Universidade do Porto

FEUP Faculdade de Engenharia

Master's in Innovation and Technological Entrepreneurship

2016-2018

# Patent output as an evaluating factor for RIS3 strategies: a case study of North of Portugal

Submitted By:

Rafael A. Duque Estrada Santos

Supervisor:

Professor José Manuel Mendonça

Co-Supervisor:

Professor Catarina Maia

# Acknowledgment

I would like to express my deep gratitude to my research supervisor and co-supervisor, Prof. Dr. José Manuel Mendonça and Professor Catarina Maia respectively, for their constant guidance and inspiration with their passion for innovation. Without their support, valuable advice and feedbacks, this dissertation would not have been possible.

I am thankful to all the professors of MIET, specially our coordinator Prof. Dr. João José Pinto Ferreira, for defying me to always go the extra mile and ask why not instead of only why. My colleagues from INESC TEC for the warm welcome during the time of my research; valuable lessons and inputs; and for cheering up even the gray days at the office.

I am eternally grateful to my family and specially to my parents for their constant support in every step of my life, no matter the continent I am in. To my love, for daily believing in my dreams and sharing his with me. To my flat mates and friends across the globe, my deepest thank you for making it all worth it and bearable.

# Abstract

Smart Specialisation has witnessed a growing importance of its role within the European Community in the formulation of the structural funding program for the period 2014-2020. Through the EU Cohesion Policy, it was incorporated the concept of Smart Specialisation into the RIS3 (Research and Innovation Strategies for Smart Specialisation) which was later on coordinated with the Horizon 2020 programme. Through this strategy policy makers of each NUTS II region were responsible to lead a bottom-up process with participation of actors from the private sector; education and research institutes; and civil society who are involved in and understand better the dynamics of the regional economic activities. This effort should result in the suggestion of the areas in which the region presents differential strengths and competitive advantages and where investments should be focused to enhance the socioeconomical development of each region.

As being a recently new concept, there is still discussions happening on how the monitoring and evaluation mechanisms of the RIS3 should be carried out, but no formal framework has been imposed to regions yet, rather it was presented some propositions to policy makers, so they can freely build the mechanism they see most fit to the RIS3 they built for their region.

This study effectively assesses if the patent outcome of a region is a valuable indicator which can derive meaningful insights, helping to monitor and evaluate the achievements of the RIS3 policy and its choice of priority domains. Patent data can provide singular information into inventive activities, processes and their outcomes once they are one of the most used means to protect inventions developed by individuals, firms and/or institutions, besides being standardized word widely. Therefore, considering the limitations of this information, it can be said this research has successfully established a valuable framework to assess a RIS3 policy using patent data.

# Contents


Acknowledgment ... 3

Abstract ... 5

List of Figures ... 9

List of Tables ... 11

Chapter 1. Introduction ... 13

1.1. Motivation ... 15

1.2. Objective of the Research ... 15

1.3. Overview of the Methodology ... 16

1.4. Structure of this Dissertation ... 16

Chapter 2. Review of Literature ... 18

2.1. Monitoring Smart Specialisation policies ... 22

2.2. Monitoring innovation policy ... 23

2.3. Conclusion ... 24

Chapter 3. Methodology ... 25

3.1. Introduction ... 25

3.2. Research Question ... 25

3.3. Research Design ... 25

3.3.1 Databases construction and analysis ... 25

3.3.2 Case study ... 26

3.4. Conclusion ... 26

Chapter 4. NORTE 2020 and the RIS3 policy of the North region of Portugal ... 27

4.1. Introduction ... 27

4.2 Priority Domains of the RIS3 policy of the North region of Portugal ... 29

4.2.1 Life Sciences and Health (“Ciências da Vida e Saúde”) ... 29

4.2.2 Culture, Creation and Fashion (“Cultura, Criação e Moda”) ... 29

4.2.3 Resources of the Sea and Economy (“Recursos do Mar e Economia”) ... 30

4.2.4 Human Capital and Specialized Services (“Capital Humano e Serviços Especializados”) ... 30

4.2.5 Mobility Industries and Environment (“Indústrias da Mobilidade e Ambiente”) ... 30

4.2.6 Advanced Production Systems (“Sistemas Avançados de Produção”) ... 31

4.2.7 Agro-environmental Systems and Feeding (“Sistemas Agroambientais e Alimentação”) ... 31

4.2.8 Symbolic Capital, Technologies and Tourism Services (“Capital Simbólico, Tecnologias e Serviços do Turismo”) ... 32

4.3 Database construction ... 32

4.4 Database treatment ... 33

4.4.1 Labeling by Standard Applicant ... 33

4.4.2 Filtering by national companies and national Institutions.......................................... 34
4.4.3 Classifying the patents by the NUTS II region of their applicants............................. 34
4.4.4 Identifying to which priority domain of the RIS3 each patent issued by an organization from the North region of Portugal belongs..................................................... 36
Chapter 5. Discussion on the Technology Classification and Domain Priorities' Profile of the patent outcome from the RIS3 of NORTE 2020 policy.............................................................. 44
5.1 Technology Classification................................................................................. 45
5.2 Domain Priorities' Profile ................................................................................. 47
5.3 Domain Priorities' Profile excluding patent's families ..................................................... 53
5.4 Conclusion.......................................................................................................... 63
Chapter 6. Conclusion ........................................................................................................ 64
Bibliography....................................................................................................................... 66

# List of Figures

Figure 1 - Process for choosing and defining the Priority Domains of NORTE 2020................ 28
Figure 2 - Framework for Database Construction........................................................................ 36
Figure 3 - Smart Specialisation rationale for the priority domain of Resources of the Sea and Economy ............................................................................................................................... 40
Figure 4 - Smart Specialisation rationale for the priority domain of Advaced Production Systems ............................................................................................................................... 41
Figure 5 - Framework for the identification of the Priority Domain addressed by each entry of the databases.......................................................................................................................... 43
Figure 6 - Framework revisited for the identification of the Priority Domain addressed by each entry of the databases.............................................................................................................. 53

# List of Tables

Table 1 - Literature Review ........................................................................................... 22
Table 2 - Technology Classification comparison.......................................................................... 46
Table 3 - Domains Priorities' patents distribution.......................................................................... 49
Table 4 - Analysis of patents' internationalization........................................................................ 56
Table 5 - Domains Priorities' patents distribution counting one entry per family....................... 59

# Chapter 1. Introduction

In the last few years, the European Union, in its effort to sustain and enhance the economic role of the whole Community and the socioeconomic development of each Member State, has put a lot of effort in studying, formulating and encouraging policies to foster research, development and innovation. In the formulation of the structural funding programs and, most notably, in the research and innovation programme for the period 2014-2020, commonly known as Horizon 2020, these areas were identified among the crucial ones for regaining economic competitiveness after the crisis of 2008.

However, differently from previous policies and as observed by some authors (Baier et al., 2012), the global framework of Europe 2020 strategy proposed by the European Commission intended to anchor the national and regional research and innovation strategies on the approaches of Smart Specialisation introduced by Foray, David and Hall (Foray et al., 2009) and the Place-based concept introduced by Barca (Barca, 2009).

In its roots, the concept of Smart Specialisation originated from strategic studies and observations carried out by the European Union from 2006 to 2009 in an effort to better tackle the issue of effectively foster and invest in Innovation. The concept then started to be addressed and conceptualized by academic work, starting out with Foray, David and Hall (Foray et al., 2009). On a later work Foray, David and Hall (Foray et al., 2011) state that "while Smart Specialisation seems to be already a policy hit and policy makers show some frenetic engagements towards Smart Specialisation, the concept is not tight in particular as an academic concept". Nonetheless, some common characteristics can be found in definitions made by different scholars: the framework of Smart Specialisation is based on the need for country – or region – based policies to prioritize a vertical selected group of industrial sectors or technologies with existing competitivity potential in international markets as the base for an innovation-driven growth.

In this sense, the European Union, through its regional and urban policy, formally called as EU Cohesion Policy, incorporated the concept of Smart Specialisation into the so-called RIS3 (Research and Innovation Strategies for Smart Specialisation) agenda (McCann, 2015). According to the author, Smart Specialisation has emerged as a framework to be used in the development of a realistic and practical policy to prioritize the access to structural funding and resources for innovation and research development.

Therefore, in the Regulation No. 1303/2013, the European Commission decided that each country and each countries' region, formally known as NUTS II (part of the Nomenclature of Territorial Units for Statistics), should develop its own RIS3 strategy as an "ex-ante condition" for applying for financial support from the Structural Investment Funds (like the European Regional Development Fund – ERDF) when seeking for investments in research, innovation and technological development (European Commission, 2014). The North Region of Portugal developed its RIS3 strategy embedded in the 2014–2020 North Portugal Regional Operational Programme, known as "NORTE 2020".

This regulation also proposed the coordination and synergy between the European structural and investment funds and the research and innovation programme Horizon 2020 and the RIS3 was the main focus of such proposition. It recommended a close association of the authorities directly concerned with Horizon 2020 in the process of development of the policy framework for Smart Specialisation in the national or a regional research and innovation strategies (E.U. Regulation, 2013).

Nevertheless, since the concept of Smart Specialisation is very recent, it is necessary, as it is in any policy, to assess the results produced by monitoring and evaluating the outcomes of the policy. Foray et al. (2009) singled out early on the importance of the identification of appropriate indicators that allow for an outcome-oriented approach in the Smart Specialisation policy-making. Later on, in 2013, the funding provided by the ERDF was conditioned by a legal requirement to the inclusion of a monitoring mechanism in the developed RIS3 (European Commission, 2015). Nevertheless, there was not provided any formal detail or provision on how this monitoring should be carried out and which parameters should be measured and monitored.

Gianelle and Kleibrink started to address the matter of monitoring RIS3 presenting a "guided reflection on the meaning of monitoring leading to the formulation of possible ways to operationalise it; we provide a minimum standard for the elements of a sound monitoring system" (Gianelle and Kleibrink, 2015). In a later work, Kleibrink, Gianelle and Doussineau analyze through a survey how policy-makers from different European countries perceived monitoring in the context of the ongoing European innovation and cohesion policy. Among the conclusions, the authors cite: “Although the result-oriented logic of intervention of innovation strategies appears generally to be fairly well understood and applied by policy-makers, only a minority of respondents established a clear link between output and result indicators” (Kleibrink et al., 2016). The definition of output indicators (as well as its baseline and target values) related to policy measures is an important final step in the development of the monitoring system of a policy in order to compare concrete results with objectives and goals.

## 1.1. Motivation

This dissertation is an attempt to investigate if the monitoring of patents issued so far during the strategic programming cycle of 2014-2020 can derive some insights for evaluating the effectiveness of such program. While the monitoring of such policy is not a defined concept, it can help on the effort of having evidence from concrete experiences to refine the development of future adjustment for the RIS3 of the NORTE 2020 policy and hopefully be used for other NUTS II regions to assess their own performance. The choice for the level NUTS II[1] because the NUTS classification uses the level NUTS II for basic regions for the application of regional policies, including the regions eligible for support from cohesion policy (Eurostat, 2013).

Also, on the researcher’s personal level, writing this thesis is a personal opportunity to work closely with the Technology Licensing Office of INESC TEC (Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência) and get a thoroughly understanding of the work involved in such an office. It would help the researcher in the future to pursue his career goals to work with public innovation policy development which he intends to do in the long run.

## 1.2. Objective of the Research

As declared by Caragliu and Del Bo, “3S[2] has been insufficiently measured. Whilst a call for a bottom-up approach of technological discovery of regional production talents, driven by local entrepreneurs, sounds like a sensible strategy, there is a clear need

[1] A hierarchical system for dividing EU’s economic territory into smaller territorial units for “the collection, development and harmonisation of European regional statistics” (Eurostat, 2013).
[2] Smart Specialisation Strategies is how the RIS3 was originally referred to.

for sound but straightforward indicators of the 3S process in EU regions." (Caragliu and Del Bo, 2015) Therefore, the objectives of this research are as follows:

- Evaluate the alignment of the selected priority domains of the RIS3 present on the 2014–2020 Regional Operational Programme of the North of Portugal (NORTE 2020) and the region's patent output;
- Investigate if a region's patent output can be a good indicator to assess the success of its RIS3 strategies;
- Analyze if the patent output could be complemented by other sources of information;
- Contribute to the existing body of knowledge of the developing concept of Smart Specialisation;
- Assist academicians and practitioners in assessing, monitoring and evaluating RIS3 policies.

## 1.3. Overview of the Methodology

Based on the analysis of literature related with the concepts of Smart Specialisation, RIS3, innovation monitoring and innovation policy evaluation the research question was formulated as follows:

- How are patent applications aligned with the North region of Portugal's RIS3? Can an evaluation of the patent output from a region help inform a RIS3, and how will it complement other sources of information?

Based on this research question, patent searches will be conducted, and database treatments will be undertaken in order to compare the obtained results, in form of applied patents classified according to their technical content, with the chosen focus areas for the RIS3 strategy. With such comparison it will be possible to evaluate the degree of alignment between the investments in the areas selected by the policy and the patents outcome.

## 1.4. Structure of this Dissertation

- Chapter 1 introduces the chosen topic for the research and the way the research will be conducted. The chapter includes the motivation, the objectives and an overview of the methodology;

- Chapter 2 presents a review of the available scholarly writing on the topic chosen for the research which helped in revising the state of art in which the topic is currently found and related knowledge and debates;
- Chapter 3 clarifies what the research will be about as well as the reasons and the means to conduct it;
- Chapter 4 will go deeper on the analysis of the RIS3 present in the policy of the 2014–2020 Regional Operational Programme of the north region of Portugal (NORTE 2020) and the related search and treatment of the patent database, in order to build and organize the dataset of patents of companies located in the region;
- Chapter 5 will assess the results of the data analysis and compare them to the NORTE 2020 policy so as to establish if the patent outcome is reflecting the intention of the policy and can be used to assess its success rate;
- Chapter 6 finally concludes the entire study, proposing recommendations for policy makers and possible future themes of research.

# Chapter 2. Review of Literature

As stressed by Webster and Watson, a review of prior and relevant literature about the chosen topic is a crucial feature of any academic project for, if properly made, it creates a solid foundation to successfully advancing knowledge (Webster and Watson, 2002). As Bem concluded (and was later recognized in Webster and Watson, 2002), "a coherent review emerges only from a coherent conceptual structuring of the topic itself". There is to say it is not enough to build a literature review organized by author or publication, but to build it around the chosen concept, structuring it in a framework that facilitates the reader to understand what has been already achieved and what aspects the current work will focus on (Bem, 1995).

