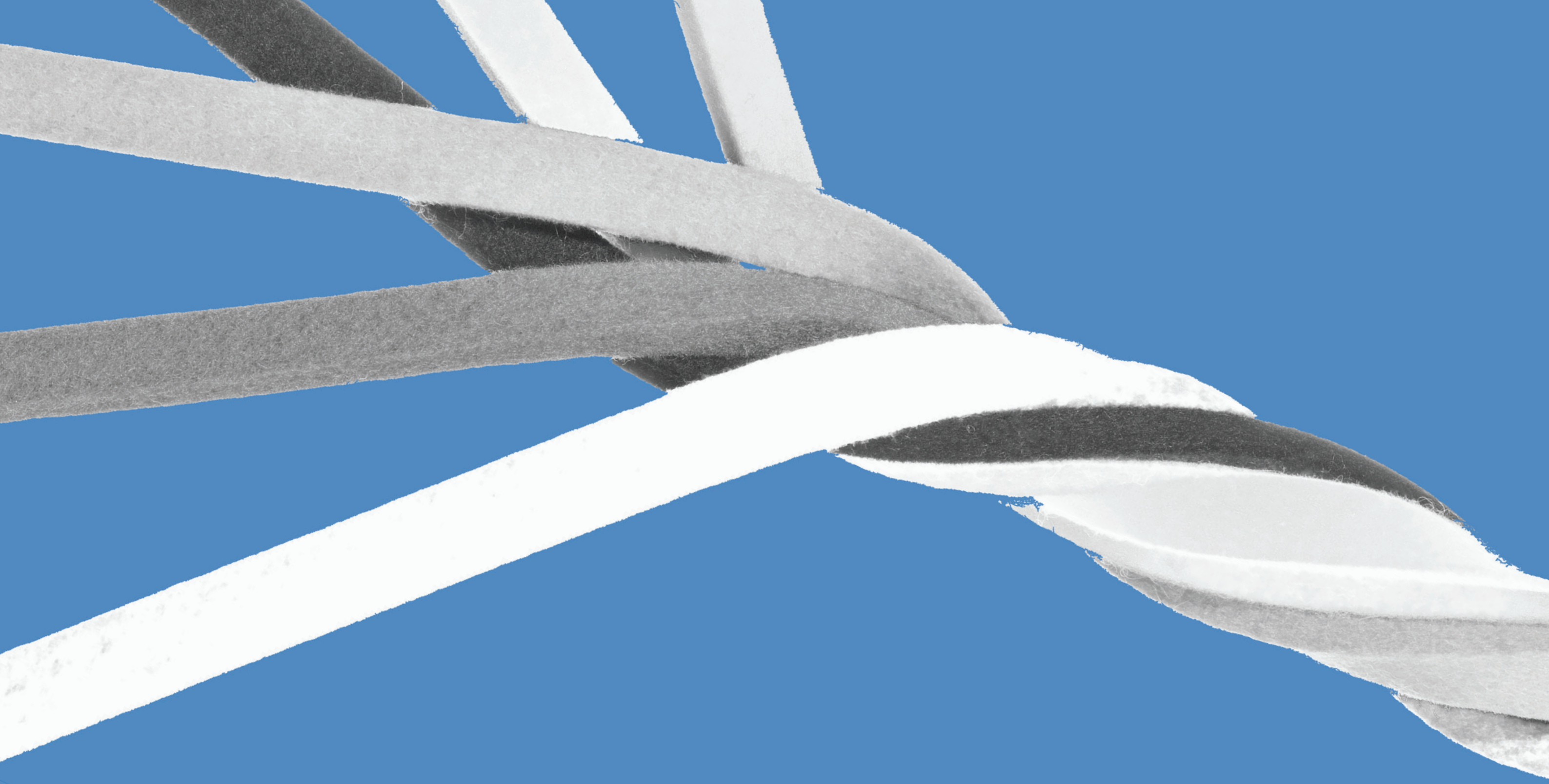

Analysis of the specialization patterns for scientific and industrial activities in the EU regions in the framework of the smart specialization strategy

Thesis by

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ANALYSIS OF THE SPECIALIZATION PATTERNS FOR SCIENTIFIC AND INDUSTRIAL ACTIVITIES IN THE EU REGIONS IN THE FRAMEWORK OF THE SMART SPECIALIZATION STRATEGY

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ABSTRACT

The thesis aims to provide a complete overview of the specialization trends of the EU regions in the context of the regional innovation smart specialization strategy (RIS3), as well as to evaluate whether some priorities can be identified form a top-down point of view, according to the preexisting patterns.

RIS3 has become one of the main tools of the European Commission for the period 2014 – 2020 and it aims to promote more integration and efficiency in the European systems of innovation, asking all regions to define their strategies based on the establishment of some priorities in which a region can excel in front of the others, so it can develop cutting-edge innovation activities in those scientific fields and industrial sectors for which it presents a larger competitive advantage.

Our work aims to evaluate up to which point a potential establishment of priorities from a top-down approach is possible given the preexisting specialization patterns in the EU regions, for both scientific and industrial activities. Additionally, we look to analyze the suitability of these trends in the framework of the regional smart specialization strategies that are being designed contemporaneously, contrasting the patterns to the structure of some regions, including their main institutions and activities.

In chapter 1, we contextualize our study in the framework of the smart specialization strategy, we review the state of art of its associated concepts, and we present the objectives, research questions, propositions, and methodology of the thesis. In chapter 2, we analyze the specialization patterns of most of the EU regions, evaluating their activities in order to define comparative advantages leading to the establishment of priorities towards the strategy. In chapter 3, we present twelve brief case studies where we analyze in detail some of the largest regions (in absolute terms regarding their scientific / industrial activities), describing and studying their specialization patterns according to their main institutions and actors. In chapter 4, we examine thirty proposals presented by EU regions regarding their smart specialization strategies, aiming to evaluate up to which point these proposals match with the main goals of the policy when we consider it from a top-down approach. In chapter 5, we present our final remarks and deductions.

Our main conclusions are centered in the fact that our analyses can prove that there are indeed specialization patterns in the EU regions, which allow policy makers to design strategies based on some top-down approaches when establishing regional priorities for science, technology, industry, and innovation in general. However, we also prove that these trends present many biases given the particular structure of the EU and its territories, and regional strategies must necessarily be more focused on integrating institutions and actors in the different regions to make them part of the whole system, not only in their area, but from an European perspective.

JEL classification codes: F15, F42, O19, O25, O32, O38

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Last, but not least, my deepest gratitude to my family and friends, for being the pillars of my whole life, the beacon to which I sail towards the future.

'The general fact is that the most effective way of utilizing human energy is through an organized rivalry, which by specialization and social control is, at the same time, organized cooperation.'
Charles Horton Cooley in 'Human Nature and the Social Order' (1902)

'The history of learning amounts to a history of specialization'
Beryl Smalley in 'Historians in the Middle Ages' (1974)

Contents

1. Introduction.
A top-down approach to the concept of smart specialization strategy

1.1. Contextualization and motivation

Five years ago, smart specialization was an unknown and abstract concept that was appearing for the very first time in some reports and communications from the European Commission as a new tool to promote growth, in an efficient way, in the European Union. By then, this concept was still too academic to be seen as a concrete action with clear activities which should lead innovation-related institutions in the EU to a new model based on a new 'smart' idea.

Smart specialization is based on a concept that has fascinated most of the economists of all times: efficiency. In this direction, the policy is based on exploiting strengths, the existing sources on the most competitive fields and sectors, through an identification of the comparative advantages and potentials that must lead to some priorities to be exploited. However, Foray et al. (2011) argue that, in an EU market-driven economy, establishing some priorities could be understood as something far from being tolerable according to the market laws, since it could lead to '*wrong choices, picking winners, market distortions*'. On the other side, it is obvious that not all regions can do everything and do it properly, so it becomes essential to focus in some fields / sectors to generate *scale, scope and spillovers in knowledge production and use* (Foray et al., 2011).

As stated by David Charles (2001), since 1988, the European Regional Development Funds (ERDF) have been looking to promote innovation. In this direction, some programs and initiatives have been launched. In 1994, the Regional Technology Plan (RTP) was set up, after renamed Regional Innovation Strategy (RIS), aimed to identify regional strengths and needs to develop better policies and programs. Additionally, the Regional Innovation and Technology Transfer Strategies (RITTS) were created and from 1994 to 2000 more than 60 European regions received their support (Landabaso, M. and Reid, A., 1999). In the first decade of the new century, some programs as the Regions of Knowledge were launched to promote the knowledge-based regional development.

The concept 'smart specialization strategy' saw the light for the very first time in 2007 as a result of the work of the experts group called 'Knowledge for Growth (K4G)' when advising Mr. Janez Potocnik, the former Commissioner for Research of the European Commission. Through different policy briefs they introduced the concept following the principle of the Lisbon Treaty, including the Lisbon growth agenda. Since then, the presence of smart specialization strategy in the EU communications and reports grew exponentially, and it switched from being an academic concept to a reality.

