,60	0,58	0,46	0,56	0,48	0,59	0,63	0,60	0,58
DED	Sachsen - Germany	0,54	0,56	0,56	0,39	0,51	0,70	0,60	0,59	0,65	0,63
ITH5	Emilia-Romagna - Italy	0,58	0,57	0,59	0,40	0,53	0,71	0,68	0,68	0,66	0,68
Average of the top 35 European refrence regions		0,56	0,55	0,55	0,38	0,51	0,61	0,63	0,63	0,60	0,62

Source: European Commission 2012; 2014; Eurostat, 2015; calculations by the author