With this in mind, the author searched for articles published from 2002 to 2017 in Scopus and Google Scholar based on the keywords 'Smart Specialisation AND patent OR monitoring OR evaluation'. A sum of 159 documents were found from the search and analyzed by their title in order to first sort out the papers relevant for the chosen theme. Following, the abstracts from 42 selected works, out of the 159 papers, were analyzed to classify them depending on their relevance to the topic of research. Then, 17 of the most relevant papers were read and analyzed in depth to search for gaps in the literature. These articles have been further organized as shown below in Table 1. The main concepts covered and the references to the use of patents were the criteria of analysis in this first level.

| Authors | Year | Concepts Covered | Patents Mention |
|---|---|---|---|
| Carlo Gianelle & Alexander Kleibrink | 2015 | The study elucidates the construction process of a monitoring mechanisms for RIS3, offering recommendations and proposing methods for choosing indicators to evaluate the policy. | Number of new patents cited as an expected change and a result indicator for a specific scenario and its chosen strategic priority. |
| Elisabeth Baier, Henning Kroll & Andrea Zenker | 2013 | The article presents potential influence of the Smart Specialisation Concept on Regional Systems of Innovation - Potential Influence of Smart Specialisation Concept on Regional development processes - Case studies of Bavaria and Austria. | Some patents application comparison analysis. |
| Victor Ferreira & Manuel Mira Godinho | 2015 | The article looks for which are the factors determinant for regional innovation in European countries. As the dependent variable to measure innovation, the authors combined variables of patent and trademark activities of the regions. | The authors resort to a joint utilization of patents and trademarks in order to achieve a more realistic and comprehensive |

| | | | |
|---|---|---|---|
| | | | perspective on the potential of innovation. |
| Alexander Kleibrink, Carlo Gianelle & Mathieu Doussineau | 2016 | The paper studies the monitoring conception of European territorial and innovation policy, presenting a survey analysis of policy-makers on their perceptions of Smart Specialisation intervention logic and monitoring. | None. |
| Sandro Montresor & Francesco Quatraro | 2015 | Analysis of the role of Key Enabling Technologies (KETs) on regional Smart Specialisation Strategies (S3). Assessment of the impact of KETs-related knowledge on the construction of new regional technological advantages (RTAs) by evaluating patents application linked to KETs and other regional economic indicators. | Study of patents related to KETs for assessing their influence in S3 policies. |
| Sorin M.S. Krammer | 2017 | The author develops a framework for placing Smart Specialisation into the regional and national systems of innovation and a methodology to identify promising areas for Specialisation and critical challenges for helping policy makers. There is also a presentation of this diagnostic tool in the case of Bulgaria. | Uses the patent record in a Revealed comparative advantage analysis as one of the parameters to choose areas to focus on SS policies. |
| M. Angelidou; N. Komninos; I. Passas; A. Psaltoglou & P. Tsarchopoulos | 2017 | Conceptualization of the significance of RSI3 monitoring and evaluation and analysis of indicators used in the process - Presentation of the M3 platform and its history and specifications - Pilot case in the region Kentriki Makedonia, Greece. | None. |
| Ricard Masana & Tatiana Sirera | 2017 | The authors present the monitoring system of the RIS3CAT of Catalunya as well as its indicators, project description, instuments and impact's evaluation. They also discuss the relation between the RIS3CAT monitoring and other governance systems. | Patent applications and registrations as an Innovation and knowledge indicator. |
| Bart Nooteboom; Victor Gilsing; Wim Vanhaverbeke; Geert Duysters & Ad van den Oord | 2006 | The authors evaluate the innovation performance of alliance networks as a result of the technological distance between the partners, the position of the firm in the network (centrality) and total network density - Analysis of the effect of an alliance network on the novelty creation and its efficient absorption - Empirical test of technology-based alliance networks in the pharmaceutical, chemical and automotive industry. | The patenting activities of 116 companies in the chemicals, automotive and pharmaceutical industries is used to assess the level of cognitive proximity between alliance partners and, therefore, the novelty creation and its efficient absorption (innovative performance). |

| | | | |
|---|---|---|---|
| Barca F. & McCann P. | 2011 | The study starts off at defining outcome indicators and why a new emphasis on outcome is necessary, presenting the methodological principles to be met by outcome indicators and the way outcome indicators should be used at project level. Some previous cases from international or EU experiences are assessed to raise attention to the sources of indicators, the deliberative process for selecting indicators and the target-setting technique. | None. |
| Technopolis Group & MIOIR | 2012 | This guide aims to present specific approaches and methods applicable for each of the following types of innovation measures: science-industry co-operation; strategic research programmes; cluster policies; services to innovative companies and funding of innovative firms. It also describes well succeeded experiences across Europe. | Patents are cited as an example of result of an illustrative measure of an intervention logic for a science-industry co-operation and as one of the possible indicators for such measure. Patents applications are also mentioned as one of possible results of an intervention logic for a strategic research measure, in order to measure the direct output of research activities. |
| Paul David; Dominique Foray & Bronwyn Hall | 2009 | The authors present the concept and framework of Smart Specialisation as well as its actors and implementation steps. They also raise the urgent question of how Smart Specialisation should be measured, suggesting a pilot study based on existing statistics to prove Smart Specialisation can be measurable and produce aggregate statistics. | Patents are related with the discovery of relevant sectors chosen by the Smart Specialisation policy. Patent data and co-patenting are suggested as possible indicators to track the process of technology specialisation, innovation in the main sectors of a particular region economy and innovation network between regions. |

| | | | |
|---|---|---|---|
| Andrés Rodríguez-Pose; Marco di Cataldo & Alessandro Rainoldi | 2014 | The article investigates the role of government institutions in the development of Smart Specialisation in European regions, clarifying how the quality of local government institutions affects the effectiveness of the RIS3 investments. An econometric study was held in order to identify main institutional characteristics that may impact innovation and key factors for the technological progress in regions presenting different stages of economic and institutional development. | In the econometric model constructed to empirically test how government institutions affect RIS3 strategies, the authors choose the annual change in patents' applications (an indicator representing innovation) as the dependent variable with independent variables of the regional government quality and other control variables. |
| You-Na Lee | 2015 | The article presents an overview and evaluation of different usually applied innovation indicators such as R&D, patents, and innovation in order to investigate any possible overlap and differences across them. It also enlights the need of a wider definition of innovation and propose new indicator to complement current ones to better apprehend the full population of possible innovations. | The author uses patents issued and patents applications to emulate a proxy innovation-related indicator for assessing the level of innovation of different industries. The patent-related data are collected from the USPTO through the NBER database and the US Inventor Survey. |
| Benoît Godin | 2002 | The author analyzes the evolution of the methodologies used for Innovation Surveys in order to measure the innovation level of a region or country. While starting off measuring innovation by using patents and industrial R&D as proxies, the author examines two different approaches: measuring innovation as an output or measuring innovation as an activity. Finally, the author discusses the reasons why measuring innovation as an activity became the standardized approach globally. | Patents used as a proxy indicator for assessing the level of innovation in an approach defined as innovation as an output. |
| Artur Santoalha | 2016 | The author proposes different indicators to be implemented in order to quantitatively measure the performance of the S3 strategy of different regions (NUTS II). With this, he hopes to assess the situation experienced by several European regions when facing this policy concept, perceiving where these regions stand on its development. | The indicators created by the author are tested making use of patents' data extracted from the OECD REGPAT database. Due to the existence of different technologies rooted in each type of patents, this database allowed him to develop a framework of analysis |

| | | | |
|---|---|---|---|
| | | | based on the technological relatedness approach. |
| Susan Rose; Stephanie Shipp; Bhavya Lal; & Alexandra Stone | 2009 | Following the advice of the U.S. Department of Commerce, the authors propose two frameworks for measuring innovation: the first one focus in intangible results of innovation and the second one is centered on the necessary investments for innovation to occur. | In the first proposed framework, patents are mentioned as one of the Intellectual Capital assets that can be used in conjunction with other indicators from the same group and from the Human Capital and Organizational Capital groups to measure innovation. |

*Table 1 - Literature Review*

While performing a literature review, it is crucial to identify the gaps "by highlighting the strengths and identifying the deficiencies in the existing literature, critical analysis is a necessary step toward improving the knowledge base." (Torraco, 2005). Thus, whereas investigating the selected articles under a critical manner, it was evident that, while RIS3 and Smart Specialisation are still recent, several authors have written about these concepts to produce different positions and perspectives that can help to consolidate the common understanding around such themes. To better fit the proposed research, the papers were divided into two main groups: 'Monitoring Smart Specialisation policies' and 'Monitoring innovation policy' in order to better understand how – or even if – patents are used to evaluate the success of such policies. Finally, the literature review is concluded by pinpointing and debating the gap in the literature.

## 2.1. Monitoring Smart Specialisation policies

The urge for finding a way to measure Smart Specialisation was first mentioned in the article "Measuring Smart Specialisation: The concept and the need for indicators", with the suggestion of a pilot study to prove it can be measurable and able to produce aggregate statistics (David et al., 2009). The authors suggest patent data and co-patenting could be indicators to track the process of technology specialisation. In a later work, the role of government institutions in the development of Smart Specialisation in European regions is assessed to measure the effectiveness of the RIS3 investments (Rodríguez-Pose et al., 2014). An econometric study was built to empirically test how government institutions affect RIS3 strategies and the authors choose the annual change in patents' applications (an indicator representing innovation) as the dependent variable for the model. More directly, Carlo Gianelle and Alexander Kleibrink explain the construction process of a monitoring mechanism for RIS3 and cite the number of patents as an output indicator for some specific scenario (Gianelle and Kleibrink, 2015). In the following year, they pair up with Mathieu Doussineau to evaluate how is the monitoring conception of European territorial and innovation policy and present a survey analysis of policy-makers on their perceptions of Smart Specialisation intervention logic and monitoring, though there is no mention whatsoever if any patent data is used by them on this process (Kleibrink et al., 2016).

The work that is closer to what will be carried out in this research is the one developed by Artur Santoalha. He proposes different indicators to be implemented in order to quantitatively measure the performance of the S3 strategy of different regions (NUTS II), in an effort to assess the situation experienced by several European regions when facing this policy concept. The indicators created by the author are tested making use of patents' data extracted from the OECD REGPAT database (Santoalha, 2016). Nevertheless, this study presents a limitation, since the indicators can only be calculated for regions and years with patents, at least, in more than one technology and comparing different regions with each other instead of comparing the evolution within each region to assess the effect of their developed RIS3.

## 2.2. Monitoring innovation policy

On the other hand, there are other articles that do not specifically address the concept of Smart Specialisation but address the concept of monitoring and evaluating innovation policies and sometimes encompassing patents as a way of measuring the success and/or effectiveness of such policies. This is the case of Benoît Godin who analyzed how the methodologies used for Innovation Surveys evolved with the intent to measure the innovation level of a region or country, measuring innovation by using patents and industrial R&D as proxies (Godin, 2002). In a later work, You-Na Lee debates about different usually applied innovation indicators such as R&D, patents, and innovation in order to investigate any possible overlap and differences across them and uses patents issued and patent applications to emulate a proxy innovation-related indicator for assessing the level of innovation of different industries (Lee, 2015). In 'Network Embeddedness and the Exploration of Novel Technologies: Technological Distance, Betweenness Centrality and Density' the authors assess the innovation performance of alliance networks as a result of the technological distance between the partners, the position of the firm in the network (centrality) and total network density by using the patenting activities of 116 companies to evaluate their innovative performance (Gilsing et al., 2008).

## 2.3. Conclusion

Based on the literature review done in the previous sections, the author concluded that there are some studies that have used patents as a mean to evaluate innovation policies ((David et al., 2009); (Montresor and Francesco, 2015); (Gianelle and Kleibrink, 2015); (Santoalha, 2016)) and others that propose the use of patents to evaluate Smart Specialisation policies ((Technopolis Group & MIOIR, 2012); (Lee, 2015); (Godin, 2002)). However, none of them, due to the lack of actual results of recently implemented RIS3 policies, can actually evaluate the results of the efforts and investments of such policy within one region. Therefore, the still existing gap lies in looking for the first patent results coming from the period when the RIS3 policies came into action and, from that, try to define a framework to evaluate if they are aligned with the propositions of the policy, judging if it can be considered a successful indicator by itself or if it needs complements of other indicators.

# Chapter 3. Methodology

## 3.1. Introduction

"Methodology is the theory of organization of an activity. Such definition uniquely determinates the subject of methodology, which is organization of an activity" (Novikov and Novikov, 2015). With this in mind, the present chapter aims to explain the chosen approach to conduct the research and to look for answers for the research question. The answer will be pursued by evaluating the degree of alignment between investments of a RIS3 strategy in the areas selected and the actual patents outcome. Lastly, an exploratory case study of the policy NORTE 2020 will be conducted to identify if the patents outcome is a good indicator for the policy and/or if it should be complemented by other indicators.

## 3.2. Research Question

With the pertinent literature reviewed, the researched concluded that, even though there are some theories about how a RIS3 strategy should be monitored and evaluated, there is still not enough evidence of the importance of using patents to measure the alignment between the chosen priority domains and the actual results obtained by the application of the underlying strategy of each region. Thus, the following research question was formulated:

- How are patent applications aligned with the Norte region of Portugal RIS3? Can an evaluation of the patent output from a region help inform a RIS3, and how will it complement other sources of information?

## 3.3. Research Design

As the sole intent of this study is to find out if the patent outcome brought by a RIS3 strategy is a good indicator aligned with the stated intention of the underlying strategy, the framework to find the answer builds on the construction, treatment and analysis of a patent database and the election of a particular RIS3 strategy to be analyzed.

### 3.3.1 Databases construction and analysis

With the goal established by the research question, a search of patents issued by organizations and/or individuals in the NUTS II region of the North of Portugal was undertaken. Beforehand, it was necessary to organize the extracted data of all the patents submitted to the Portuguese patent authority by the type of applicant, the location of its headquarters and the time of the submission. Then, it was possible to build four patent databases based on the two periods of submission (before and after the initial period of the Horizon 2020 policy) of each of the two groups of applicants (companies and research institutions).

Once the data has been categorized and the four databases were made, a framework for analysis was presented encompassing: a labeling based on the different areas of technology to which each of the patents belong, according to the Technology Analysis[3] method presented by the Fraunhofer Institute; the identification of the priority domain of the RIS3 with which each of the patent entry is aligned; a counting and comparison among periods and groups; and an assessment of the most frequent technologies most present in the entries not identified to a particular priority domain.

### 3.3.2 Case study

To evaluate if the patent outcome can be a valuable indicator to assess the success of the formulation and implementation of a RIS3 strategy, it was decided to run a case study analyzing the RIS3 of a specific NUTS II region. Due to the location of the author and the opportunity to develop the research in collaboration with INES TEC, an analysis of the NUTS II region of the North of Portugal and its RIS3 strategy – embedded in the policy NORTE 2020 – will be held. For this intent, the priority domains rationales developed for the RIS3 will be presented as well as the framework used for their election. Nevertheless, the intention is to develop a methodology structure that could be adapted to different regions, so they can assess their own RIS3 strategies by the resulting patent outcome of the period.

## 3.4. Conclusion

This chapter presented the design methodology of the research, highlighting the relevance of the existing gap of knowledge, formulating this gap in the form of a research question and selecting the intended approach for the search of answers to the underlying question.

[3] Framework proposed by the study 'Concept of a Technology Classification for Country Comparisons' which aims to draw up a systematic technology classification for country comparisons based on the codes of the International Patent Classification (IPC) in order to avoid inconsistency of the various used methods.

# Chapter 4. NORTE 2020 and the RIS3 policy of the North region of Portugal

## 4.1. Introduction

NORTE 2020 (2014–2020 North Portugal Regional Operational Programme) is a financing instrument designed with the purpose of supporting the regional development of the north region of Portugal, being a part of the PORTUGAL 2020 Partnership Agreement and of the current cycle (2014-2020) of structural funds provided by the European Union (Horizon 2020). Its main goal is that "in 2020, the North Portugal Region will be able to generate a level of production of tradable goods and services that allows resuming the convergence trend towards the European level, ensuring sustainable increases in the population's income and employment levels and thus promoting economic, social and territorial cohesion" (CCDR Norte, 2014).