In the COM(2010) 546, *Europe 2020 Flagship Initiative Innovation Union*, the European Commission established smart specialization as a key concept for the innovation plans of the EU. In October 2010, through its COM(2010) 553, about the *Regional Policy contributing to smart growth in Europe 2020*, it established, as one of the actions to be applied in order to support this smarty growth, the development of smart specialization strategies, understood as "*concentrating resources on the most promising areas of comparative advantage, e.g. on clusters, existing sectors and cross-sectorial activities, eco-innovation, high value-added markets or specific research areas*". Towards this goal, the Commission designed three main activities that they would undertake: the development of the Smart Specialization Platform, which already operates depending on the JRC-IPTS, the provision of analysis and information on research, innovation, and specialization form a EU perspective, which has been translated in some reports from different experts that we will later summarize, and the development of platforms for mutual learning and to facilitate de implementation of the strategies.

Within this framework, the European Commission asked states, regions, and territories in general, to develop their own smart specialization strategies, under which precepts the European structural funds (the European Regional Development Funds and the European Social Funds) will be allocated. For instance, in the case of regions, each one of them is asked to establish some priorities that must be considered when deciding to which projects (linked to sectors) are going to be funded by European funds. At the present moment, regions and states are finishing the design of their strategies to start implementing them related to the structural funds in the present period 2014 – 2020.

The main interest for the present work, which becomes the motivation to undertake it, is, first, the novelty of the topic and the room that there still is to study the implications of the smart specialization strategy, being it rather new in the economic literature, allowing us to provide some relevant information and analyses that aim to be useful towards the implementation of the programs based on the smart specialization strategy in the following years.

Another motivation that led us to undertake study is the contemporaneity of the concept, which is in the EU's innovation programs, aimed to stimulate economic growth in the next years. Our work wants to provide and additional point of view based on objective evidence, data, case studies and analyses around the smart specialization in order to evaluate the potentialities of this policy in the near future's Europe.

1.2. The concept of smart specialization strategy

1.2.1. Origin and goals of the smart specialization

As stated by Foray and Van Ark (2007), the EU faces two main problems regarding the attraction of international R&D flows. The first one is the existing disunion among the different states regarding the generation of new knowledge, which has led to a limited exchange of knowledge and a potential replication of research and also facilities. The second one is the imitation of those strategies that have been successful within the EU by other regions and states, instead of designing new ones, leading to uniformity on the innovation-based policies, which have translated to excessive homogeneity on knowledge and what relates to it. These two problems were the main arguments to design a policy based on a European model for specialization with a higher degree of coordination.

The origin of the concept cannot be really found around these arguments though. The basis goes back to the study of the traditional gap on the productivity between the US and the EU due to different aspects, including labor markets, industry performance and the adoption of information and communication technologies (Ortega-Argilés, 2012). An important number of them is connected to the level of the economic integration and the economies of scale it generates (McCann and Ortega-Argilés, 2011). In this framework, the idea of promoting a European system increasing spillovers coming from the new cross-border generation of knowledge was seen as the key to reduce the productive gap.

In section 1.1 we already presented the historical background of the concept, including the design of the concept by the group of experts called 'Knowledge for Growth (K4G)' and the main objectives of the policy, especially based on improve the coordination to reduce problems associated to this gap that we were mentioning.

Smart specialization is based on the entrepreneurial discovery process, consisting in a procedure where entrepreneurs, understood in a broad sense, including companies, research and education institutions, innovators, etc., are to discover the fields and sectors in which a region has the largest comparative advantage and can excel. It is expected that these 'entrepreneurs' will, through different actions, establish the priorities of the region or the state (European Commission, 2012). A top-down approach is seen in the strategy as something that must be considered but not as the base of the policy. However, applying a general rule to define a bottom-up approach seems much more difficult than doing it form a top-down point of view if we aim to consider objective and observable data.

In words of Foray et al. (2011), the principle of entrepreneurial discovery is essential but, on the other hand, the constraints this imposes should not be used to justify a shrinking of policy scope to exclude all governmental actions as being 'top-down directions', inimical to the 'bottom-up' logic of entrepreneurial discover. In other words, a top-down approach, as the one we consider in our study, where we aim to identify priorities coming from specialization trends, is also complementary and necessary to define the strategies.

The European Commission (2012), through the 'Guide for the Smart Specialization Strategies', defines the concept, which links to the mentioned goals, as an integrated, place-based economic transformation agenda to focus policy support and investments to some priorities, challenges and needs, to build on each state/region strengths, to support investments in technology and stimulate the participation of the public sector, to get a larger involvement of the different actors by encouraging innovation, and to be defined from an evidence-based point of view. In other words, the strategy aims to promote fields and sectors according to the potentialities they have to grow and to interconnect with the rest.

Choosing priorities and establishing leaders and followers for each scientific domain or industrial sector does not mean signaling better and worse regions, but defining which ones are more prepared to develop general purpose technologies and which are ready to work on their potential applications (Foray et al. 2011).

As explained by McCann and Ortega-Argilés (2011), even if the goals of the strategy appear to be concrete and clear, when it is time to define the actual policies, we face three main challenges. The first one is the large analysis around the actors involved in the scientific, industrial and innovation activities, and the difficulty to find an analytic and systematic way to compare them all. In our study, we define a common methodology for all regions, taking into account the biases that may appear due to this generalization. The second one is based on the differences that we find when applying the concept to a regional level, instead of considering the whole state, since it leads to externality and interdependence issues related to agglomeration processes. This complicates the desired systematic analysis, since it is difficult to find general arguments when comparing regions instead of states, which will be evident in chapters 2 and 3. Finally, the third challenge is related to the unclear connections between the policy goals and its instruments. Given that the concept of smart specialization is rather new, literature about it is still scarce and indicators on the outputs are still needed to evaluate it. In our study we will not discuss about the implementation of the policy, and we will focus on the design and definition of priorities though the specialization patterns.

Up to now, several EU regions have already defined their strategy, which are beta versions, since they need to be tested. These challenges, and other, are still present in the structuration of the policy in each region. It is now time to start implementing all the measures and actions that have been created in order to see is there is room to link the entrepreneurial discovery process and the unavoidable top-down approach to promote the goals of the whole strategy.

1.2.2. Design of the smart specialization strategies

The design of the strategies related to the concept of smart specialization is based on the guide from the European Commission (2012), devoted to facilitate the process through different tools to define the right strategy. This guide has been used by those in charge of defining the regional innovation strategies. In chapter 4, where we analyze the proposals of 30 regions towards de design of these strategies, we will see that all the follow the same scheme, and it is the one that is established by this guide. In order to define priorities, base of the smart specialization strategy, the guide talks about the **4 Cs**:

Choices and critical mass: based on the identification of some priorities for specialization taking into account the global the whole EU, in order to promote efficiency, create synergies and avoid duplicities. In our study, we link these concepts to the data that we use, which will allow us to identify, for each scientific field and industrial sector, where the larger critical mass is located.

Competitive advantage: based in what is conceptualized as ‘entrepreneurial discovery process’, a bottom-up approach to the strategy, in which the entrepreneurial base of the economy must lead the identification of priorities. We concentrate our study in a top-down approach, so we will not analyze this ‘entrepreneurial discovery process’. We understand the competitive advantages as a concept related to the relative advantages of a region compared to the others when we aim to identify the research fields and industrial sectors in which that region could specialize itself.

Connectivity and clusters: in order to promote the synergies that the strategy aims to achieve, the connectivity among regions, but also sectors and fields, becomes a key element when designing the right policies. Even if our study does not cover this issue directly, the establishment of priorities (which we analyze) is the base to start designing methods to connect and cluster interregional initiatives.

Collaborative leadership: collaborations based on the public-private partnerships among the actors related to the quadruple helix model (science, industry, administration and final users). In our study, we will evaluate these actors separately but we include a section in which we aim to see how scientific fields and industrial sectors are correlated, which will allow us to see the potential of these partnerships within a region, even if the objective is to have a global vision.

Following these 4 Cs, and with the objective of establishing a common framework for all the smart specialization strategies, the guide proposes a **6 steps model**, also presented in the guide. The first one, called *'Analysis of the regional context and potential for innovation*' is the one most related to our study, since it is the one devoted to do exactly what we aim to study and which title indicates. To perform this analysis, the guide proposed 2 different analyses, one for scientific and technological specialization and the other for regional economic specialization. In our work we perform both. Additionally, the guide proposes case studies and peer reviews on clusters and foresights.

The other 5 steps of the model are: *'Governance: Ensuring participation and ownership'*, based on the implication of representatives coming from industry, research institutions, public administrations and final users, *'Elaboration of an overall vision for the future of the region'*, planning an scenario for the development of the region, *'Identification of priorities'*, based on the results of the three previous steps, *'Definition of coherent policy mix, roadmaps and action plan'*, where some pilot projects and concrete activities should be established to be implemented under the strategy framework, *'Integration of monitoring and evaluation mechanisms'*, to evaluate the implementation of the ongoing programs and strategies.