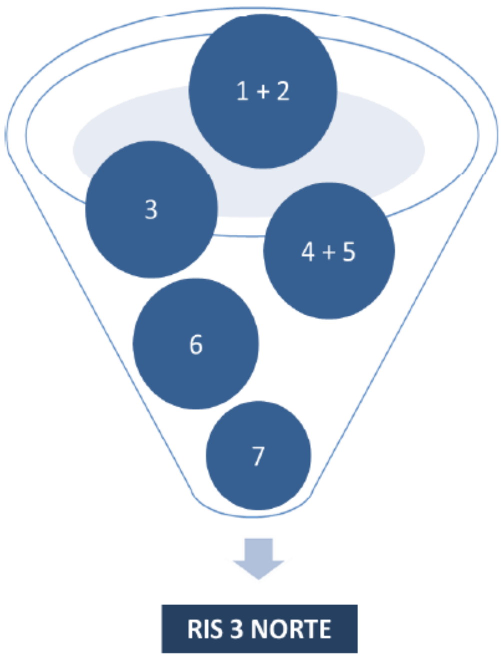
This Operational Program is based in the same broad political strategy both national and in the European Community, as outlined in the Horizon 2020 Agenda and its three priority initiatives, namely the Smart Growth (Knowledge and Innovation based), Sustainable Growth and Inclusive Growth. With the concept of Smart Growth in mind, the European Commission adopted the paradigm of Smart Specialization as a rationale to direct its public policy intervention and investments in Research and Innovation grounds.

This was the encompassing scenario in which the North of Portugal Regional Coordination and Development Commission (CCDR-N) coordinated the process of the construction and management of the NORTE 2020 and, particularly, the development of the embedded RIS3 strategy. By promoting a dynamic process of building competitive advantages based on existing territorial strategical resources, technological or not, this strategy should allow each region of the European Union to build a new competitive positioning within the community and to develop a globally competitive business base.

Hence, the conception of the RIS3 is inexorably built on the contextual reality of each NUTS II region, striving to identify its singular characteristics and their relevance so the public policy instruments can have a concrete focus for their application. This is in line with the paradigm of Smart Specialization raised by Foray et al. (2009), which argue that innovation policies can only have visible impacts on the competitiveness of a region, and therefore contribute to its economic development and employment, if they are aligned with the distinctive assets and resources of the region.

Each region is responsible for defining its own RIS3 policy to focus their available funds on a limited number of priorities (known as priority domains), in which significant, globally competitive assets and resources can be found. By evaluating the current and potential competitive advantages of the region that have the capability of fulfilling an existing international demand, it is possible to discover resources and assets with characteristics of inimitability and non-transference ability and choose these areas as the priority domains.

These domains are usually multi-sectoral priorities which share a technological and/or a market affinity that allow inter and intra-sectoral spillovers, contributing to a mutual reinforcement of competitive advantages. In practice, it is necessary to perform an evaluation of the technological resources of the regional scientific structure, the business base and the existence and potential of articulation with advanced users. With this triangulation, it is possible to identify nodal points presenting considerable potential articulation that would constitute the foundation for possible priority domains.




1. **Quantitative analysis of the regional resources and assets (analytic and synthetic knowledge bases) and of the regional entrepreneurial base;**
2. **Identification of the non-technological resources and assets (symbolical knowledge base);**
3. **Technology relatedness and market relatedness evaluation – 8 domains;**
4. **Fine analysis by domains;**
5. **Prospective analysis (demand and trends);**
6. **Thematic workshops;**
7. **Surveys: fine tuning and follow-up.**

*Figure 1 - Process for choosing and defining the Priority Domains of NORTE 2020. From "NORTE 2020 - Estratégia Regional de Especialização Inteligente" by Comissão de Coordenação e Desenvolvimento Regional do Norte (CCDR-N), 2014 (https://www.portugal2020.pt/Portal2020/Media/Default/Docs/EstrategiasEInteligente/EREI%20Norte.pdf). In the public domain. Translation by the author.*

## 4.2 Priority Domains of the RIS3 policy of the North region of Portugal

In order to formulate the RIS3 to guide the NORTE 2020 policy in the allocation of its funds and based on the idiosyncratic characteristics of the region and the endorsement of its existing and emerging international competitiveness potential, eight priority domains were identified, and their corresponding rationales proposed. Their descriptions are briefly presented below:

### 4.2.1 Life Sciences and Health (“Ciências da Vida e Saúde”)

In this domain, the raised rationale is to seek a “consolidation of the dynamics of articulation between regional research (in particular in tissue engineering, cancer, neurosciences and the development of surgical techniques) and companies in the health and general services industries (pharmaceuticals, medical devices, health services’ provision, health tourism and wellness and cosmetics)” (CCDR Norte, 2014).

This means the North region of Portugal presents a relevant critical mass in scientific production and research structures in areas such as Biology and Molecular Biochemistry, Oncology, Genetics, Biomedical Engineering and Pharmacology and Pharmacy. And this should be aligned with existing businesses and provide the grounds for the emergence of a business base specialized in the Pharmaceutical Industry, Medical Devices and Information Systems for Health.

### 4.2.2 Culture, Creation and Fashion (“Cultura, Criação e Moda”)

The rationale presented for this domain is to foster the “exploitation of the creative industries (especially in the areas of design and architecture), new materials and innovative production technologies, for the creation of new competitive advantages in sectors linked to the production of consumer goods with a strong design component (design-based consumer goods), namely textiles and clothing, footwear, accessories, furniture, jewelry, etc” (CCDR Norte, 2014).

The RIS3 considers the creative industries and their support industries such as new materials, TIC and nanotechnology, as key enabling technologies for the so-called traditional sectors of the region in order to build competitive advantages based on research results and knowledge. Among these sectors with a strong expression there are textiles, clothing, footwear and furniture whose competitive dynamics can be boosted with the incorporation of creativity.

### 4.2.3 Resources of the Sea and Economy ("Recursos do Mar e Economia")

The rationale that RIS3 presents for this domain aims to "establish an articulation between applied engineering (civil, mechanical, naval, robotics, energy, biosciences and information technologies, materials), sea resources (wind, waves, algae, beaches, etc.) and economic activities that value them (offshore energy production, construction of platforms, nautical tourism, biofuels, offshore food and aquaculture, etc.)" (CCDR Norte, 2014).

Although the region offers interesting opportunities for economic exploitation of resources provided by the sea in terms of energy sources, biomaterias, aquiculture and leisure, the initiatives are still incipient. Though the RIS3 chooses to focus on offshore engineering and construction associated with energy production, it also raises the importance of biosciences, aquiculture and food industrial activities as supplementary areas for this domain.

### 4.2.4 Human Capital and Specialized Services ("Capital Humano e Serviços Especializados")

The RIS3 defined this domain as a wildcard, due to the bet it is making in this emergent area, and presents its rationale as an effort to "promote the accumulated ICT skills (in particular in the multimedia applications development and systems programming and engineering) for the development of e-government solutions, the dematerialization of processes and, in association with the conversion of human capital, harnessing trends for specialized service operations to proximity locations (engineering centers, shared services and contact centers)" (CCDR Norte, 2014).

With this is mind, the aim of this domain is to explore the alternative of positioning the North of Portugal as a location for European Shared Services centers for the remote operation of international companies, creating qualified employment opportunities to retain human capital. It also believes the reconfiguration of the Government's scope will create new opportunities for the development of shared service platforms and corresponding technological support solutions.

### 4.2.5 Mobility Industries and Environment ("Indústrias da Mobilidade e Ambiente")

One of the nuclear domains identified by the RIS3 is defined as a field with existing scientific expertise in the areas of production technologies and materials for the automotive components and mould industries that can leverage from supply contracts with aeronautical companies, such as EMBRAER and Airbus in order to upgrade and realign industries of medium technological intensity.

With this intent, the goal of this domain is to take advantage of the opportunity to supply industries with technologically demanding specifications, such as the aeronautics industry, to further develop the accumulated human capital and manufacturing experience associated with the manufacturers of moulds and components for the automotive sector that already exist in the area as already established industry.

### 4.2.6 Advanced Production Systems ("Sistemas Avançados de Produção")

This domain's rationale focuses on the transverse character of the Key Enabling Technologies that hold the ability of promoting innovation across multiple sectors while inducing relevant productivity gains. Sectors such as Advanced Manufacturing Systems, Nanotechnologies, Biotechnologies, New Materials and Information and Communication Technology present a potential to dynamize established industries while creating new enterprises.

The RIS3 considers that these areas have scientific and technological capabilities and infrastructures in the region which can be combined with the demand of potential user sectors already entrenched or lead to the creation of new companies based on and promoting the transfer of vertical and horizontal technology, especially in the area of Nanotechnologies, Biotechnologies and New Materials.

### 4.2.7 Agro-environmental Systems and Feeding ("Sistemas Agroambientais e Alimentação")

As the North region presents a set of traditional products of agricultural origin, this domains rationale suggests the "articulation of the regional agricultural potential in high added value products (wine, olive oil, chestnuts, etc.) with scientific and technological (oenology, engineering, biology, biotechnology, etc.) and business skills (milk and dairy industry, viticulture, etc.), for the development of associated products and aimed at more dynamic demand segments, namely functional food and local gastronomy." (CCDR Norte, 2014).

In this sense, the RIS3 seeks to combine resources, scientific assets and the productive dimension of the region with its natural and symbolic resources and assets in order to exploit the economic valorization of such combination. According to this rationale, based on the local agricultural and animal production activities and in the agri-food industry (including packaging, marketing and design), the region should pursue the strategy of promoting its products aligned with other economic activities (for example, tourism) and targeting more sophisticated market segments, in line with trends of increasing appreciation of the origin, tradition and authenticity of its products.

### 4.2.8 Symbolic Capital, Technologies and Tourism Services ("Capital Simbólico, Tecnologias e Serviços do Turismo")

This domain's goal is to take advantage of the tourist potential of the North region of Portugal and integrate it with new technologies. As described in its rationale, it seeks an "appreciation of cultural and territorial resources, taking advantage of scientific and technological capacities, namely in the areas of Management, Marketing and Information and Communication Technologies, and the relevant tourism offer of the area, promoting routes and itineraries as a way to take advantage of the main infrastructures of visitors' inflow." (CCDR Norte, 2014).

As tourism is an economic activity with high national added value and the North Region has been showing a growing inflow of visitors increasing the tourism activity, it has been contributing to leverage and develop the entire region. Therefore, it is important to integrate natural and historical resources which are specific to the region in order to develop related economic activities which tourism can contribute to increase the products value or to generate a demand due to relevant proximity with the activity. As examples, activities such as agri-food (specially related to the wineries of the region), Information and Communication Technologies (mobile applications to enhance interaction and experience of tourists) and creative industries.

## 4.3 Database construction

With the purpose of performing this research, it was necessary to build a database of all the patents submitted through the *Instituto Nacional da Propriedade Industrial* (INPI), the Portuguese official organization responsible for registering and protecting the industrial property rights in trademarks, patents and designs in the country. These patents should present a first priority date included in the period when the Horizon 2020[4] policy was already under effect. To build such a database it was used Patent Inspiration, a web-enabled software tool for research of patent-based content in which INESC TEC holds an

[4] As each region developed its own RIS3 policy as part of the "ex-ante condition" of the Structural Investments Funds, each development might have had different timings. To avoid biasing the analysis, it was decided to take the 2014-2020 time period of the Horizon 2020 programme as the time reference for the undertaken analysis.

access account. It is based on the DOCDB, the master documentation database from the European Patent Office (EPO) with bibliographic data of patents from many countries across the globe. The software offers a vast option of filters and cross analysis tools.

As an applied patent takes the maximum time of 18 months to be published and to guarantee that different times of publication would not contaminate the database, we have only considered patents with first application date from January 2014 (date of the beginning of the Horizon 2020 policy) to June 2016 since, to consider the 18-month interval to avoid biasing the database and as it was built in January 2018 for beginning the research necessary to develop the thesis, this was the maximum of available data to analyze. This database was named *'Patents Applicants PT JAN2014-JUN2016'.*

Aiming to do a comparison to evaluate the effects induced by the NORTE 2020 policy, it was also built a database of patents with a first application date prior to the period in which this policy was in effect and with the same period length as the previous database of patents with first priority date after it was in effect. In other words, it was considered the patents with a first priority date included in the two years and a half period before January 2014 (date of the beginning of the Horizon 2020 policy). Therefore, this second database contained patents with first priority date from July 2011 to December 2013. This database was named *'Patents Applicants PT JUL2011-DEV2013'.* The two databases had the following amount of entries:

1. *Patents Applicants PT JUL2011-DEC2013: 2121 entries;*
2. *Patents Applicants PT JAN2014-JUN2016: 1777 entries;*

## 4.4 Database treatment

### 4.4.1 Labeling by Standard Applicant

Once the databases were ready, it was necessary to perform some classification and analysis in order to draw some conclusions. First of all, it was necessary to identify which type of organization was registered as the applicant of the each of the patents. For this, it was required to look for the "Standard applicant" field of the database. Each patent was identified based on this field in at least one of the following categories: national companies (EMP); Technological Interface Centers (CIT); Associated Laboratories (LA); State Laboratories (LE); Hospitals (HOSP); Polytechnic institutes (POL); research institutes without previous framework (INST); Inventors (INV); and Universities (U). Whenever the person or institution was identified as not being from Portugal, the suffix

EXT was added to the category. So, for example, if it was a foreign company it was classified as EMPEXT or if it was a University located in a country other than Portugal it was classified as UEXT and so on.

### 4.4.2 Filtering by national companies and national Institutions

Once having the data classified by the "Standard applicant", the two periods databases were filtered by patents which had a national company (EMP) as the applicant or one of the applicants. From this, it was possible to achieve one database of the patents with a Portuguese enterprise as an applicant for the period before the Horizon 2020 policy was in effect (named *Patents Applicants PT JAN2014-JUN2016 – Companies*) and another one for the period when it was already working (named *Patents Applicants PT JUL2011-DEC2013 – Companies*).

Afterwards, with the aim of analyzing the dynamics of private companies and research institutions concerning their adequacy of the RIS3 present in the NORTE 2020 policy, the same filter was applied but this time for patents which had an institution (CIT; LA; LE; HOSP; POL; INST; or U) as the applicant or one of the applicants. By doing this, it resulted one database of the patents with a Portuguese institution as an applicant for the period before the Horizon 2020 policy was in effect (named *Patents Applicants PT JAN2014-JUN2016 – Institutions*) and another one for the period when it was already working (named *Patents Applicants PT JUL2011-DEC2013 – Institutions*).

Due to the entropy of the work of individual inventors who do not necessarily follow cohesion or development policies for the development and patenting process of their inventions, the patents issued only by individual inventors were not considered in the analysis.

After filtering by national Companies and National Institutions, the databases had the following number of entries:

1. *Patents Applicants PT JUL2011-DEC2013 – Institutions: 540 entries;*
2. *Patents Applicants PT JUL2011-DEC2013 – Companies: 1136 entries;*
3. *Patents Applicants PT JAN2014-JUN2016 – Institutions: 488 entries;*
4. *Patents Applicants PT JAN2014-JUN2016 – Companies: 992 entries;*

### 4.4.3 Classifying the patents by the NUTS II region of their applicants

Once the four databases were ready, it was finally time to identify the patents by the NUTS II region where their applicants were located. To do so, in the case of the databases of companies, it was decided to identify in which city the headquarter of the company was based and with this information define the NUTS II of the patent. The list of the Portuguese NUTS II and the used code is:

- PT 11 – Norte (North Region) – N;
- PT 15 – Algarve – AG;
- PT 16 – Centro (Center Region) – C;
- PT 17 – Área Metropolitana de Lisboa (Lisbon Metropolitan Area) – LI;
- PT 18 – Alentejo – AJ;
- PT 20 – Região Autónoma dos Açores (Azores Autonomous Region) – AÇ;
- PT 30 – Região Autónoma da Madeira (Madeira Autonomous Region) – M.

To find such information, it was first checked in each company's website. If it was not provided or in the case of the nonexistence of a website for a certain company, this information was then searched in companies' web databases. The same procedure was adopted to define the NUTS II region of the patents issued by research institutions. In case of a patent with more than one organization as applicants, if each organization was based in a different NUTS II region, the patent was registered as being a patent issued by an organization in each of the regions.

After all these treatments were performed, the result was four databases:

1. *Patents Applicants PT JUL2011-DEC2013 – Institutions – North region: 156 entries;*
2. *Patents Applicants PT JUL2011-DEC2013 – Companies – North region: 430 entries;*
3. *Patents Applicants PT JAN2014-JUN2016 – Institutions – North region: 203 entries;*
4. *Patents Applicants PT JAN2014-JUN2016 – Companies – North region: 358 entries;*

After performing the previous steps, it is possible to define a framework to follow for the construction of the database of patents for the analysis we intend to perform. It can be observed in the following Figure 2.


*Figure 2 - Framework for Database Construction*

### 4.4.4 Identifying to which priority domain of the RIS3 each patent issued by an organization from the North region of Portugal belongs

After building the four databases, classifying the patents by the type of organization of their applicant(s), filtering by patents with Portuguese applicants, classify them by the NUTS II location of their applicant(s)' headquarters and filtering them by patents with one of the applicants being a company or/and a research institution located in the NUTS II of the North of Portugal, it was necessary to evaluate if each of them was aligned with a priority domain of the RIS3 and to which domain each of them was aligned with.

However, this step was not obvious to do, and some assumptions had to be made to create a pattern to be applied to the four different databases. First of all, it was necessary to find a method to analyze the patents' content that was common to all or almost all the patents. As the level of detail presented in a patent vary greatly with its applicant, the most reliable information available to the majority of the entries in the database was the International Patents Classification (IPC) code.

As stated in the OECD Patent Statistics Manual, the IPC system "grew out of the Strasbourg Agreement of 1971 as an internationally acknowledged method of classifying patents for inventions, including published patent applications, utility models and utility certificates." (Zuniga et al., 2009). Ever since, the IPC system has been used in more than 100 countries, being the major or, in some cases, the only form of classifying this type of document. Although the database also contained information about the Cooperative Patent Classification (CPC) code of the patents, this system, developed in a joint effort of the European Patent Office (EPO) and the United States Patent and Trademark Office (USPTO), was effective only from 1 January 2013, not being applicable to all the entries of the built database.

According to the Guide to the International Patent Classification 2018 issued by the World Intellectual Property Organization (WIPO), the IPC system allows an invention to be assigned to a corresponding IPC class in accordance to its function or intrinsic nature or to its field of application. Thus, to define the IPC of an invention, it is necessary not only to look at the function of the invention or its field of application but to a combination of these two dimensions (WIPO, 2018).

In the same document, the WIPO elucidates the hierarchical layout in which the IPC code is structured: Section; Class; Subclass; and Group (Main Groups and Subgroups). The highest level of hierarchy belongs to the Section which depicts the general body of knowledge in which the invention's field falls and is divided in eight sections represented by the eight first letters of the alphabet which are explained as:

- A – HUMAN NECESSITIES;
- B – PERFORMING OPERATIONS; TRANSPORTING;
- C – CHEMISTRY; METALLURGY;
- D – TEXTILES; PAPER;
- E – FIXED CONSTRUCTIONS;
- F – MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING;
- G – PHYSICS;
- H – ELECTRICITY.

Following the Section, there is a two-digit number code known as Class, the second hierarchical group, which starts to define, inside each Section, classes of technologies to which the invention may be applied. Next in the hierarchy, comes the Subclass, represented by a capital letter it aims to better refine inside a Class what is the function and/or application of the invention. Lastly in this hierarchical order, comes the

Group level which can be Main Groups or Subgroups and serves to give a final detailed classification of the function and/or application of the invention.

For the purpose of this research, it was followed a technology classification based in the IPC code proposed by Ulrich Schmoch from the Fraunhofer Institute for Systems and Innovation Research (ISI) which is a revision of a previous conjoint effort of the Fraunhofer ISI, the *Observatoire des Sciences et des Technologies*, in cooperation with the French patent office.

In this effort, the author, inspired by the economic studies which use sector classifications – such as comparisons of production, employment or research & development investments – for international comparison, proposes rather a technology classification since he believes once the concepts of “sector” and “technology” represent different aspects of products, they must be analyzed separately. And in the case of patents, they “are oriented towards the legal protection of technologies and therefore the classification of patents is based on technologies or products which use specific technologies.” (Schmoch, 2008).

The author continues listing some basic requirements that should be fulfilled as much as possible for such a technology classification system to be useful. These are:

1. All codes of the IPC should be covered;
2. The size of each raised technology field should be as balanced as possible, avoiding both too large fields with technologies that are too heterogeneous and too small fields with a low number of patent applications which could be too small to draw a relevant statistical analysis;
3. The proposed classification should rely only on IPC codes since it is one of the only information surely to be present in different data sources;
4. The level of differentiation among the proposed technology classes should be appropriate for a broader and a more detailed analysis;
5. The fields should present contents which are different from each other to avoid overlap of technologies as much as possible.

Following this guidance and basing himself in the previous classification raised by Fraunhofer ISI and other partner institutions, the author proposes a new classification with 35 technology fields distributed in five main areas: ‘Electrical engineering’;

‘Instruments’; ‘Chemistry’; ‘Mechanical Engineering’; and ‘Other fields’. All the IPC codes existing at the time were then distributed in these technology fields. Though in a few cases the author refines until the Group level or leaves it in the Class level of the IPC code, he usually goes down until the Subclass level of the IPC since going any further would make it too detailed and refined for an overall analysis and not going further enough would cause an overlap of technology.

Thus, the next step for the treatment of the data was to identify the IPC codes delegated to each of the patent entries of the four databases and classify them until the Subclass level. With all the entries’ IPC identified until the Subclass, it was possible to apply this Technology Classification method and evaluate how the technology pattern of the patents issued by companies and institution located in the NUTS II region of the north of Portugal have changed after the NORTE 2020 policy came into action.

Although this Technology Classification method allows for a starting point of evaluation of the technological profile of patents based on the IPC codes granted for the technology they aim to protect, it may be not enough in some cases for the intent of establishing if the patent is aligned with the RIS3 of the NORTE 2020 policy and with which of its priority domains it is aligned. The main reason for this is that the policy does not focus solely on the type of technology that should be developed for the socioeconomic development of a region, but rather on the development of technologies in strategical sectors of specialization and how they could profit from the already existing industrial structure of the region to achieve this intent.

Therefore, although sometimes the classification of the technology already embeds the sector of application of such technology, in some cases having only information about the technology is not enough to define in which industry it can be applied. This can be observed in the document in which the RIS3 is thoroughly described. When defining the domain areas for investment priorities and building the rational for each of them, it follows a triangular methodological framework where, at the apex of the triangle are the assets and resources present in the region (especially those hard to copy or imitate), the business base that would be the vector for integrating and focusing these resources and assets in order to produce innovative goods and services, and the advanced users, including companies or final consumers who will be the end users of the innovative solution. In this sense, it is possible to observe that two domains can make use of the same strategical assets and resources (the technology) present in the region. As an illustrative example, it can be noticed that the rationales of both priority domains Resources of the Sea and Economy (Figure 2 below) and Advanced Production Systems (Figure 3 below) raised Mechanical Engineering and Metallurgy and Metallurgic Engineering as areas containing assets and resources strategical to the region. Thus, looking only for the Technology Classification in some cases can be insufficient to determine if a patent is aligned to the RIS3 raised priority domains of the NORTE 2020 policy and to which one of them it can be attributed.

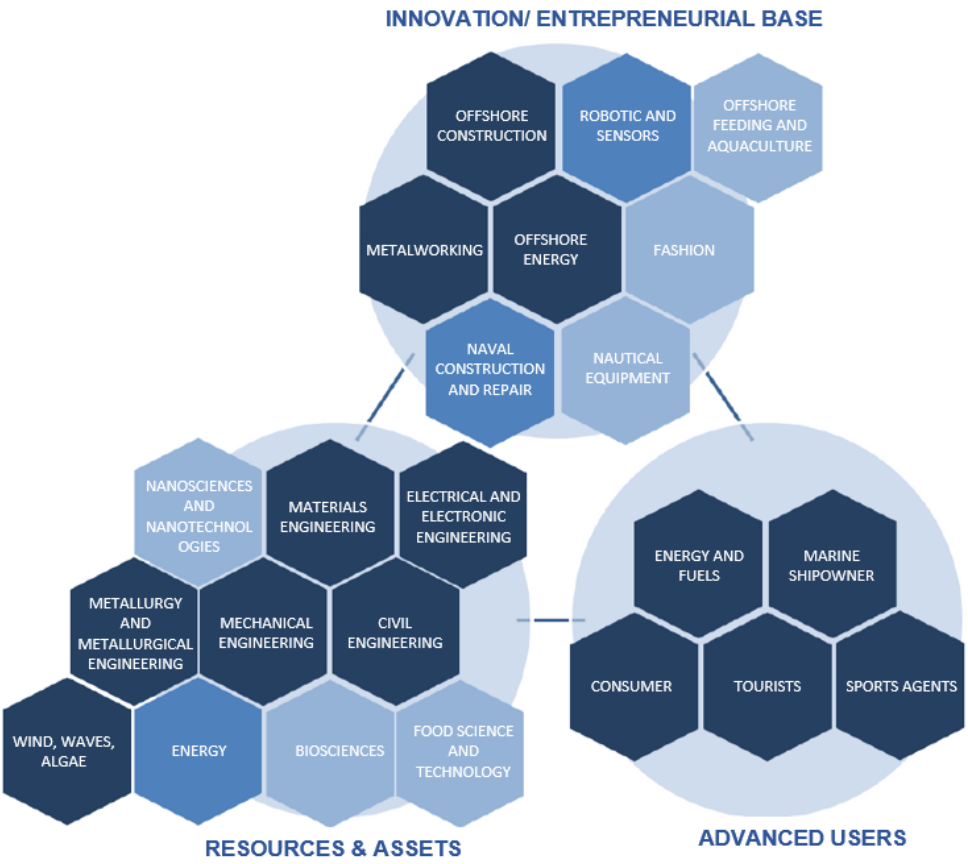



*Figure 3 - Smart Specialisation rationale for the priority domain of Resources of the Sea and Economy. From "NORTE 2020 - Estratégia Regional de Especialização Inteligente" by Comissão de Coordenação e Desenvolvimento Regional do Norte (CCDR-N), 2014 (https://www.portugal2020.pt/Portal2020/Media/Default/Docs/EstrategiasEInteligente/EREI%20Norte.pdf). In the public domain. Translated by the author.*

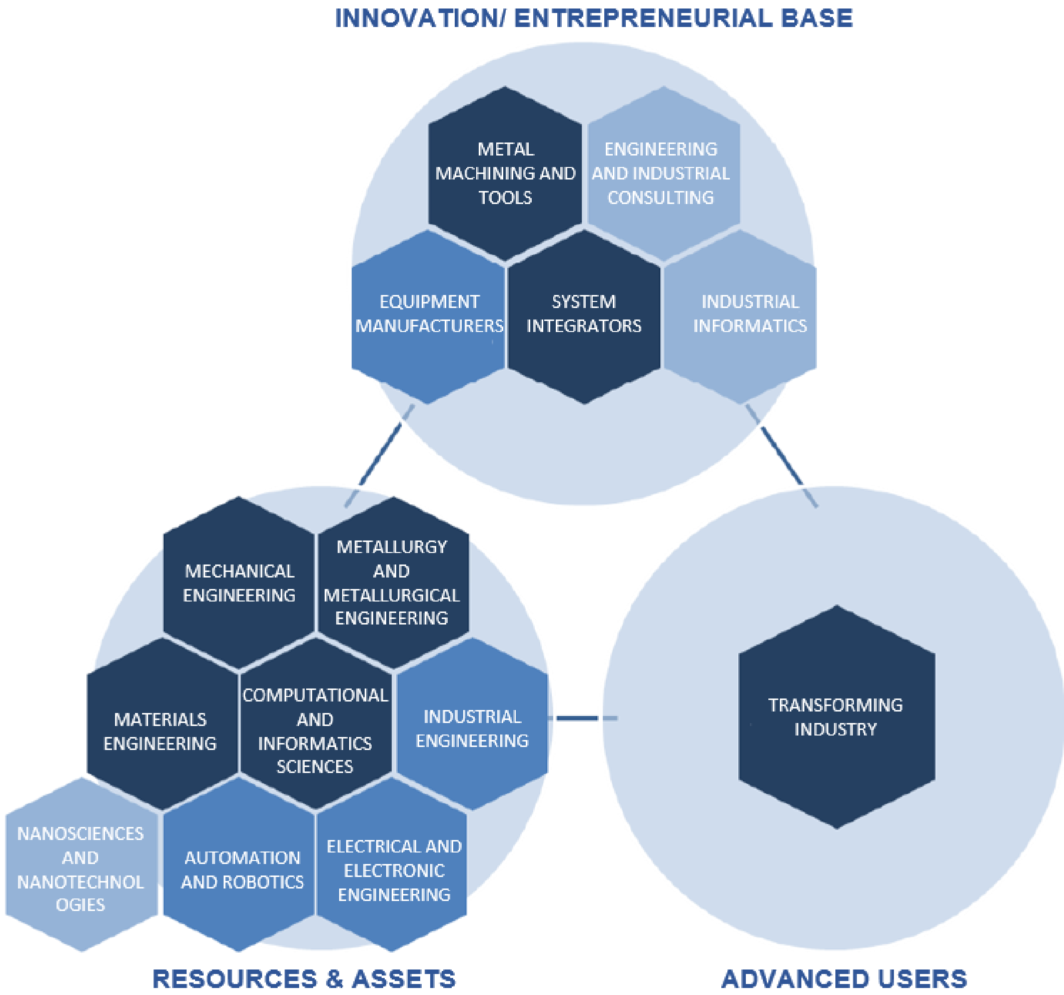



*Figure 4 - Smart Specialisation rationale for the priority domain of Advaced Production Systems. From "NORTE 2020 - Estratégia Regional de Especialização Inteligente" by Comissão de Coordenação e Desenvolvimento Regional do Norte (CCDR-N), 2014 (https://www.portugal2020.pt/Portal2020/Media/Default/Docs/EstrategiasEInteligente/EREI%20Norte.pdf). In the public domain. Translated by the author.*

Hence, it is necessary to take in consideration the other two vertexes of the triangle: the industry able to transform the resource and assets in the patented technology and the final user who will take advantage of the innovative technology, in order to fully identify to which priority domain each patent would be aligned with, if any.

With this intent in mind and starting from the previously presented Technology Classification of the patent based in the given IPC identified by the correspondent patent office, an extensive effort was made to analyze the available content of each patent entry. In particular the fields related to the technical description of the invention such as (but not limited to): title; abstract; the list of claims with the description of the innovative content; prior art; and patent references. This search aimed to find extra information that could be used to help in this identification in the cases in which the technology itself was not sufficient to identify the priority domain area.

Using this information, it was possible to identify to which industry the technology seeking patenting could be applied or the context of the problem this technology was developed to address, and it was finally feasible to categorize the patent into the priority domain classification raised by the RIS3 of the NORTE 2020 policy.