Through these 6 steps and the analyses they include, the designed regional smart specialization strategy should lead to the rationalization of the European funds that will be structured in the context of the policy. Our study, focused in the first step that must complement the forth one aims to provide an overview based on the guide's precepts.

1.3. State of art around the smart specialization and its related topics

This section aims to provide an overview of the framework in which the smart specialization strategy appears, not only through the concept itself but also taking into account the related ones, for the strategy is linked to many other topics and fields.

1.3.1. Bibliometric study

'Smart specialization' is a relatively new concept that has not yet been much used in the literature. This is the main reason why we consider that a bibliometric study will help us to understand to which fields and concepts this strategy is linked to.

When establishing a method for bibliometrics it is important to choose the appropriate data base to be used, according to the goals of the study. In our analysis we chose two reference academic data bases: the Web of Science (WoS) and Scopus. Both cover more than 12.000 journals from many different countries worldwide, from a multidisciplinary perspective. Additionally, Google Scholar has been also used as a support tool to enlarge the results of our study. Regarding the available bibliometric software, we chose VOSviewer, which allows us to perform a very illustrative analysis.

Since, as we said, the concept of smart specialization is rather new in the literature, the starting point for our bibliometric study was difficult to establish. Following a working report from the CITEK project (2014) on the monitoring of the smart specialization strategies, we have put some boundaries around the concept of smart specialization and its related topics since it was not possible to include all the potential connected subjects. Different specific queries were used on the WoS, using some searching alternatives and filters to obtain different results that could be aggregated, eliminating duplicities. Same strategy was followed using Scopus instead. By performing this screening on different data bases, using the tools this software puts to disposition, we found a number of concepts related to the initial one: smart specialization. These concepts go from broad fields like international trade to more concrete ones, as regional innovation policies, but all they are linked to the smart specialization strategy. Figures 1.3.1.1, 1.3.1.2 and 1.3.1.3 aim to illustrate the results from the bibliometric study. We have not applied any particular methodology to design these figures; VOSviewer automatically designs them.

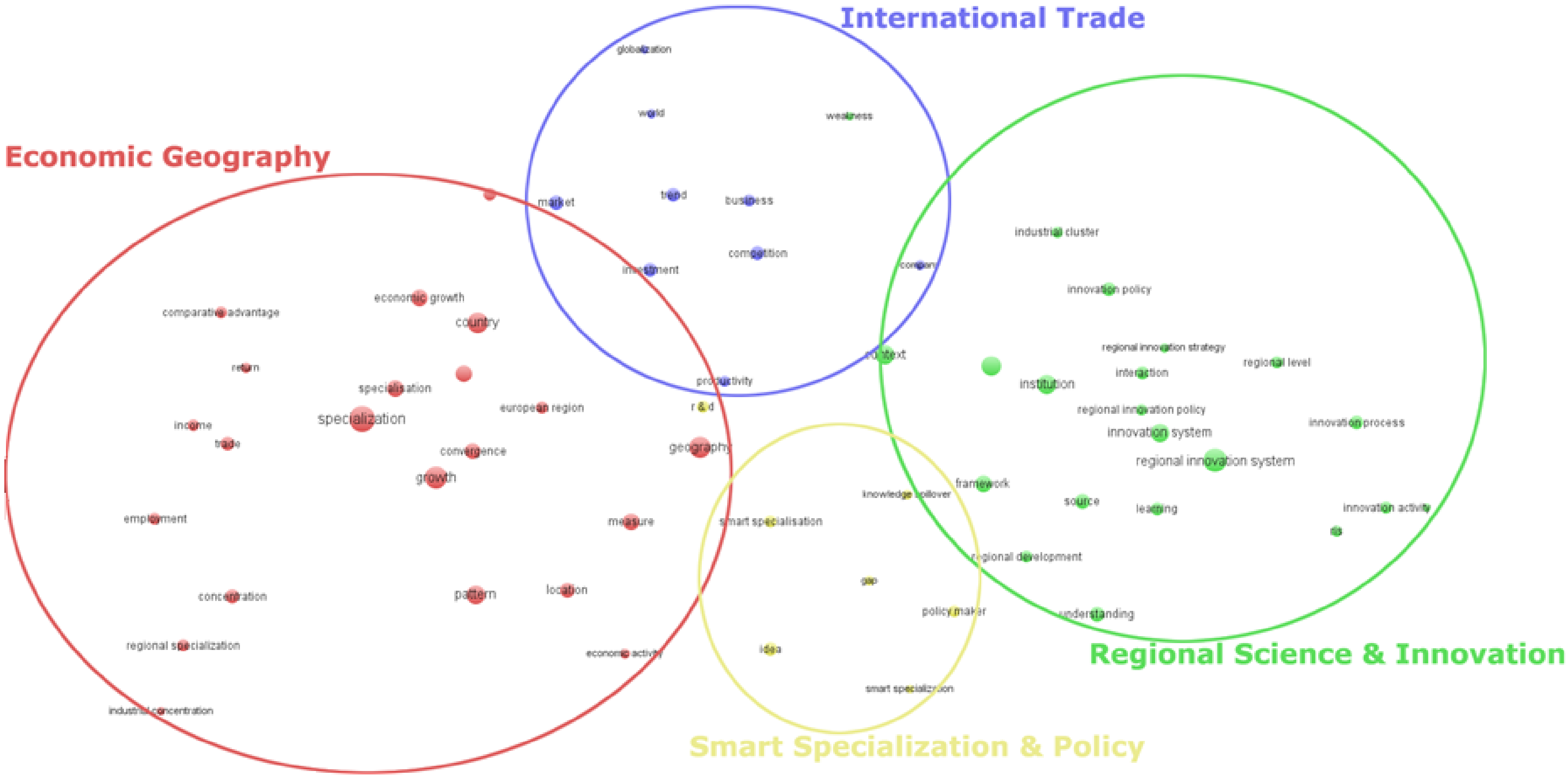
Figure 1.3.1.1 clusters the concepts in four main fields: economic geography, international trade, regional science and innovation, and smart specialization and policy. Every concept is inside the circle where it belongs. Additionally, every concept is represented by a label and another small full circle; the size of these circles corresponds to their weight in the bibliometric study (number of appearances) and the distances between them are related to their co-occurrence values. In order to introduce some general comments (since the figure is already really explicit), we can say that it seems surprising that, for example, the concept 'specialization' is located in the circle of 'economy geography' instead of the one for 'smart specialization and policy', as well as the concept 'comparative advantage'. This is probably due to the tight relation between smart specialization and economy geography in the literature. As we can see, the concepts with a larger weight are 'regional innovation system', 'growth', 'geography' or 'specialization', among other, and the larger cluster is 'economic geography', followed by 'regional science and innovation'. Note that the concept 'specialization' is repeated, due to the fact that the tool understands that 'specialisation' (same word but in British English) is another concept.

Figure 1.3.1.2 is more related to the density of the concepts. Their position in the 'map' stands, but now we can see the most important and populated areas according to the density, i.e. the number of weighted items in an area. These areas appear in red where there is the largest intensity, and they go 'colder', passing to yellow, green and finally blue when there is less weighted density. According to this, there are six main 'concepts' with a larger associated density related to 'economic geography': specialization, country, economic growth, European region, country, and convergence. Another dense area is located in the right side, with these main concepts: (regional) innovation system, institution, or regional innovation policy. The last 'red area' is located in the center of the 'map', and the main concepts are: productivity, R&D, and geography.

Finally, figure 1.3.1.3 mixes the previous two figures in what VOSviwer calls a 'cluster density view'. Clusters are represented with the colors in figure 1.3.1.1. The more dense areas are represented with a highlighted stronger color, while the areas with a lower density are shown in a lighter color.