The data source for getting this information was firstly the link available in the built dataset to the Espacenet database, an open database provided by the European Patent Office (EPO) with documents of more than 100 million patents from across the globe. If there was no information or the available information was insufficient for the aimed evaluation, then a search for any available content was performed in the Patent Inspiration tool using the publication number present in the built dataset.

In the cases in which there was a complete absence of any valuable information or if the available information of the patent showed no apparent connection to any of the priority domains raised by the NORTE 2020 policy, the patent was classified as ND. For cases where it was clear to which domain the technology protected by the patent belonged, either only by using the method of Technology Classification using the IPC code of the patent or a combination of this method and the information about industry of application of such technology when present in the patent's documents, the patent was identified to be aligned to one of the priority domains in question.

Once this procedure was performed in all four databases it was possible to undertake a comparison not only of the evolution of the patent outcome intragroup due to the new RIS3 policy introduce by the NORTE 2020 development project but also comparing the patent profile of private companies with that of research institutes, to identify if the patenting activities of both groups are following the tendency of such policy and how they are doing so: in a comparable manner or each one is following a different approach.

For the evaluation of which priority domain of the RIS3 is being addressed by each entry of the built databases, the framework presented in the following Figure was proposed.

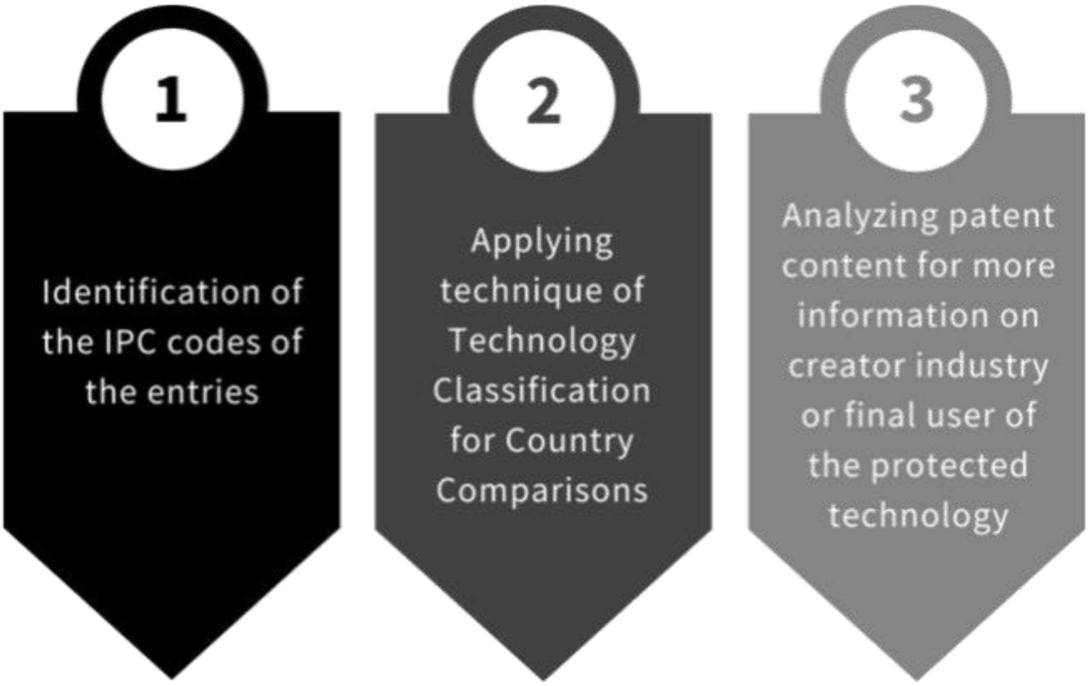



*Figure 5 - Framework for the identification of the Priority Domain addressed by each entry of the databases*

The evaluation of the results observed after the described database treatments and analysis were performed will be presented in the next chapter, as well as possible interpretations of the distribution of the applied patents' technologies throughout the priority domains of the RIS3 developed within the scope of the NORTE 2020 policy. Further on, it is also important to analyze the main areas of those patents which apparently are not aligned to any of the proposed priority domains to evaluate if these technologies' classes should have possibly been added to the RIS3. Lastly, it would be relevant to assess if the patent outcome is indeed a meaningful indicator to evaluate the success of the RIS3 policy and what other indicator should be present to enrichen this analysis.

# Chapter 5. Discussion on the Technology Classification and Domain Priorities' Profile of the patent outcome from the RIS3 of NORTE 2020 policy

This chapter aims to showcase the results of the performed analysis described in the previous chapter. It firstly intends to demonstrate, based on the Technology Classification proposed by Ulrich Schmoch from the Fraunhofer Institute for Systems and Innovation Research, the evolution of the patents comparing the technology profile of the patents applied by private companies and by research institutes before and after the beginning of the Horizon 2020 policy.

This first analysis allows a hint on if there has been a change on the technology profile of the patents submitted since the policy has been put in place and in which direction this change went. It is crucial to check if changes went towards the technology areas aligned to the priority domains identified in the RIS3, meaning the identification of these domains was successful and they are areas in which there is a differential production of knowledge capable of producing innovative technology that can be protected by patents. And also, to evaluate if there was any area which was discarded in the process of choosing the priority domains but nonetheless had emerged as producing scientific knowledge significant enough that is generating a considerable number of patents applications not predicted by the RIS3 drafters.

As previously stated, this analysis is not capable by itself to allow the evaluation of the alignment of the whole set of patent data with the priority domains of the RIS3, because there are some technologies that may fall into two different domains. Thus, one needs to go further on the analysis of the content of the patents to understand in which industry each technology can be applied and, therefore, to which priority domain it can be associated with.

This last step, combined with the previously done technology classification, allows to have all the patent data distributed among the priority domains or to none of them in case of no alignment. From this point on, with all the four databases classified, it is possible to analyze three main aspects:

- The evolution of the patents alignment with the RIS3 among companies and among research institutes by evaluating the dataset before the Horizon 2020 policy has been deployed and after. It is also possible to identify if and how the alignment profile changes when comparing companies and research institutes and draw some conclusions if the policy is having similar impacts on these groups or not;

- The identification of the domains presenting a good patent activity in each of the dataset groups and of those presenting a low activity and would probably need more attention and investment;
- Among the patents which apparently do not seem to be aligned with any of the priority domains of the RIS3, to investigate if there is any area which shows up recurrently and therefore could have been classified as one of the priority domains when formulating the policy.

After doing these analyses it is possible to draw some conclusions about using patents as an outcome indicator for RIS3 policies and what benefits and information they can offer to monitor and evaluate the results of the effort of this approach. Moreover it is possible to assess if their contribution can be enriched with other kind of indicators, in order to build a more complete framework to assess the overall performance of such a policy.

## 5.1 Technology Classification

As previously stated, a Technology Classification system for patents proposed as a joint effort of the Fraunhofer ISI, the Observatoire des Sciences et des Technologies, in cooperation with the French patent office (INPI), was used to have a first indication on if and how the technology profile of patents went through any change after the Horizon 2020 policy has been put in place. The results of such analysis are presented below:

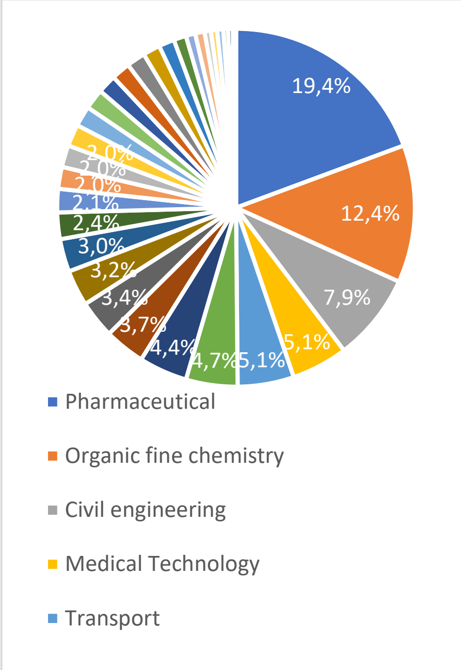
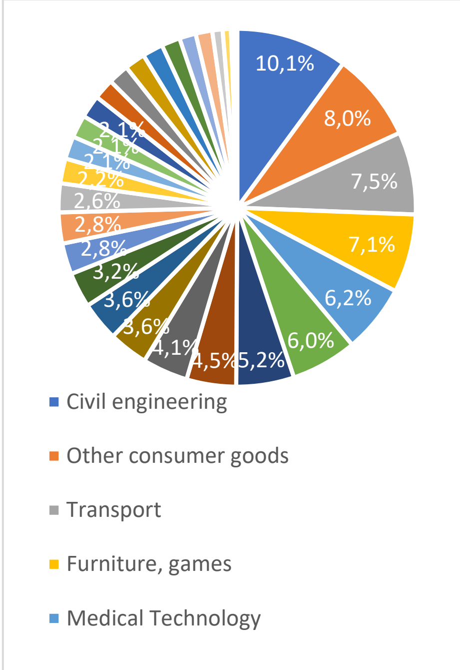
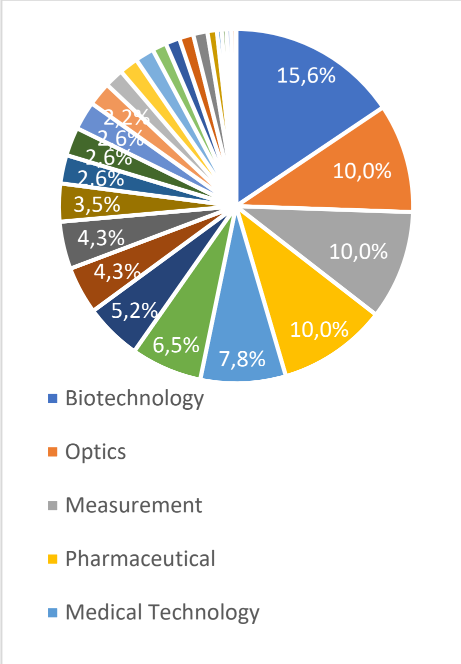
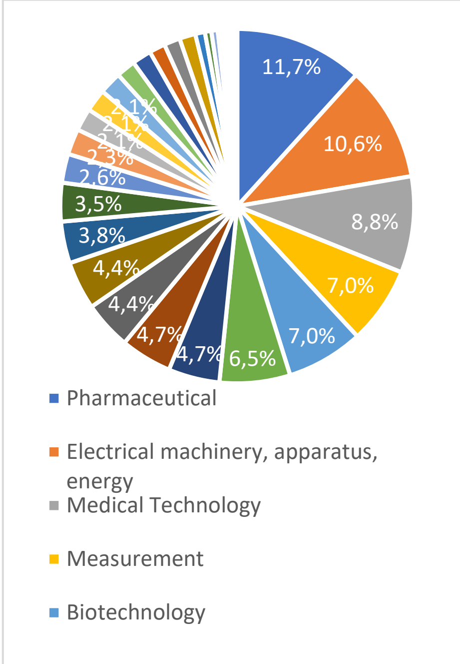
<table>
<tr><th></th><th>Before RIS3: JUL2011 - DEC2013</th><th>After RIS3: JAN2014 - JUN2016</th></tr>
<tr><td>Companies</td><td>
</td><td>
</td></tr>
<tr><td>Research Institutions</td><td>
</td><td>
</td></tr>
</table>

*Table 2 - Technology Classification comparison*

By taking a first glance at the generated charts in Table 2, it is possible to see that in the period when the RIS3 of the NORTE 2020 policy was already in place, the technology profile of the submitted patents seems more spread out in terms of percentage throughout the different technology fields proposed by such method. This movement happened in both groups: patents submitted by private companies and by research institutions and indicates there was a shift that could have been caused by the policy.

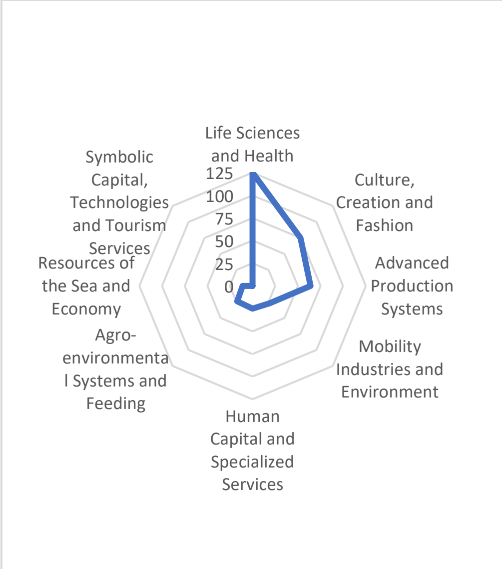
Beyond this behavior, it is interesting to analyze the main differences among each group from one period to the other. In the case of companies, it is remarkable the shift from a profile in which the fields 'Pharmaceutical' and 'Organic fine chemistry' were the top 2 fields in term of IPC code frequency to one in which they are ranked as the $7^{th}$ and the $23^{rd}$ fields respectively. This change may indicate either a great shift from the innovative technology production and, consequently, its patenting process in Pharmaceutical and Chemical companies from one the period to the other or, alternatively, be the result of a different patent strategy more focused and with smaller families of patents. This will be later investigated. It is also important to notice the presence of the field 'Civil Engineering' in the top 5 of the fields in both periods, since it is a field covered by a small number of priority domains in the document of the RIS3.

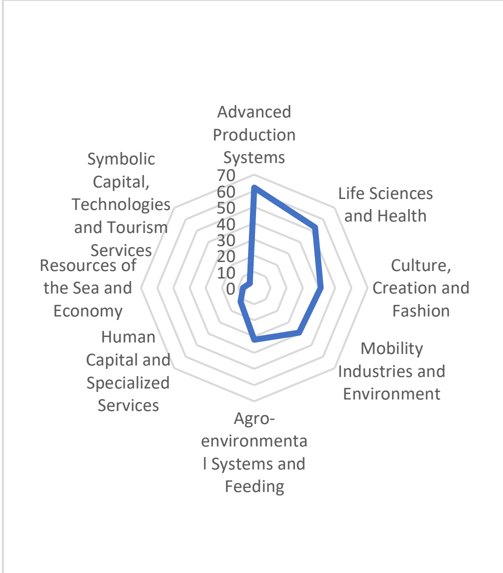
Regarding the research institutes patent data, it is possible to see that the group's patent activity is focused in medical and pharmaceutical technologies in both periods. The main change has been the drop of the 'Optics' field and the rise of the 'Electrical machinery, apparatus, energy' one. As these are fields that can be applied to different priority domains of the RIS3, it is not possible to draw any conclusion from this difference.

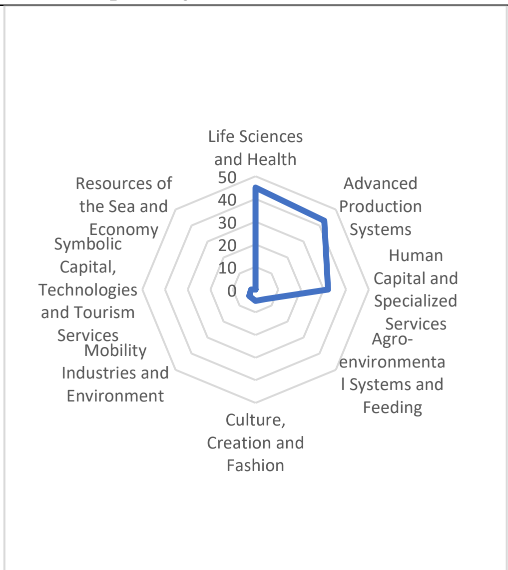
Thus, based on this initial classification and its analysis, it is necessary to further investigate the data on the classification of the patents among the RIS3's priority domains to draw some further conclusions. This will be carried out in the next section.

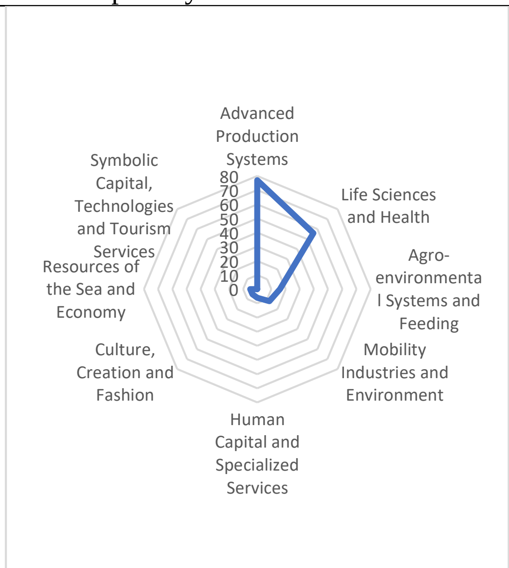
## 5.2 Domain Priorities' Profile

Starting from the previously presented Technology Classification, the contents of the patents were analyzed to combine both the information of the technology field provided by the IPC codes and the information about the industry or industries of application of such technology when provided by other contents of the patent in order to allocate the data among the 8 priority domains raised by the RIS3 of the NORTE 2020 policy. The following results were found:

<table>
<tr><th></th><th>Before RIS3: JUL2011 - DEC2013</th><th>After RIS3: JAN2014 - JUN2016</th></tr>
<tr><td>Companies</td><td>


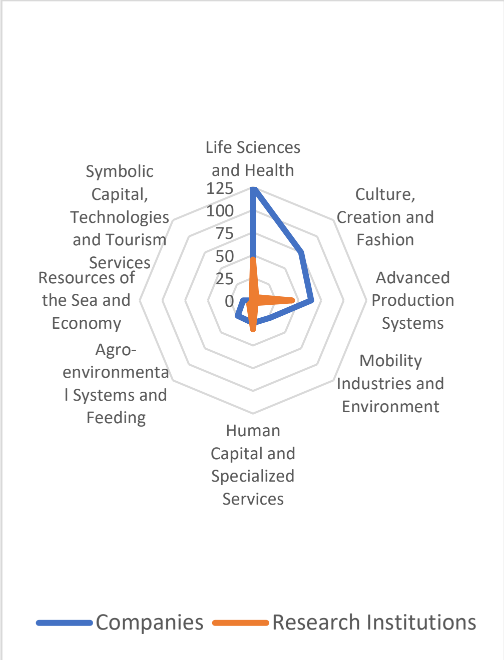
82% of the patents could address one of the priority domains of the RIS3</td><td>


72% of the patents could address one of the priority domains of the RIS3</td></tr>
<tr><td>Research Institutions</td><td>


88% of the patents could address one of the priority domains of the RIS3</td><td>


87% of the patents could address one of the priority domains of the RIS3</td></tr>
</table>

Companies vs Research Institutions



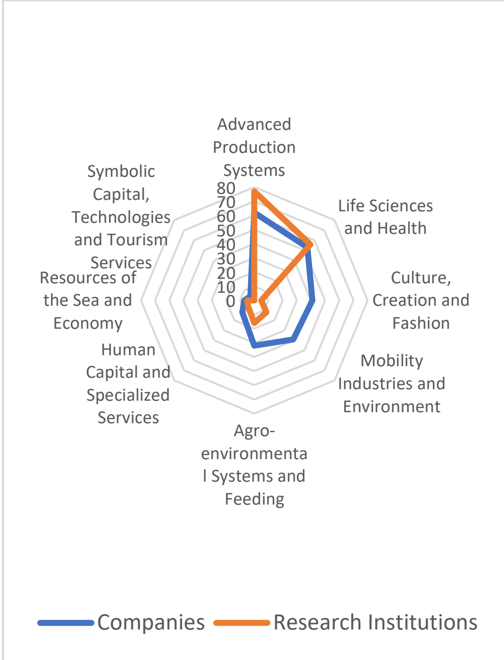




*Table 3 - Domains Priorities' patents distribution*

When analyzing the Companies’ patents data distributed through the priority domains of the RIS3 in Table 3, some observations are evident:

- the large number of patents addressed as ‘Life Sciences and Health’ in the period before the RIS3 and the subsequent drop to less than half of its value after the policy is deployed are facts aligned with the behavior of the data of the technology fields ‘Pharmaceutical’ and ‘Organic fine chemistry’ shown previously at Technology Classification section;
- The domains ‘Advanced Production Systems’; ‘Culture, Creation and Fashion’; and ‘Life Sciences and Health’ were on the top 3 of number of patents applied in both years. The first two domains were expected to be in this position since they were classified in the RIS3 as nuclear domains, but the last one was classified as an emerging domain. The document “NORTE 2020 - Estratégia Regional de Especialização Inteligente” (CCDR Norte, 2014) declared this domain’s area of Pharmaceutical Products and Fine Chemistry presented as a low patent activity which was not observed on the data of patents previous nor after the RIS3;
- There was a better distribution of the patents among the domain areas after the RIS3, which can demonstrate a shift change caused by the NORTE 2020 policy. It can be specially noticed the increase of the number of submitted patents addressing the nuclear domains ‘Agro-environmental Systems and Feeding’ and ‘Mobility Industries and Environment’;

- The patents submitted in domains ‘Symbolic Capital, Technologies and Tourism Services’; ‘Human Capital and Specialized Services’; and ‘Resources of the Sea and Economy’ did not present considerable variations. While the last two domains are classified as wild-card domains, the document describing the RIS3 considered patents to be of little relevance for the ‘Human Capital and Specialized Services’ domain but no mention was made to the other domains. As the ‘Symbolic Capital, Technologies and Tourism Services’ is a domain more focused in historical and natural assets of the North region of Portugal, a very low patent activity was expected. The surprise has been the very low patent activity of the ‘Resources of the Sea and Economy’ domain; although considering the important assets in the region, in terms of patents application still seems to be underappreciated even after the RIS3 deployment;
- Lastly, it is important to acknowledge the change in the percentage of submitted patents adressing one of the priority domains between the two periods. While it shows a drop of 10 percentage points, it is important to further investigate if this is an effect of the presence of patents from the same family or some other effect instead of considering it can be a sign of the inefficacy of the policy.

The main insights brought by the distribution of the Research Institutions’ patent data among the priority domains of the RIS3 are as follows:

- The domains ‘Advanced Production Systems’ and ‘Life Sciences and Health’ are on the top 2 in both periods, showing that the scientific work of the Research Institutions of the North region of Portugal is focused on these areas and the number of patents submitted that are aligned with these domains increased from the period before the RIS3 to after its deployment. Once more, the ‘Life Sciences and Health’ domain appearing on the top 2 by number of patents submitted, what again raises doubts on why this domain was classified as an emergent domain (with an allegedly low patent activity) and not a nuclear one;
- Though showing considerable increase after the implementation following to the RIS3, the nuclear domains ‘Agro-environmental Systems and Feeding’ and ‘Mobility Industries and Environment’ still do not show a high output in patents submitted by Research Institutions;

- The domain ‘Human Capital and Specialized Services’ shows a notable drop since the beginning of the strategy present in RIS3. Together with the increase of the domain ‘Advanced Production Systems’, this may mean that the technologies protected by the patents applied by Research Universities in ICT fields, such as Application Development, Programming and System Engineering which are related to the first domain shifted to be conceived and/or written to be addressed in a production environment which relates more strongly with the second domain;
- The priority domains of ‘Culture, Creation and Fashion’; ‘Resources of the Sea and Economy’; and ‘Symbolic Capital, Technologies and Tourism Services’ presented an inexpressive patent activity for Research Institutions in both periods;
- The overall percentage of submitted patents which could be assigned to one of the priority domains do not show any progress between the two periods, staying stable around 90%. Nevertheless, it is possible to notice that Research Institutions do not show any sign to be following all the priority domains of RIS3 when it comes down to protecting their production technologies with patents. Their focuses remain in the domains ‘Advanced Production Systems’ and ‘Life Sciences and Health’.

Lastly, when making a comparison of the distribution of the submitted patents among the eight priority domains of the RIS3 between Companies and Research Institutions it may be observed that:

- The only domains in which the Companies and Research Institutions seem to be cooperating on the creation of innovative technologies followed by their protection with patents are ‘Advanced Production Systems’ and ‘Life Sciences and Health’;
- Companies, though apparently having a smaller percentage of submitted patents addressing one of the priority domains of the RIS3 when compared to Research Institutions, seem to present a better distribution of their patents throughout the different domains. A special reference should be made to the domains ‘Culture, Creation and Fashion’; ‘Mobility Industries and Environment’; and ‘Agro-environmental Systems and Feeding’ which are referred to in the RIS3 document as domains in which Research Institutions present important competences and know-how for research and high level of publication but this fails to be translated

in the submission of patents. Moreover, the Companies are submitting more patents addressing to these priority domains than Research Institutions;

- The three domains where neither group is submitting a large number of patents are ‘Human Capital and Specialized Services’; ‘Resources of the Sea and Economy’; and ‘Symbolic Capital, Technologies and Tourism Services’. This last domain is classified as emergent, the important with rather important assets – the historical, territorial and cultural heritage of the region, but patents are not the adequate instrument to protect their value. The other two domains were classified as wild-cards. The document of the RIS3 states that patents and publications are not relevant to the domain ‘Human Capital and Specialized Services’. However, for the domain ‘Resources of the Sea and Economy’, eight scientific institutions are mentioned which undertake research in areas related to the domain and the publication level is classified as of medium importance. Nonetheless, this domain still presents a very low number of submitted patents;

After the analysis of this data, one needs to investigate the larger number of patents in the ‘Life Sciences and Health’ domain in the period before the RIS3. The aim is to find out if many different technologies are being protected by the application of patents or if it is a smaller number of technologies but with many of them being part of a family of patents as an effort for the internationalization of the patent, protecting the same technology in different territories.

Therefore, the previously proposed framework for identification of which priority domain of the RIS3 is being addressed by each entry of the built databases in Figure 5 had to be revisited by adding a last step to evaluate if the internationalization strategy is changing from one period to the other and, if so, try to eliminate the influence of such change. The updated framework is presented in the following Figure.

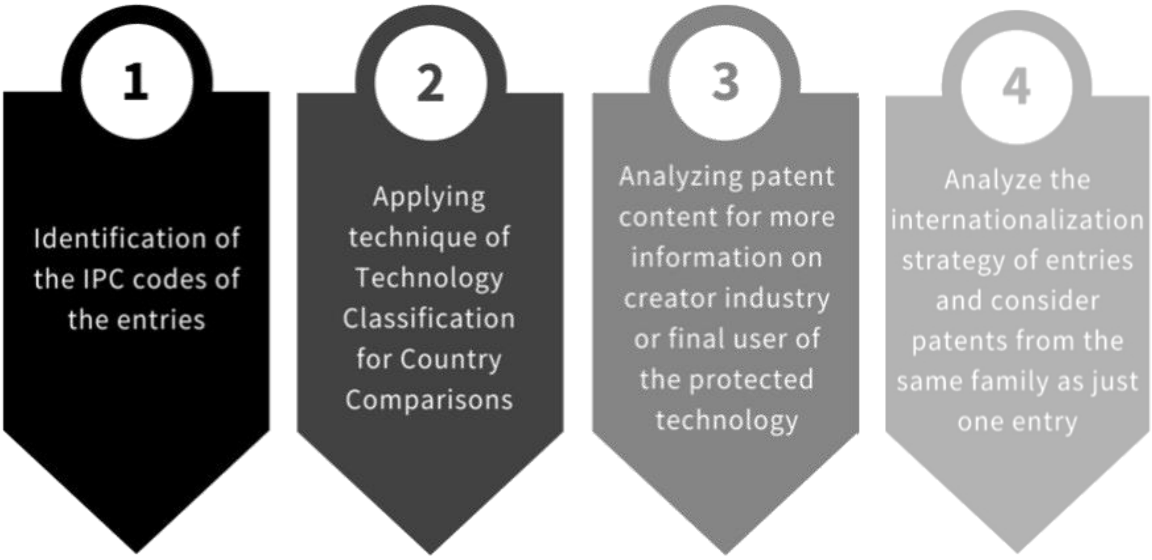



*Figure 6 - Framework revisited for the identification of the Priority Domain addressed by each entry of the databases*

## 5.3 Domain Priorities' Profile excluding patent's families

In its Patents Statistic Manual, the Organisation for Economic Co-operation and Development (OECD), defines a patent family as a "set of patents (or applications) filed in several countries which are related to each other by one or several common priority filings […]. It is also often considered that a patent family comprises all patents protecting the same invention […]" (OECD, 2009).

Considering the patent protection has a territorial scope, meaning that the protection exists only in the country or countries where the patent has been submitted, if there is an intent to protect the invention internationally, the patent application must be filed in each country where an applicant seeks protection. This can be made either through each country's patent office or through a single collective procedure in the office of only one country (usually the home country of the applicant). Thus, the first procedure made to protect the invention by a patent filing (priority filling) is followed by successive filings in other countries. This procedure originates a patent family.

The European Patent Office (EPO), in one of its Patent Information News, states that "Databases can identify groups of patents that have the same priority or priorities, and bundle these together into a 'patent family' of publications for an individual invention." (EPO, 2014). It goes on proposing this identification can be done based in three different definitions of patent family:

- Definition 1 – Documents only belong to the same patent family if they have exactly the same priority or combination of priorities;
- Definition 2 – A patent family is composed by all the documents which have at least one common priority;
- Definition 3 – Documents which are directly or indirectly linked via a priority document belong to one single patent family.

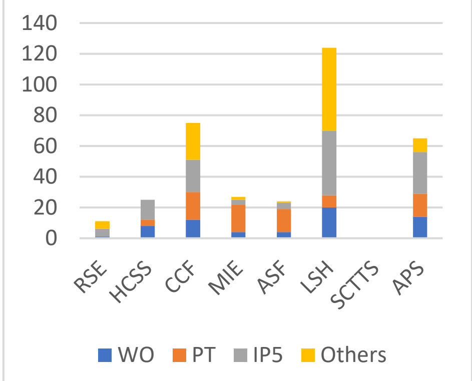
It finishes stating which are the applications in which each of the definitions behaves best. Since Definition 3 is the one to be used when retrieving “a family of related patent documents (linked by priorities) throughout the world, for example to establish the geographical coverage of a particular patent” (EPO, 2014), this was the definition chosen to support the search aiming at identifying if the internationalization strategy of the submitted patents has changed due to the RIS3 of the NORTE 2020 policy.