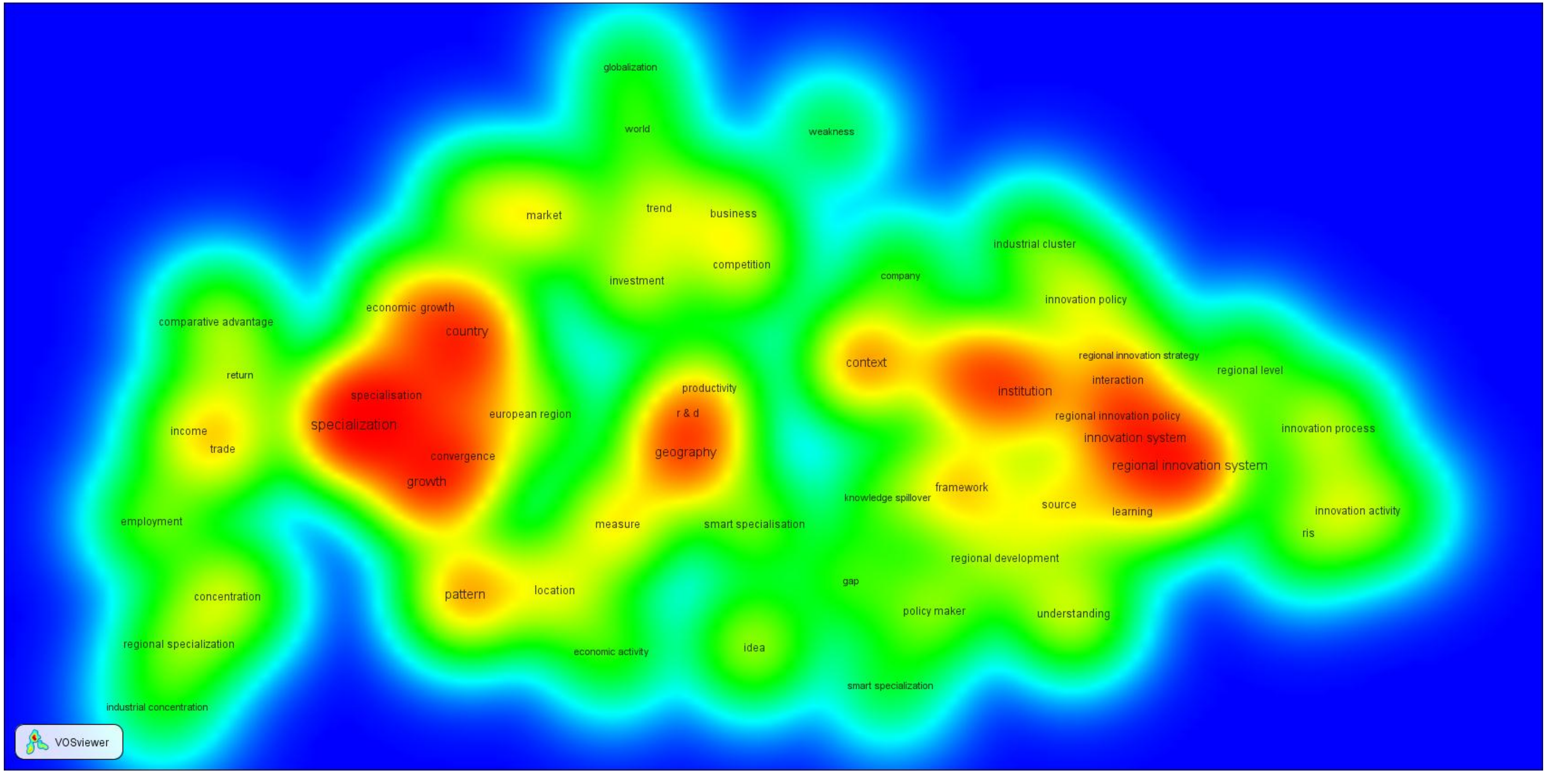
Regarding the authors of those articles containing the main topics that we are considering for our bibliometric study, we can say that some of them appear to be recurrent. For example, Philip McCann and Bjorn T. Asheim published 9 papers each where its topics where related to the smart specialization. David Doloreux published 8, and Philip Cooke 7. Dominique Foray and Raquel Ortega-Argilés, two well-known authors in the framework of the smart specialization, published 6 each (not taking into account the working papers, policy briefs, etc.). Andrés Rodríguez-Pose published 5. Lars Coenen, Bronwyn H. Hall, and Linda A. Hall published 4. Finally, Franz Todtling, Michael E. Porter, Saeed Parto, Charlie Karlsson, Arne Isaksen, Maryann P. Feldman, Paul A. David, Ron Boschma, and Zoltan J. Acs, published 3 each. Figure 1.3.1.4, where the authors with a larger number of published articles appear, illustrates it.

Figure 1.3.1.1. Clustering map for labeled concepts linked to the 'smart specialization strategy'



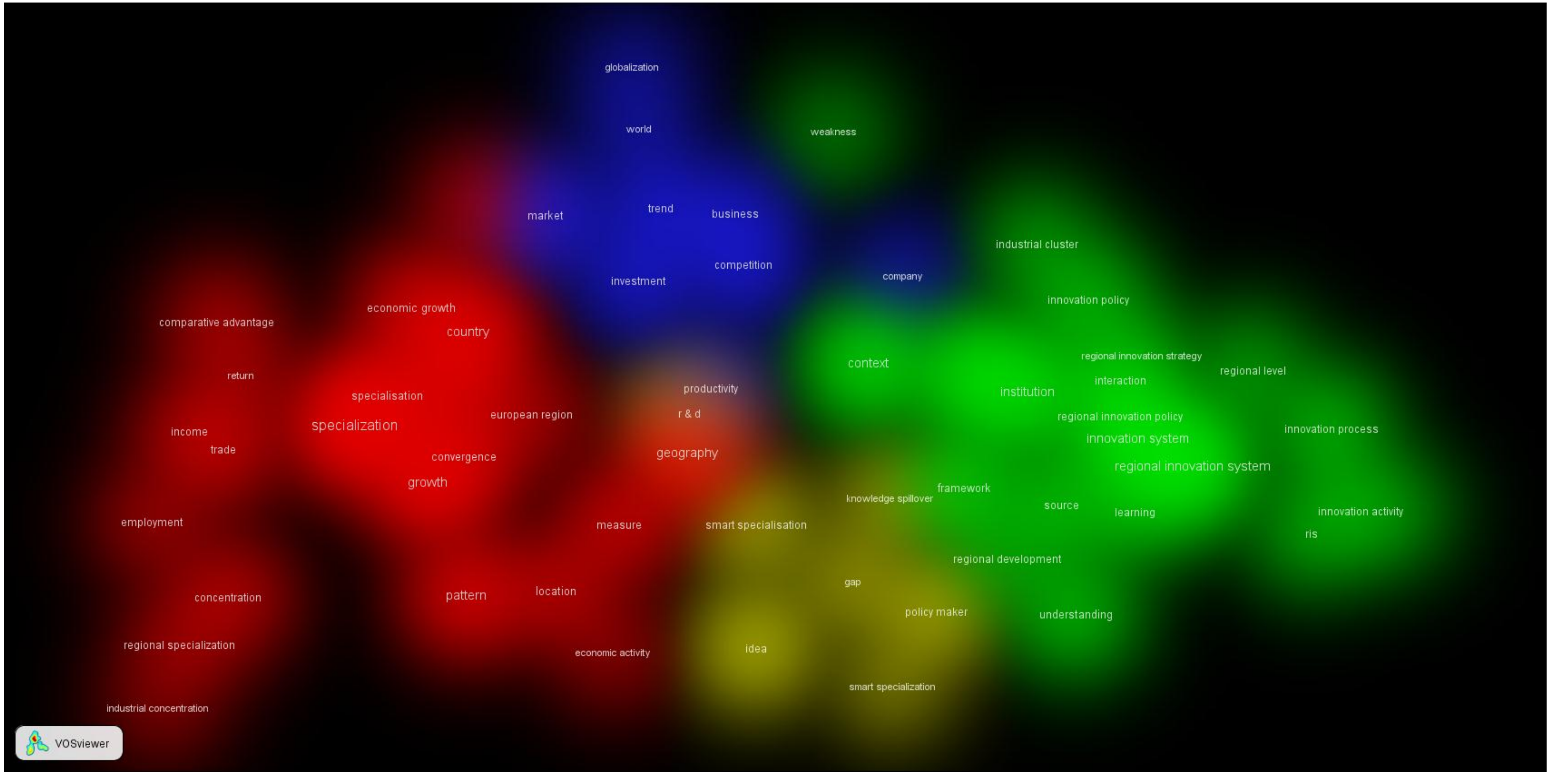
Source: Own elaboration and CITEK (2014) through VOSviewer

Figure 1.3.1.2. Density map for concepts linked to the 'smart specialization strategy'



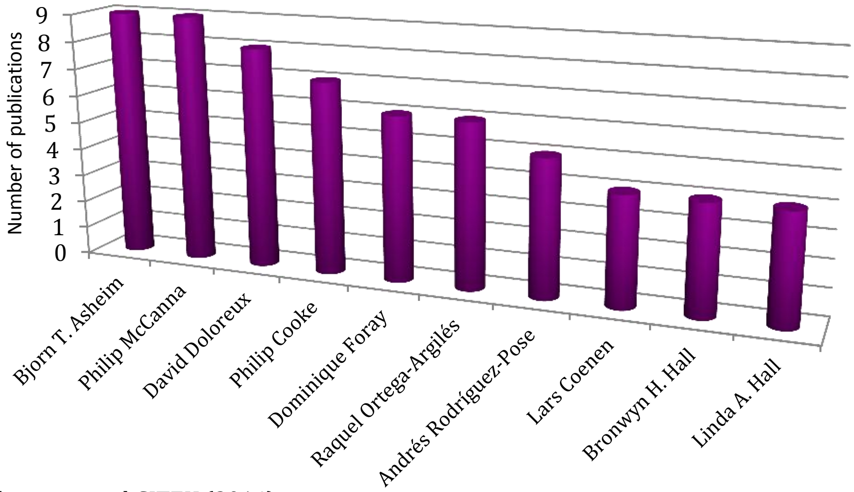
Source: Own elaboration and CITEK (2014) through VOSviewer

Figure 1.3.1.3. Clustering-density map for concepts linked to the 'smart specialization strategy'



Source: Own elaboration and CITEK (2014) through VOSviewer

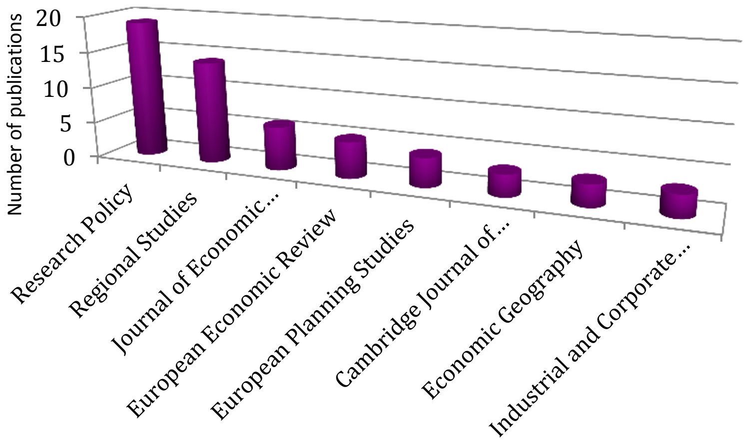
Figure 1.3.1.4. Main authors with articles published in topics related to the smart specialization strategy (until December 2013)



Soure: Own elaboration and CITEK (2014)

If we take a look to the journals that have published articles with these concepts, we find that articles related to the topics we are considering are mostly published in these journals: Research Poly, with 19 articles leads the raking, followed by Regional Studies with 14; with 6 published articles we find the Journal of Economic Geography, followed by the European Economic Review, with 5, and the European Planning Studies, with 4. With 3 published articles we find the Cambridge Journal of Regions, Economy and Society, Economic Geography, and Industrial and Corporate Change. Finally, with 2 published articles in topics related to the smart specialization strategy we find the American Economic Review, Economic Modelling, Economic Systems, Economic Letters, Entrepreneurship and Regional Development, Environment and Planning A, European Urban and Regional Studies, Geoforum, International Regional Science Review, Journal of Common Market Studies, Journal of Evolutionary Economics, Journal of Technology Transfer, Journal of Urban Economics, Procedia Economics and Finance, Technological Forecasting and Social Change, Technology in Society, Technovation, The American Economic Review, and Tijdschrift voor Economische en Sociale Geografie. Figure 1.3.1.5 illustrates it presenting those reviews with a larger number of publications in this field.

Figure 1.3.1.5. Main journals with articles published in topics related to the smart specialization strategy (until December 2013)



Soure: Own elaboration and CITEK (2014)

This bibliometric study helps us to conclude that there are several topics and research fields related to the smart specialization strategy, which makes very difficult to establish a methodology based on the comparison among the existing literature around this topic. However, through this analysis we are now able to know which are the concepts connected to the strategy, form an academic point of view, and we can now take a look at the state of art of the concept, based not only on 'smart specialization', since it is a new topic, as we have already said, but to some of the concepts that are tightly linked to it.

1.3.2. The smart specialization and its related topics in the literature

A review of the state of art for the smart specialization strategy can be already found in subsection 1.2.1. Now we aim to see how this concept is connected to many others, as those we found in the bibliometric study, in the literature. We have divided our literature review in five main concepts: regional innovation systems, economic geography and technology change, clusters, concentration and agglomeration, and finally, of course, specialization.

Regional innovation systems

Smart specialization is linked to the concept of 'regional innovation systems or strategies (RIS)'. Cooke (1992) used it more than 20 years ago when evaluating the impact of the economic regulation in Europe, concluding that interactions among institutions from different regions improve the spillovers coming from the mutual learning. This author continued analyzing this topic later. Cooke et al. (1997, 1998) developed the concept of regional systems of innovation as a result of the previous national models and they proposed some methods towards the design of these systems. Later on, this topic was more developed under concrete systems' implementation and their impact in Europe, also related to the gap with the US (Cooke, 2001) and by taking into account the knowledge transfer regarding these implementation models and the public-private governance methods, seen as crucial for the proper carrying out (Cooke et al., 2003). This author did not finish here his research on this topic, and in Cooke (2005) he reviewed the subnational or regional innovation systems, focusing again in different implemented initiatives that were designed in this framework, concluding that top-down approaches should leave room to bottom-up ones, later evaluated for the generation of spillovers and other results of the policy implementation (Cooke, 2009). Cooke can be considered then a referent if we aim to analyze regional innovation systems and his works are a reference for the implications of different policies in this field.

On his side, Bjorn Terje Asheim, who intensely studied the regional innovation systems, clusters and location theories, through the study of the innovation frameworks in the Nordic countries and their regions, stated that, when considering the innovation policies, the regional level is more adequate since it has an embedded network of different actors noticing the industrial basis of a region (Asheim et al., 1997a, 1997b, 2002, 2003, 2005). Later on, he, jointly with other authors, discussed the main dimensions of the regional innovation systems: specific knowledge bases, globally distributed knowledge networks and different territorial competences bases (Asheim et al., 2006, Asheim, 2007, Asheim et al. 2007). These dimensions are linked to the three main trends of thought that have been created around innovation, specialization and agglomeration: 'spatial economics', focusing in economic linkages, 'territorial agglomeration theory' related to the sociocultural dimensions, and 'path dependence', linked to the influence of the past (Karlsen, 2005).

Another author who deeply explored the regional innovation systems was Martin Andersson. He analyzed the structure of the actors related to these systems and they proved that their proximity is crucial for successful initiatives (Andersson and Karlsson, 2004). After reviewing different regional innovation systems (Andersson and Karlson, 2006), he made some conclusions based on the fact that the aim of increasing competitiveness and productivity is the source of the innovation systems, and not their result.

Besides these authors, many others have reviewed, studied, analyzed, and contrasted regional innovation systems, establishing different theories and models. For instance, Iammarino (2005) reviewed the literature around the regional innovation systems, from both top-down and bottom-up perspectives, and the evolutionary mechanisms around them. D'Allura et al. (2012), in their literature review, provided a complete overview of diverse positions from different authors around the regional innovation systems. Berger et al. (2008) analyzed the innovation system dynamics trying to apply them into a practical scheme of analysis for policy makers. Doloreux and Parto (2004a, 2004b, 2005) centered their research in the concept of 'regional innovation systems' regarding three main issues: the confusion around their definition and the empirical validation, their territorial dimension and the role played by institutions. Natário et al. (2012), to put an example, analyzed the Portuguese regions, concluding that competitiveness among regions and the dynamics based on innovation are closely linked to the effectiveness of the innovation systems.

Regional innovation systems within the EU have also been largely studied, especially related to the role they play in regional development and growth. Boldrin and Canova (2001) showed that most of the regional structural policies are designed around a redistributional objective, following the concept of 'political equilibria', but they conclude that these policies do not foster economic growth. Grillo and Landabaso (2011) examined the problems around the regional innovation policies in the EU, since they also found that structural funds did not achieved really effective results. In this direction, Hajek et al. (2013) concluded that EU regions' growth is linked to the European integration for the lagging ones and to the level of innovation and entrepreneurial activities to those more knowledge-intense. In any case, as stated by Puga (2002), even if there have been large expenditures on regional policies, inequalities have not really changed in the last decades.

Even if much research has been developed in this framework, there is still not an ideal model for innovation policy since territories differ a lot depending on their industrial background (Tödtling and Trippl, 2005). More measurement methods and more concretion around this topic are still needed, because, even if there is some unity related to the use of concepts like agglomeration, innovation system, governance, or network organization, territorial innovation models still present some ambiguities (Moulaert and Sekia, 2003). Regarding these systems' measurements, Autant-Bernard and al. (2013) aimed to evaluate the policy implications within the EU regions, and they concluded that data and indicators must be improved, since policy makers need a more accurate knowledge of the local features. With this purpose in mind, some authors have been trying to develop better measurement ways, like Carlsson et al. (2002), who centered their study on the measurement of the regional innovation systems, centering it in the type of interactions among the different actors involved, the purpose of these systems, as well as their performance.

Economic geography and technology change

The work of Krugman (1991, 1993) is the reference to another important research field: geography economics, since his work is around the study of the location in space of the production factors, introducing topics like specialization or agglomeration, two concepts that have been traditionally connected, when analyzing absolute versus comparative advantages (Ricci, 1999). Other authors have been studying this topic. For example, Davis and Weinstein (1996 and 1999) performed some research analysis on the effects related to the economic geography, comparative advantages and returns to scale, concluding that the location of the factors is crucial for the regional structure of production. Boschma (2005) introduced the concept of 'coordination' when defending the idea that proximity cannot be analyzed in an isolated way, but it also must consider the other dimensions affecting it, since the main goal must be the improvement of the coordination between the different agents.