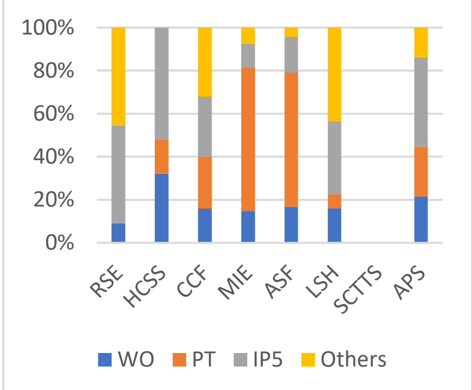
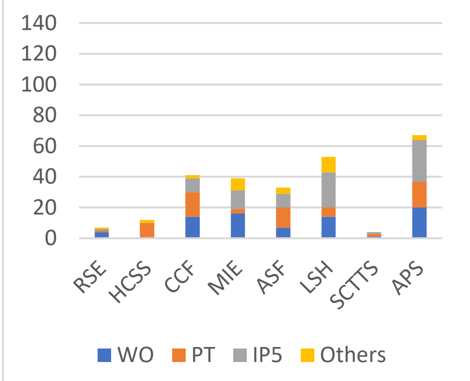
With this definition in mind, the dataset was analyzed to identify the country in which each patent entry was supposed to protect the innovative technology. This can be easily found through the initial two digits of the ‘Publication Number’ field of the patent which indicates the initials of the country’s name. This information can provide insights on the patent internationalization strategy of the submitted patents of each domain. With that purpose, main groups were created and used as the groups in the following Table 4:

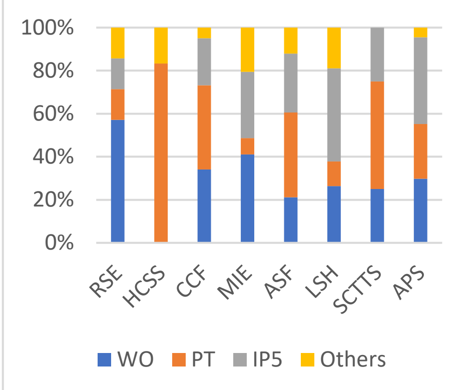
- WO – patents submitted to the World Intellectual Property Organization (WIPO);
- PT – patents submitted to the Portuguese patent office (Instituto Nacional da Propriedade Industrial – INPI);
- IP5 – patents submitted to one of the five largest intellectual property offices in the world: the US Patent and Trademark Office (USPTO); the European Patent Office (EPO); the Japan Patent Office (JPO); the Korean Intellectual Property Office (KIPO); and the State Intellectual Property Office (SIPO) of China;
- Others – patents submitted to the national patent office of a country not covered by the groups above.

Having done this, based on the ‘First Priority Number’ field and excluding duplicates showing the same priority code, it is possible to have a distribution of the technologies protected by the patents among the priority domains of the RIS3 and eliminate the effect of different internationalization strategies in the two periods under study.

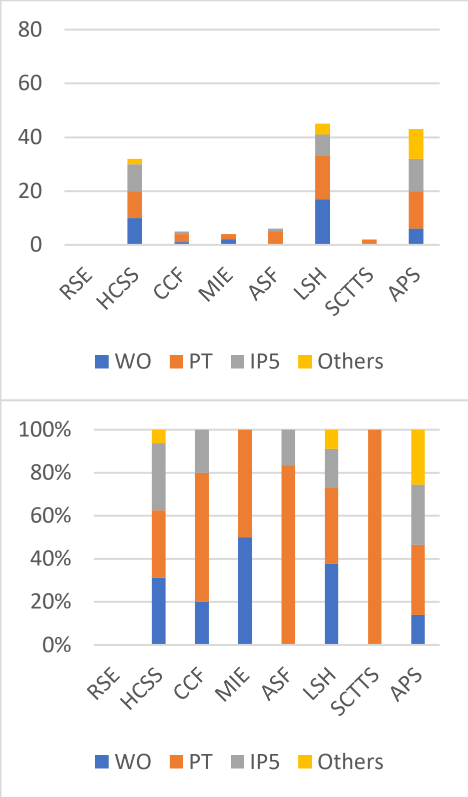
The following results can be observed:

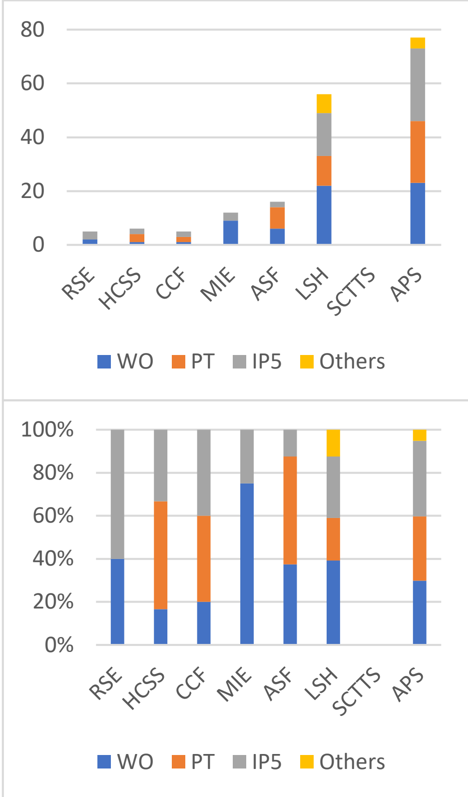
<table>
<tr><th></th><th>Before RIS3: JUL2011 - DEC2013</th><th>After RIS3: JAN2014 - JUN2016</th></tr>
<tr><td>Companies</td><td>


</td><td>


</td></tr>
</table>

Research Institutions




Priority Domains Captions: RSE – Resources of the Sea and Economy; HCSS – Human Capital and Specialized Services; CCF – Culture, Creation and Fashion; MIE – Mobility Industries and Environment; ASF – Agro-environmental Systems and Feeding; LSH – Life Sciences and Health; SCTTS – Symbolical Capital, Technologies and Tourism Services; and APS – Advanced Production Systems

*Table 4 - Analysis of patents' internationalization*

When analyzing in Table 4 the internationalization behavior of the patents Submitted by companies, it is possible to notice that:

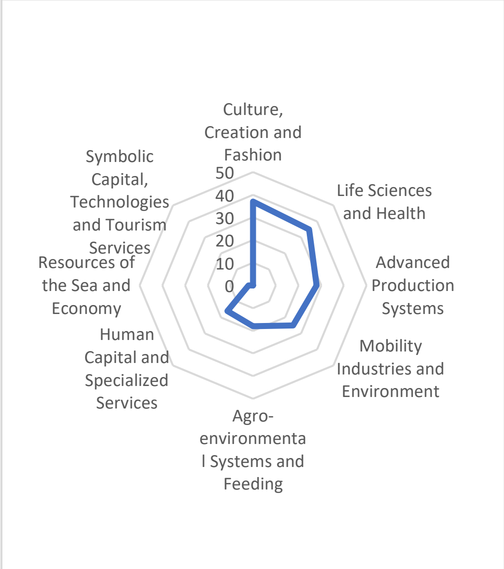
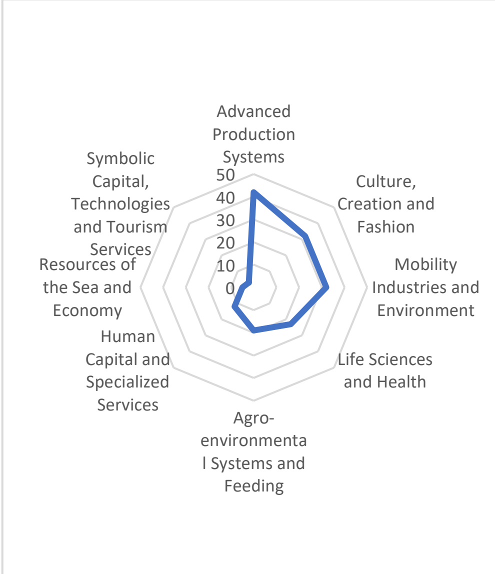
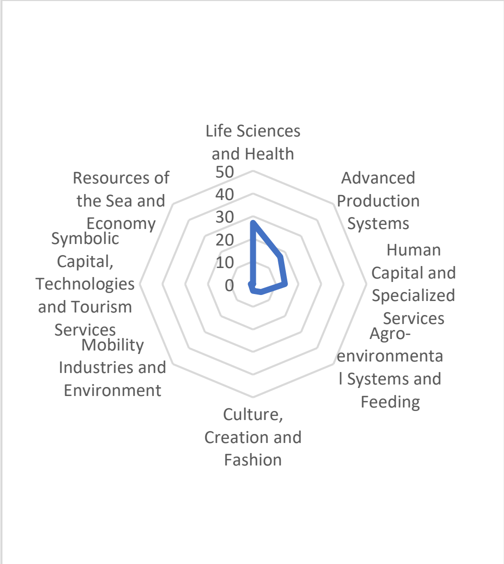
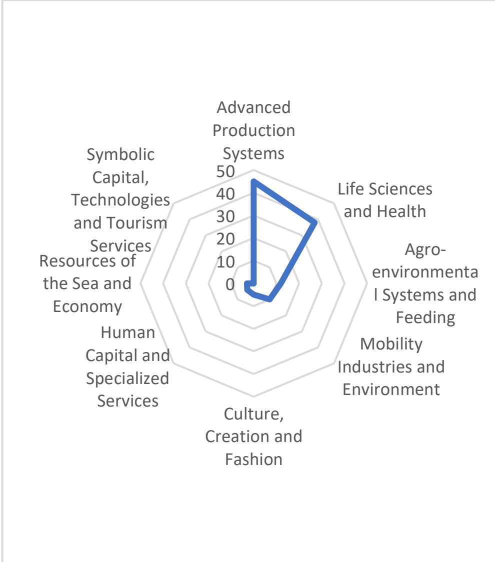
- There was a drastic change of pattern regarding the priority domains of 'Life Sciences and Health' and 'Culture, Creation and between the two compared periods, with a large drop of patent submission. This drop may be a consequence of the abandonment of the strategy of defending the invention in many countries (especially because the large drops are in the groups 'Others' and 'IP5') which can be costly and ineffective in some cases;
- While the domain 'Advanced Production Systems' did not show significant changes either in number of patents submitted or internationalization strategy, the domains 'Mobility Industries and Environment'; and 'Agro-environmental Systems and Feeding' present an increase in the number of patents submitted after the RIS3 deployment and a shift in the internationalization strategy to better protect their inventions in the IP5 and Others groups' countries.

When analyzing the internationalization pattern of the submitted patents by research institutions, it is possible to notice that:

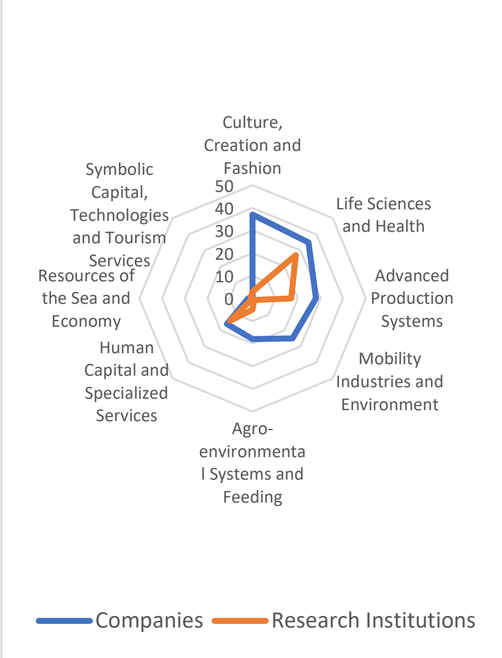
- There was an increase in the number of patents applied regarding the priority domains of 'Life Sciences and Health' and 'Advanced Production Systems'. Both domains present an increase in the internationalization of the patents submitted, the first one with an increase of patents applied in the groups 'WO' and 'Others' and the second one in the groups 'WO' and 'IP5';
- The domains 'Mobility Industries and Environment'; and 'Agro-environmental Systems and Feeding', though with more modest numbers, also presented an increase on the number of patent submitted. Both domains also seem to give evidence of an internationalization strategy with the reduction of the percentage of patents with prefix PT.

All these remarks above emerge from the after analysis of the country prefix of the 'Publication Number' field of the patent database to determine in which countries each patent entry protects the innovative technology. This may be used to identify a diverse set of internationalization strategies for each priority domain. This may be the result from family of patents protecting the same technology in different territories. And after analyzing Table 4, it may be observed that this behavior is differently distributed among the priority domains of the RIS3, making it inappropriate for comparing them.

It is therefore necessary to analyze the patent database excluding different entries with the same 'First Priority Number' and keeping only the first entry. After carrying this procedure, a new priority domain profile of the technologies is reached and shown below:

| | Before RIS3: JUL2011 - DEC2013 | After RIS3: JAN2014 - JUN2016 |
| --- | --- | --- |
| Companies | <br>76% of the patents could address one of the priority domains of the RIS3 | <br>76% of the patents could address one of the priority domains of the RIS3 |
| Research Institutions | <br>83% of the patents could address one of the priority domains of the RIS3 | <br>89% of the patents could address one of the priority domains of the RIS3 |

Companies vs Research Institutions



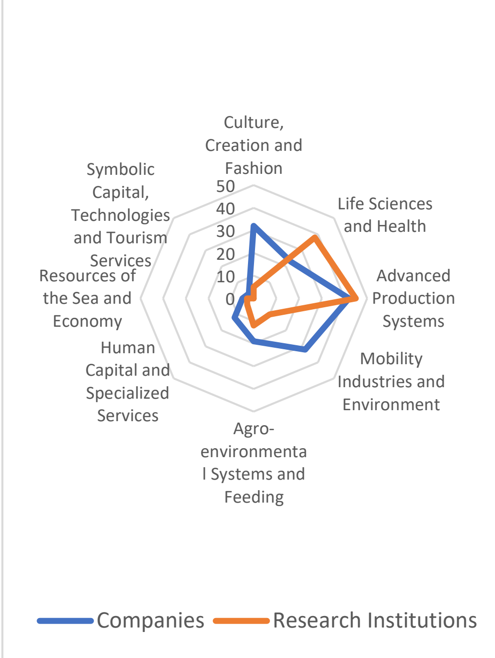




*Table 5 - Domains Priorities' patents distribution counting one entry per family*

In Table 5 it is possible to observe the data of submitted patents when the cases which have several entries with same priority code are excluded in order to count the technology they protect as just one entry. Companies present the following behavior when analyzing the distribution among the priority domains of the RIS3:

- While it seemed there were many entries in the domain 'Life Sciences and Health', with 125 entries before the RIS3, when excluding all the entries with same priority code, this number dropped to 35 entries. This gives evidence of the strong internationalization strategies of the companies submitting patents in this domain. Despite this considerable drop, this domain still remains at the top 2 in number of technologies protected by at least one patent in the period before the RIS3, raising the question on why the commission responsible to draft the strategy has considered this as a generally low level of patenting and classified this priority domain as being an emerging domain and not a nuclear one;
- The domains 'Advanced Production Systems'; 'Culture, Creation and Fashion' ; and 'Life Sciences and Health' are still on the top of number of patents applied in both periods, even when removing the effect of families of patents. However, there was a drop on the number of technologies addressing the last two domains between the compared periods;
- The better distribution of the patents among the domain areas following to the RIS3 observed before does not hold when the effect of patents' families is not

present. Nevertheless, an increase of the number of submitted patents addressing the nuclear domains ‘Agro-environmental Systems and Feeding’ and specially ‘Mobility Industries and Environment’ can be noticed;

- When performing a new analysis to remove the bias of families of patents, the behavior of the domains ‘Symbolic Capital, Technologies and Tourism Services’; ‘Human Capital and Specialized Services’; and ‘Resources of the Sea and Economy’ did not present significant variation. Taking into account the low capacity identified by the RIS3 of the two first domains to produce patents, the surprise resides on the very low patent activity of the ‘Resources of the Sea and Economy’ domain. Although encompassing important assets in the region, in terms of patents submission this domain underperforms even after the RIS3 has been deployed;
- Finally, it is important to acknowledge that the drop in the percentage of submitted patents which could address one of the priority domains between the two periods observed before is not present when reducing the family of patents to just one entry. It rather remains constant at 76%, portraying no alteration after the NORTE 2020 and its proposed RIS3 has been deployed.