In any case, it has been proven that the decision regarding whether locate these activities is crucial for the regional development. Barca et al. (2011) examined the place-neutral versus place-based policies regarding the regional economic development, showing that intervention should focus on efficiency and social inclusion. On their side, Rodríguez-Pose and Crescenzi (2008) underlined the importance of proximity in order to promote the transmission of productive knowledge, since they found that spillovers are affected by distance. However, even if proximity is a key issue, connections with other regions, both nationally and internationally is also essential, since industrial innovation increasingly takes place within international networks (Kuhlmann and Edler, 2003).

The World Bank (2009), through its World Development Reports, has been active regarding this topic. In 2009, they aimed to see the implications of the economic geography and the factors' location related to their effects in growth, involving economics and geographers to take part in an active discussion around these effects and other considerations, including specialization in a location framework. Some of the conclusions can be found in Peck and Sheppard (2010), including opinions of Deichmann et al. (2010), aiming to shape the economic geography to concrete regional context, or Beugelsdijk et al. (2010), who analyze the connection and the interests of geography economics and international trade, regional science and international business strategies.

In words of Krugman (1991), economies of scale, reduction on transportation costs and market demand can interact to produce agglomerations even when there is absence of external economies. However, if there are not significant externalities or any other social increasing returns, it is less probable that economic growth stays constant, as non-diminishing rate in the future (Griliches, 1992). In any case, it has been proven that usually these knowledge externalities tend to be geographically bounded within the region where the new economic knowledge was created (Anselin et al., 1997).

Smart specialization, as an academic concept, is also influenced by the literature around the technology change. Many authors, as McCann (2008) have shown that globalization and the improvement of technologies, especially ICTs, have favored the reduction of the former geographic distances, entering a more discriminative global economy, led by cities, which are affected by many different factors, including specialization trends in their influence areas (Storper, 2010). Improvement on technology was also studied by Crauser (2002), who defined the regional innovation strategies as a key element in the globalization, the technological change and its affectation to the markets worldwide.

This technology growth and globalization can be then understood as a cause of the new role of the concept 'location', which has switched from being related to comparative advantages to save input costs to another comparative advantage based of the improvement of the inputs' productivity which requires innovation (Porter, 1998a). It was Porter (1996, 1998b) who, by establishing the bases of the concept 'cluster' proved that innovation and competitive success are very influenced by agglomeration processes, which end up creating these clusters, defined as geographic concentration of companies and institutions operating in the same field, which are interconnected.

Clusters

The concept of 'cluster' has been understood as a key for the specialization processes. Clusters have been contributing to the regional specialization through agglomeration processes around a concrete sector in a concrete location, promoting the improvement of innovation and competitiveness in the industry. They have been defined as geographic concentrations of interconnected companies and institutions in a particular field or industry, as stated by Acs et al. (2002). According to Slövell et al. (2006), clusters are important because they lead to tangible economic benefits. These benefits are mostly related to the possibilities for companies to operate with a higher level of efficiency, since they are in contact with more specialized assets and suppliers, including shorter reaction times, and they can also achieve a higher level of innovation (Porter, 1998b).

Literature around this topic is large, and many authors have studied clustering initiatives all around the world. Porter (1998a, 1998b), as we have said, was one of the introducers to the concept when he analyzed the most relevant clusters of the US and Portugal. Other authors started doing the same for other countries. For instance, Edgington (2008), when studying the Japanese innovation systems, evaluated the Nippon clusters. Long and Zhang (2012) focused in China, and they found that besides a good net of clusters, Chinese regions appear to be largely interconnected and they present some specialization trends. Brookfield (2007) studied the relation between specialization and clustering in Taiwan, detecting some new clusters in the state. Doloreux et al. (2003, 2004, 2007, 2008) analyzed the regional innovation systems in the rural and peripheral areas of Canada, and they found that clusters are one of the key concepts in these systems.

In Europe different studies have been also undertaken. Scandinavian states have a large cluster tradition. For example, Asheim (2001), Karlsen (2005) or Palshaugen (2011) studied the clustering initiatives in Norway, as Asheim and Coenen (2005) did also for Denmark or Sweden. Regions from third countries have also been taken into account when studying regional clusters. Schlossstein and Yun (2008) analyzed compared two different regions, one German and another from South Korea, in order to evaluate the cluster presence in these regions. Giuliani (2007) did something similar for Italy and Chile, focusing in the wine clusters in different regions in these countries.

As we see, in any case, clusters are mostly analyzed from a regional dimension and the relation cluster-region is the basis in many studies. Padmore and Gibson (1998) presented some examples, proposing an overall framework for the analysis of regional clusters, including some application examples within the EU. Rosenfeld (2012) analyzed clusters in detail and proposed a guide to foster cluster competitiveness through some actions and strategies, especially for less favored regions.

Probably, one of the best analyses was developed by Slövell et al. (2006), aiming to provide an analysis of the regional concentration trends in ten new EU states, compared to the EU15 and the US. To do so, they measured clusters using employment in a sector and a region as a proxy. They did so for 38 sectors and 41 regions. Cluster size and specialization were measured depending on the number of employees, degree of specialization in terms of the total number of employees (relative measure) and the degree of regional market labor dominance (percentage of employment in a sector). Through these measures, they gave a rate to each cluster, identifying 19 top-rated regional clusters, 92 medium-rated and 313 low-rated.

Concentration and agglomeration

Since the 90s, researchers have drawn attention to questions related to the location of production, how it is distributed in space and which are the forces that create co-location. In words of Feldkircher and Polasek (2006), concentration is an a-spatial concept because it does not take the location of industries into account; an industry can be highly concentrated when its production is located in 2 of 250 regions, but concentration proxies are blind in regard to which these regions are located. The concept that describes this phenomenon is 'agglomeration'. On the other hand, specialization describes the distribution of the output across sectors holding a region fixed, being specialized when it presents a high share of activity for a sector compared to a reference distribution.

In many cases, specialization has been presented as a mirror image of concentration. Empirical studies have usually use the same matrix of region and sector shares, using different economic variables like added value, production or employment, when they aim to calculate concentration, but also specialization. In most of the cases, an increase in specialization is repetitively linked to an increase in concentration (and the other way around). This is the reason why empirical studies usually focus either on specialization or concentration, given that those two concepts go in parallel (Aiginger and Rossi-Hansberg, 2006). Nevertheless, specialization and concentration not always go this way. Some studies, as Rossi-Hansberg's (2005), present results proving that under some circumstances, an increase in specialization and a decrease in concentration can take place at the same time. For this reason, it is crucial not no mix the measurement of concentration and specialization when performing a study around these two topics.

Some authors have focused more on agglomeration. For example, Ciccone (2002) studied agglomeration-effects (using employment as a proxy) in the five larger EU states, concluding that these effects are only slightly smaller than in the US. On his side, Brülhart (1996) found that European integration was leading to some concentration and agglomeration in central Europe, in terms of employment in scale-intense industries.

Some advantages of industry agglomeration have been identified in the literature, but there is still a lack of concrete theoretical frameworks to analyze spatial clustering (Malberg and Maskell, 2002). In this sense, Chapman and Meliciani (2012) concluded in their study that agglomeration alone cannot explain regional patterns of growth, since socio-economic factors have an important and increasing role. It has also been proved that regional equality and economic growth not always go in parallel, since policies promoting equality can harm growth. A way to overcome this problem may be agglomeration and the dynamics it cause (Thissen and Van Oort, 2010).

When measuring concentration, most authors have used the Gini coefficient as empirical method. Some authors, as Imbs and Wacziarg (2003), even if the also use this coefficient, they believe that there is no particular reason to choose a particular proxy, so they use a number of other measures, including the Herfindahl index, which is an absolute measure of specialization taking into account the weighted shares of each sector, the max-min spread index or the log-variance for sector shares. On their side, Aiginger and Rossi-Hansberg (2006) used the Gini coefficient to measure the importance of an economy activity for a state or an industry, analyzing two data sets to evaluate concentration in order to make a comparison between the EU and the US.

Paluzie et al. (2001) constructed a Gini coefficient for 50 Spanish provinces and 30 industrial sectors from 1979 to 1992. They found that only 13 of these sectors showed an increase in their geographical concentration, and this increase is moderate. Slövall et al. (2006) took three data sets for 38 industry clusters, one for 199 EU15 regions, another one for all EU10 regions and the last one from 50 US states and they also apply the same coefficient, concluding that concentration in the EU is less than in the US. Hallet (2000), on his side, used a coefficient of variation to measure concentration, using Eurostat's data based on the gross added value for 17 sectors in the period 1980 – 1995 for 119 EU regions. He showed which sectors are more and which less concentrated. Krugman (1991) also developed an index to estimate concentration, taking into account the absolute differences between the industrial structures of different regions. It was used by different authors as Combes and Overman (2003), who presented a descriptive analysis of the spatial distribution of economic activities in the EU. Molle (1997) also used this index in one of the largest historical study for industrial concentration, from 1950 to 1990, showing a decrease in concentration.

Another empirical method is the entropy index. Aiginger and Davies (2006) use it to measure concentration with EU and US data sets, defining the index as the summation of the products of the shares and log shares of each EU state in the aggregate output for a specific industry. Ellison and Gleaser (1999) talked about the influence of the natural advantages in the location of industrial centers, concentrating in the spillovers coming from them, concluding that at least one fifth of the concentration can be attributed to natural advantages.

In any case, using the index of Gini, Herfindahl, Krugman, etc. do not change results that much. Even if these indexes use different methods, which are not described here since this is not our purpose, all they aim to evidence concentration in a similar way. Feldkircher (2006) presents some of these indexes analyzing their characteristics.

Specialization

According to Smith (2009), the background of the specialization analysis is the claim that the EU has been duplication efforts in R&D for a long time, where many actors were developing the same technologies, causing large efficiency losses. As we have mentioned in section 1.2, (smart) specialization has been presented as a way to solve this inefficiency. However, other authors have outlined the negative effects of an overspecialization, supporting the concept of 'diversification' as the appropriate response when facing a risky economic environment, and a reduction in variety might lead to undermining the potential (Mollas-Gallard and Salter, 2002).

Territories are said to be specialized when a limited range of sectors / areas of knowledge dominate the activities, while specialization is usually defined as a distributional indicator on the share and authors have used a vast range of methodologies to quantify it. When measuring specialization, many models refer as a departure point to the trade theories, which, in their traditional point of view, predict that a territory will trade according to their relative comparative advantages, following the theories of Ricardo or Heckscher-Ohlin.

We can mention here other studies that have been developed by different actors, providing different conclusions. For example, Mora et al. (2005) studied specialization and convergence in the EU regions since 1985 and they found that regions with higher specialization rates in low-tech industries present less convergence than those less specialized. However, persistence in employment structures can coexist with regional convergence, and these structures are larger within the states compared to the whole EU (Marelli, 2004). On his side, Cutrini (2010) studied concentration and specialization in the EU for the period 1985-2001, showing that national specialization emerged especially in the EU funding states, while a general but slight regional agglomeration occurred.

The role of multinational corporations is also relevant when studying specialization, since they have become the core of some specialized areas in different regions. Cantwell and Iammarino (2001) concluded from their study that European regions can be divided into those in which these multinationals have consolidated areas of traditional specialization for a region, and those in which there has been a shift towards the growth of some fields presenting new high technological opportunities. Additionally, in general, larger and more distinctive regions present the smallest average competitive threat compared to all other regions (Burget et al., 2012).

Camagni and Capello (2013) think that the geography of innovation is much more complex than the ideas presented under the smart specialization strategy, and they conclude that before establishing 'smart strategies', 'innovation patterns' must have been properly analyzed, since regions face very different modes of innovation. In this context, smart specialization is still new and complex, needing it to be clarified for the use of policy makers as well as an effective implementation (Rusu, 2013).

To empirically measure specialization, the most used index has been Balassa's (1965), based on the revealed comparative advantages. This index will be explained in chapter 2 since it is the one we will use in our analysis. Balassa's first goal was to measure the trade performance of individual countries in regard to manufactures, for comparative advantages would be expected to determine the structure of exports. However, the index has been adapted to measure specialization in more general terms. Additionally to Balassa, who measured this advantages for the US, Canada, the European Economic Community, the UK, Sweden, and Japan, for the periods 1953-1955 and 1960-1962, other authors used the same index when measuring international trade related to the specialization levels, like Dalum et al. (1999) did for the OECD states.

Basile and Girardi (2009) used the Balassa index as an indicator for the overall specialization constructed around sector shares in employment for 144 EU regions in 15 states for the period 1995-2000, analyzing the risk sharing behind specialization and the positive effects that they found. In other cases, Balassa's formula has been used to measure relative scientific and technological specialization in a state/region, studied as the performance of a territory in a specific field relative to its overall international performance, like in European Commission (2009a) or Cooke (2009), where the index was constructed with a data set on the number of scientific publications in 11 fields and a data set on absolute number of patents for the manufacturing sector on the basis of the European Patent Office (EPO), for the EU27 in the period 2000-2005. In many cases, scientific publications have been used as a proxy, but it is also likely to use both input and output indicators, such the R&D expenditure as a share of the GDP or the personnel devoted to R&D (2009b). On his side, Lee (2011), also using the Balassa index, on a sample of 71 countries since 1970, found that economies tend to grow faster is they specialize, especially in high-technology as opposed to low-technology goods.

Other empirical methodologies have been also used. For instance, Hallet (2000) uses an index for regional specialization consisting in the absolute difference between the sectorial share of a specific branch in a specific region and the respective EU15 average, which takes value 0 if the productive structure of the region is identical to the EU15 average, and takes value 1 is it is completely different;

values in between show intermediate solutions. Through this analysis, he found that 34 regions became more specialized in the period 1980-1995, while 85 became less specialized.

On his side, Aiginger and Davies (2004) consider the Entropy index, which consists in the addition of the products of the shares and log shares of each industry in the state's aggregate manufacturing, being the index higher when the state spreads its activities across the different industries. He found that specialization had risen in most of the countries considered. Another index is Theil's; the absolute index indicates the deviation from the uniform distribution of regional economy activity across industries, and the relative, which measures inequality with respect to the overall distribution of the regional economic activity. This index was used, for example, in De Benedictis et al. (2009).

Another index that has also been used to measure specialization is the Kurgman index, also used to measure concentration. It was used by Combes and Overman (2003) and it takes a value 0 if a specific location has an industrial structure identical to that of the rest of the EU and it rises the more divergent it is up to a 2. Helpman (1998) focused in the Krugman model to measure specialization, building into a structure in which endowments are allowed to matter at one level of aggregation. Additionally, other measures have been used, but Balassa is still the most used proxy. Dalum et al. (1999), to put a last example, analyzed a data set consisting in 11 manufacturing sectors for the period 1965-1988 in the OECD countries, and they concluded that specialization matters for growth, but this impact decreased during the latest period of time.

1.4. Objectives, research questions and propositions

1.4.1. Objectives of the thesis

As we have already mentioned, the thesis intends to analyze whether the preexisting patterns of specialization and the institutions related to smart specialization are related to design and implementation of the regional strategies. In this framework, we establish 5 main objectives aiming to analyze it from both qualitative and quantitative points of view.

Objective 1: Provide a new, homogeneous and comprehensive overview of the specialization patterns in the EU regions, for both scientific and industrial activities.

As we have seen in the previous section, specialization has been studied in the literature, for many countries and regions in the world, including the EU. However, there are no studies that introduce both science and industry at the same time, establishing a common denominator for all regions to be able to compare. The smart specialization strategy has a strong bottom-up component, following the entrepreneurial process, but a top-down approach, establishing whether there are existing specialization trends or not, is crucial before measures are designed towards this policy, since methods may change a lot depending on whether it starts from scratch or from existing patterns from which the strategy should take advantage.

Objective 2: Evaluate whether there are preexisting specialization trends in the EU regions or not.

Providing an overview of the specialization patterns in the EU regions is not enough. Our main goal is to identify preexisting trends which are to be taken into account when designing the regional smart specialization strategies. Related to this objective there is a clear relation between chapter 2, where we will analyze the specialization patterns, and chapter 4, where some regional proposals around this policy will be evaluated, allowing us to see whether the policy makers are considering these trends when defining their strategy.

Objective3: Establish whether the existing specialization patterns in the EU regions are consistent enough to be taken into account when defining measures towards the smart specialization strategy.

Identifying specialization patterns may be rather easy, since data usually allows having some conclusions on a topic. However, what really matters is whether these conclusions are significant or not. We aim to evaluate this statistical significance so we can be able to judge up to which point data must be used when designing the regional strategy. Additionally, it is also important to see if the consistence of the patters identified can be generalized to all the EU regions or if some of them, depending on their size or structure, present differences and biases.

Objective 4: Evaluate whether the comparisons among regions can be homogeneously done or if some other criteria must be applied.

Related to what was explained in the previous objective, we need to have in mind that not all regions are the same, especially when considering its structure and, even more important in our comparison, their size, i.e. depending on the population and the associated number of institutions they have, regions differ in absolute terms (in our case in the number of scientific articles and employees, respectively), and these differences may lead to heterogeneous results which must be evaluated in order to define the type of comparisons that we can do among different size regions. These differences must be taken into account when defining a proper strategy since patters may largely differ depending on each region characteristics.

Objective 5: Analyze whether a top-down approach for deciding the specialization fields / sectors is easy to be applied or not.

This is probably the most important objective of the whole thesis. As most of the bibliography around the concept of smart specialization points out, this policy must be based on the entrepreneurial discovery process; however, it is rather obvious that the strategy is being defined by policy makers which point of view is more related to a top-down approach. Even if some measures are being taken for this entrepreneurial discovery process to take place, analyzing preexisting patters and identifying their significance is also essential when establishing some priorities in terms of scientific and industrial fields and sectors. We aim to see if this top-down approach based on these specialization trends is consistent enough to be presented as a first-class variable when defining and implementing the regional strategies.

1.4.2. Research questions

According to the methodology that we will use for our study, based on Yin (1994), we need to establish some research questions in which we can build our propositions. This methodology is properly described in the next section. Taking into account the objectives that we have defined, these main questions are the following.