For the Research Institutions, it is possible to observe the following when excluding the different entries with same priority code:

- The domains ‘Advanced Production Systems’ and ‘Life Sciences and Health’ remain at top two in the analyzed periods, confirming the focus of the research performed by Research Institutions in the North region of Portugal on these two areas. Again, the ‘Life Sciences and Health’ domain stays at the top two by number of patents submitted, raising once more the doubt on why this domain was classified as an emergent domain and not a nuclear one;
- Though the domains ‘Agro-environmental Systems and Feeding’ and ‘Mobility Industries and Environment’ are less representative, they present a relevant increase in the period, giving evidence of what can be the beginning of a greater participation of Research Institutions in the production and patenting of technologies aligned to these priority domains as a result of the RIS3;
- The priority domains of ‘Culture, Creation and Fashion’; Symbolic Capital, Technologies and Tourism Services’; and ‘Resources of the Sea and Economy’

presented an inexpressive patent activity for Research Institutions in both periods. While in the RIS3, these Institutes were not cited as part of the resources and assets of the region for the first two domains, they are mentioned when describing the 'Resources of the Sea and Economy' domain. However, these Institutes did not show a considerable patent activity related to it;

- When considering only one entry per technology, the percentage of submitted patents which could addressed one of the priority domains shows a progress between the two periods. This can be an effect of the patent co-financing programs such as Aviso 4 of the "Sistema de Apoio à Investigação Científica e Tecnológica" (Support System for Scientific and Technological Research) launched by COMPETE 2020, which require an alignment of the technology developments proposed to the national and regional RIS3. We may however conclude that the changes shown by the Research Institutions in following all the priority domains raised by the RIS3 when it comes down to protecting their technologies with patents are still slow. Their focuses nevertheless remain in the domains 'Advanced Production Systems' and 'Life Sciences and Health'.

Finally, when comparing the profile of Companies and Research Institutes after disregarding the effect of many entries due to family of patents, it is possible to behold the following:

- 'Advanced Production Systems' and 'Life Sciences and Health' remain as the only domains in which Companies and Research Institutions show a cooperation to create innovative technologies and undertake their protection with patents. Nonetheless, now it seems that the Research Institutes are stronger in developing and patenting technologies than Companies following to the RIS3 implementation;
- When comparing the number of patents aligned to each of the priority domains of the RIS3, Companies show an inferior percentage which may imply that they are having a harder time to respond to the policy. However, a better distribution of their patents throughout all the domains can be observed when comparing to Research Institutions, especially in domains such as 'Culture, Creation and Fashion'; 'Mobility Industries and Environment'; and 'Agro-environmental Systems and Feeding'. Nevertheless, Research Institutions resemble to be

producing a higher number of technologies to be patented and going slowly on the way to close the existing gap when comparing to Companies in the last two mentioned domains.

- There are still three domains where neither group is submitting a considerable number of patents: ‘Human Capital and Specialized Services’; ‘Resources of the Sea and Economy’; and ‘Symbolic Capital, Technologies and Tourism Services’. As previously mentioned, the only one of this three in which research is an important asset is the ‘Resources of the Sea and Economy’ domain. Nevertheless, neither Companies nor Research Institutes presented a relevant number of patents in this field before or after the RIS3. This may generate apprehension on which initiatives are being held to foster this domain and why it is still not showing any trend for improvement.

One last observation worth mentioning is the previous appearance of “Civil Engineering” in Table 2 as one of the Technology Classification fields with more related IPC codes used in the patents submitted by Companies both before and after the RIS3. This fact places this field as one which seems to show a distinctive characteristic and relevance in the contextual reality of the region as a unique asset capable of creating an impact on the competitiveness and therefore on economic growth and employment of the North region of Portugal.

Notwithstanding, the only two priority domains which include Civil Engineering as an asset field are: Human Capital and Specialized Services’ and ‘Resources of the Sea and Economy’. Both areas show a low number of patents which does not translate the expressive numbers shown by the Technology Classification analysis. In order to further analyze this fact, when evaluating the database entries whose available information could not address any of the priority domains of the RIS3 (the ones tagged as ND), the corresponded Technology Classification which had the largest number of entries among those patents in both periods analyzed was the ‘Civil engineering’ field. This confirmed the previous hypothesis that this field stands out as a distinctive one in terms of patent submission but seems not to have its potential fully encompassed by the RIS3.

Accordingly, when monitoring the ongoing effects of RIS3, the competent commission should consider a reevaluation of this field as one of the priority domains since its high patentable technology production can perhaps contribute more than expected for the regional development of the North of Portugal.

## 5.4 Conclusion

As it has been demonstrated in the Literature Review undertaken, it is not unusual to use patents data as a way to measure and assess the results of innovation policies. Even before the advent of the Smart Specialisation approach and the development of the RIS3, the number of patents had been already used as proxies to measure innovation or as a part of composite variables to do so.

For assessing RIS3, authors have been proposing the use of patents filed with their correspondent IPC class to build, based on the standard Balassa indicator[5], a framework to analyze the Revealed Technological Advantage of regions of the community. It is used for comparing the regions and their degree of specialisation in different IPC areas.

However, no previous study has addressed the use of the patents filed data to assess the evolution of the filing from each particular NUTS II region considering the priority domains of their RIS3. The present study proposed a framework of how this data can contribute to the assessment of the developed strategy, pointing out to possible conclusions that can be reached based on this analysis. Which answers positively to our research question regarding if evaluation of the patent output from a region can help inform a RIS3 on its performance.

[5] Also known as Revealed Comparative Advantage, this indicator was proposed by Bela Bassala as a way to evaluate if a country presents a strong position in an industry or sector by comparing the share of the exports of such sector in the total export of the country to the share of this same sector in a group of reference country’s total export.

# Chapter 6. Conclusion

The importance of innovation policies to the economic development of a region and country is out of question. The RIS3 tries to bring strongly participative dynamics to the innovation policies by combining a top-down framework, important to regions with less integration which need policy makers and other public authorities to lead the process, with a bottom-up approach where public and private stakeholders, with greater practical knowledge of the industrial fabric of the region than the policy makers, are the main actors to contribute to the formulation of the policy. All this effort is made to discover and profit from areas where the region truly presents competitive advantages, and which could generate benefits to the territory's development.

Monitoring mechanisms should help to progressively evaluate what the RIS3 has been achieving and whether its implementation is following what is expected, allowing decision makers to improve the alignment of such strategy, if necessary. It has been showed, after the analysis carried out, that patent data is an important output to be monitored. This applies to both common to public and private institutions and brings valuable information about the inventions whose rights are being protected and the organization which is applying for this protection. This information allows also the obtention of information on the localization of the organization, a very relevant factor for the territorial approach of the RIS3 and also the technology field of the invention and its application. The framework built for this study can be replicated on the analysis of different NUTS II region.

When applying the framework to the case of the NUTS II region of the north of Portugal, it was possible to analyze through the patent data if there was any shift in the patenting behavior of companies and research institutions reflecting an alignment (or a lack thereof) of the technologies produced and patented with the priority domains identified by the RIS3. This analysis is important once an organization only endeavors into a patent process if the technology produced is innovative enough to produce a competitive advantage that can be translated to value for the organization and consequently to the whole region. And therefore, patents can point to where the organizations are investing their R&D resources. It was also possible to identify priority domains which were not presenting a strong-enough scientific production in form of submitted patents. Likewise, spotting which were the technology fields presenting relevant patent production but not properly encompassed by the RIS3's priority domains was a very important finding. All these conclusions can help as valuable inputs to inform policy makers responsible for coordinating the development, monitoring and assessing of the RIS3 of Norte 2020 (or the RIS3 of any other analyzed NUTSII region) for performing a reformulation of some actions to foster the adjustment of the efforts of the policies or to the update of the RIS3 itself.

Future research should focus on evaluate other kind of variables which could enrich this patent analysis, since patents may have the limitation of being considered as an upstream indicator on the innovation activity for not necessarily reflect the utilization of the protected technology. With this in mind, the number of licensing of patented technologies related to the priority domains can inform on a more practical utilization and competitive advantage creation of the patents of a region. Other beneficial sources of information on the results of a RIS3 may be the R&D expenditure of companies considering the alignment of their core business with the priority domais, amount of funding applied into projects in each priority domain and creation of startups/ spin offs resulting from their R&D activities. Overall, further studies are required on how the RIS3 can identify priority domains where the interaction of companies and research institutes can be strengthened to foster the technology spillover in the different territories, including a revisit to the framework proposed in this study for the assessment of the Norte 2020 policy following to its conclusion.

# Bibliography

Angelidou, M., Komninos, N., Passas, I., Psaltoglou, A., & Tsarchopoulos, P. Monitoring the Impact of Smart Specialisation Strategies Across EU Regions. *31 Aug–1 Sept 2017*, 343.

Baier, E., Kroll, H., & Zenker, A. (2013). *Templates of Smart Specialisation: Experiences of place-based regional development strategies in Germany and Austria* (No. R5/2013). Working Papers Firms and Region.

Barca, F. (2009). *An Agenda for a Reformed Cohesion Policy: A place-based approach to meeting European Union challenges and expectations.* Brussels: European Commision.

Barca, F., & McCann, P. (2011). Outcome Indicators and Targets. Towards a New System of Monitoring and Evaluation in EU Cohesion Policy. *Nota metodologica presentata al Hight leve group reflecting on future of cohesion policy il*, *15*.

Balassa, B. (1977). 'Revealed'comparative advantage revisited: An analysis of relative export shares of the industrial countries, 1953–1971. *The Manchester School*, *45*(4), 327-344.

Bem, D. J. (1995). Writing a review article for Psychological Bulletin. *Psychological Bulletin*, 118(2), 172.

Caragliu, A., & Del Bo, C. F. (2015). Smart specialization strategies and smart cities: An evidence-based assessment of European Union policies. *The rise of the city. Spatial dynamics in the urban century*, 55-84.

CCDR Norte (2014). 2014–2020 North Portugal Regional Operational Programme, Porto, December 18th 2014.

CCDR Norte (2014). NORTE 2020 - Estratégia Regional de Especialização Inteligente. Retrieved May 28th, 2018, from https://www.portugal2020.pt/Portal2020/Media/Default/Docs/EstrategiasEInteligente/EREI%20Norte.pdf

David, P., Foray, D., & Hall, B. (2009). Measuring Smart Specialisation: The concept and the need for indicators. *Knowledge for Growth Expert Group*.

European Commission (2014). *Guidance on Ex ante Conditionalities for the European Structural and Investment Funds PART II*. Brussels: Directorate-General for Regional and Urban Policy.

European Commission (2015). *Guidance Document on Monitoring and Evaluation*. Brussels: Directorate-General for Regional and Urban Policy.

European Patent Office (2014). *Patent Information News – 1st Issue*. Retrieved June 8th, 2018, from http://documents.epo.org/projects/babylon/eponet.nsf/0/CE0CCA52C8BAEFCDC1257C99004C1BA2/$File/patent_information_news_0114_en.pdf

Eurostat. (2013). *NUTS - Nomenclature of Territorial Units for Statistics*. Retrieved May 22nd, 2018, from http://ec.europa.eu/eurostat/web/nuts/background.

Ferreira, V., & Godinho, M. M. (2015). 14 The determinants of innovation. *Dynamics of Knowledge Intensive Entrepreneurship: Business Strategy and Public Policy*, 38, 369.

Foray, D. (2014). Smart specialisation: opportunities and challenges for regional innovation policy (Vol. 79). Routledge.

Foray, D. (2017). The Economic Fundamentals of Smart Specialisation Strategies. In *Advances in the Theory and Practice of Smart Specialisation* (pp. 37-50).

Foray, D., David, P. A., & Hall, B. H. (2009). Smart specialisation: The concept. Ch. 3 in Knowledge for growth: Prospects for science, technology and innovation. *Report*, *EUR 24047*, European Union, 2009. Also available as K4G Policy Brief No. 9, EC (DG-Research).

Foray, D., David, P. A., & HALL, B. H. (2011). *Smart specialisation from academic idea to political instrument, the surprising career of a concept and the difficulties involved in its implementation* (No. EPFL-WORKING-170252). EPFL.

Gianelle, C., & Kleibrink, A. (2015). Monitoring mechanisms for Smart Specialisation strategies. *S3 Policy Brief Series*, (13).

Gilsing, V., Nooteboom, B., Vanhaverbeke, W., Duysters, G., & van den Oord, A. (2008). Network embeddedness and the exploration of novel technologies: Technological distance, betweenness centrality and density. *Research policy*, *37*(10), 1717-1731.

Godin, B. (2002). The rise of innovation surveys: Measuring a fuzzy concept. *Canadian Science and Innovation Indicators Consortium, Project on the History and Sociology of S&T Statistics, Paper, 16*.

Kleibrink, A., Gianelle, C., & Doussineau, M. (2016). Monitoring innovation and territorial development in Europe: emergent strategic management. *European Planning Studies*, *24*(8), 1438-1458.

Krammer, S. M. (2017). Science, technology, and innovation for economic competitiveness: The role of Smart Specialisation in less-developed countries. *Technological Forecasting and Social Change*, *123*, 95-107.

Lee, Y. N. (2015). Evaluating and extending innovation indicators for innovation policy. *Research Evaluation*, *24*(4), 471-488.

Masana, R. & Sirera, T. (2017). The RIS3CAT Monitoring System. Accessed 20th November 2017. http://catalunya2020.gencat.cat/web/.content/00_catalunya2020/Documents/angles/fitxers/MonitoratgeRIS3CATen.pdf

McCann, P. (2015). *The regional and urban policy of the European Union: Cohesion, results-orientation and Smart Specialisation*. Edward Elgar Publishing.

Montresor, S., & Francesco, Q. (2015). *Do Key Enabling Technologies shape regional Smart Specialisation Strategies? A patent based analysis of European data* (No. 201517). University of Turin.

Novikov, A. M., & Novikov, D. A. (2013). *Research methodology: From philosophy of science to research design* (Vol. 2). CRC Press.

OECD (2009), *Patent Statistics Manual*, OECD, Paris.

Regulation, E. U. (2013). No. 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083 .... *Official Journal of the European Communities*, 20.

Rodríguez-Pose, A., Di Cataldo, M., & Rainoldi, A. (2014). The role of government institutions for Smart Specialisation and regional development. *S3 Policy Brief Series*, (04).

Rose, S., Shipp, S., Lal, B., & Stone, A. (2009). Frameworks for measuring innovation: Initial approaches. *Athena Alliance, Washington*, (s 5).

Santoalha, A. (2016). *New Indicators of Smart Specialisation: A related diversification approach applied to European Regions* (No. 20161220). Centre for Technology, Innovation and Culture, University of Oslo.

Technopolis Group & MIOIR (2012). *Evaluation of Innovation Activities. Guidance on methods and practices.* Study funded by the European Commission, Directorate for Regional Policy.

Torraco, R. J. (2005). Writing Integrative Literature Reviews: Guidelines and Examples. *Human Resource Development Review*, 4(3), 356-367. DOI: 10.1177/1534484305278283

Schmoch, U. (2008). Concept of a technology classification for country comparisons. *Final report to the World Intellectual Property Organisation (WIPO), WIPO*.

Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS quarterly*, xiii-xxiii.

WIPO. (2018). *Guide to the International Patent Classification*. Retrieved May 24th, 2018, from http://www.wipo.int/export/sites/www/classifications/ipc/en/guide/guide_ipc.pdf

Zuniga, P., Guellec, D., Dernis, H., Khan, M., Okazaki, T., & Webb, C. (2009). OECD patent statistics manual. *Francia: OECD Publications*.