Research question 1: Are there preexisting specialization patterns in the EU regions regarding the scientific and industrial activities?

We aim to see whether there are relevant specialization trends in the EU regions or not. Using the methodology summarized in section 1.5 and explained in chapter 2, we will be able to identify in which scientific fields and industrial sectors each region should specialize when comparing most of them. The indexes of specialization will let us know the regional comparative advantages that we will use to identify leaders and followers for each field and sector.

Research question 2: Are these patterns (in case there are) statistically significant to be considered in a top-down approach of the strategy?

As we have already mentioned, it is not enough having indexes telling us the existing regional comparative advantages, we need to know if these indexes are large and consistent enough to be taken into account by the policy makers when defining their regional smart specialization strategy, establishing some priorities related to these results. Many biases may appear and they must be taken into account, as it will be explained in chapter 2.

Research question 3: Should large and small regions (in absolute terms for scientific articles and number of employees) be compared independently or not?

Large biases may be present when comparing large regions to small regions regarding to the intensity in science and industry. Because of this, we must evaluate whether is possible to compare all regions at the same time. In chapter 3, instead of doing it, we will only compare 12 of the largest EU regions aiming to see if an independent analysis leads us to clearer specialization patterns, with more significant indexes.

Research question 4: Are the institutions and entities linked to innovation, science and technology in the EU regions linked to the framework defined under the smart specialization strategy?

Specialization patters should not be difficult to find, even if, as we have said, results must be properly interpreted. However, we must make sure that institutions related to innovation, R&D and other topics linked to the smart specialization strategy are aligned to its contents. In chapter 3 we aim to evaluate this issue by entering in detail to the institutions of 12 of the largest EU regions (in absolute terms for science and industry) and their relation to the strategy.

Research question 5: Do the already existing regional proposals towards the smart specialization strategy take into account the specialization patterns coming from a general comparison with the other EU regions?

In chapter 4 we will examine 30 regional proposals towards the design and implementation of the smart specialization strategies and we aim to see if these proposals, which are supposed to present some priorities in which the region wants to specialize, according to their comparative advantages, take into account not only their strengths but also the conclusions coming from a more general comparison with as many regions as possible in order to promote the desired efficiency.

Research question 6: Does specialization seem to be the right policy for the EU regions or diversification would be a more certain bet?

The smart specialization strategy aims to put some limits to the generalized *café para todos* (coffee for everyone) that has been traditionally used when subsidizing the European regions. However, some academics, experts and policy makers consider that diversification is much better from an economic point of view, since it reduces risk and may generate growth from many areas instead of a few. We aim to know whether specialization seems to be consistent enough to say that preexistent trends endorse choosing this strategy in front of diversifying.

1.4.3. Main propositions to be contrasted

Following the objectives of the thesis, and the research questions coming from them, we now present the main propositions that we aim to contrast through the studies and analysis on the three central chapters of this work.

Proposition 1: There are some specialization trends in the EU regions regarding their scientific and industrial activities but, in most of the cases, they are not significant enough.

We aim to evaluate the specialization patterns within the EU regions. It seems clear that we will be able to identify some trends, since we have the date to study the comparative advantages. However, we also face the fact that, probably, in most of the cases, the indexes of specialization are not significant enough to make strong conclusions. We shall evaluate this proposition in order to contrast the following ones.

Proposition 2: It is possible to establish leaders and followers for every scientific field and industrial sector, but there exist many biases to be taken into account.

It is not only possible to identify some trends of specialization, but it is also feasible to decide, for every scientific field and industrial sector, which regions are leaders (those with a largest comparative advantage) or followers (with less comparative advantage). However, the fact that regions are very diverse among them, with very different characteristics, makes the results influenced by some biases that must be analyzed.

Proposition 3: There is not a large correlation between the scientific production in some fields for a region and the industrial sectors to which these fields should be linked to.

It could seem that if a region has some strength in a scientific field (for instance, agriculture and food technologies), the industrial sectors linked to it (food industries, following the same example) should also be strongly present. Nevertheless, this relation is not that clear according to the literature. Even if this study is not the main pillar of the thesis, we aim to take advantage of the data we have to also study this relation according to the smart specialization strategy and its implications.

Proposition 4: Specialization patterns are biased by concentration, since for both scientific and industrial activities, indexes are high.

As we have seen in section 1.3, specialization is highly linked to concentration. The separate analysis of these two concepts can be hardly undertaken, so we consider that the latest has a large impact on the first. This affectation seems to also take place in the European regions, and it must be analyzed and discussed to evaluate its effects.

Proposition 5: Larger regions (in absolute terms) present lower indexes of specialization, meaning they have a larger rate of diversification.

Larger regions are expected to present a higher degree of diversification, since their critical mass allows them to have a larger number of actors (understood as companies, universities, research centers, etc.) in many different fields and sectors. In this framework, smaller regions (taking into account their number of employees and scientific publications) should present a higher specialization indexes, facilitating top-down points of view.

Proposition 6: Regional institutions are, in general, aligned to the patterns of regional specialization, when we consider them as a whole.

If, instead of analyzing institutions one by one, as we will do in chapter 3, we evaluate them in an aggregated way, we can expect to see that there is, in general, a common trend regarding the specialization patterns of the region. This means that, if a region presents some specialization trends in a sector, even if, of course, some institutions are not linked to it, in a general overview we will find that the region presents positive biases towards that sector.

Proposition 7: Even if, as a whole, regions are in general ready to implement a smart specialization strategy, individual regional institutions are still far from being aligned to its main goals.

As stated in the literature review, regional innovation systems are complex and very diverse across Europe. This conclusion leads us to think that maybe some regions are better prepared to implement the policies related to the smart specialization strategy than other, but, in general, they are probably ready for that, in a higher or lower degree. However, differences among regional institutions are much larger and, analyzed one by one, they are probably far from being completely in lined up to the strategy.

Proposition 8: Designs of regional smart specialization strategies can easily incorporate some priorities based on cross-border analyses on scientific and industrial activities.

From a top-down point of view, it should not be so difficult to identify some regional priorities, based on measurable results and data pulls coming from scientific and industrial outputs. These priorities should be also easy to compare to other regions applying the same logic and analyzing their own contexts. To contrast this proposition we will focus in the descriptive analysis on 30 proposals for regional smart specialization strategies.

Proposition 9: Smart specialization, when analyzed from a top-down perspective, taking into account the specialization patterns, seems to be able promote efficiency in front of diversification in the EU regions, according to the existing trends and the framework in which it will operate.

This is the latest but the most important proposition of all. We aim to see if, given the specialization patterns of the EU regions, the structure of the institutions linked to science and industry, and the first approaches to the smart specialization strategies that some regions have presented, it is possible (or not) to state that this framework leads us to think that the policy will lead to a more efficient system than another based on diversification.

1.5. Methodology

As we have seen in the previous sections, the smart specialization strategy is still a new concept that has not yet been much studied in the literature. Additionally many concepts are linked to it and it is difficult to perform an analysis excluding most of these topics, since they have some affection on the strategy. Moreover, the lack of proper data to be analyzed makes even harder the evaluation of the specialization patterns around the smart specialization strategy as a whole.

Because of this, we have considered that the methodology must be based on the case study approach, following the points that will be announced in the next subsection, but also including a quantitative approach, aiming to analyze data that will support the arguments in our work.

Case methodology allows us to choose among very diverse approaches, including the development of case studies, interviews, literature reviews, or real cases analyses, among other. In this framework, we have analyzed the context in which we operate regarding the current state of development of the concept that we are analyzing and we have concluded that, at this point, more descriptive analyses are still needed when aiming to build around it. In this direction, even if we could have chosen other approaches from the list, objectiveness and logic tells us that the path we must follow includes:

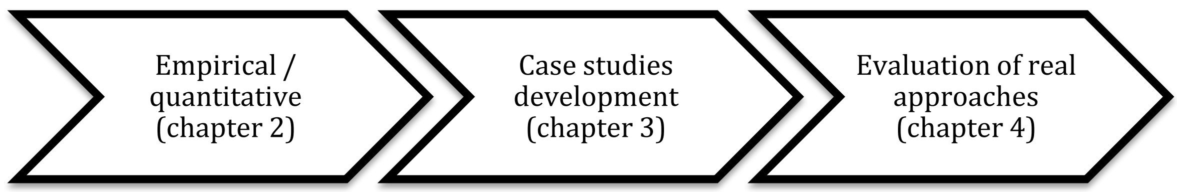
- Empirical approach to support case study descriptions: we use data sets for the starting basis of our research, since we want first to evaluate empirical results towards the definition of propositions.

- Descriptive case studies to be put as examples: we evaluate empirical results through some case studies, to be able to see whether they fit within the boundaries established by data.

- Analysis of real existing approaches: we finally want to contrast if the empirical analyses and the descriptive case studies fit within the real framework of RIS3 development in Europe.

These three approaches follow a logic pat, as presented in figure 1.5.1. First we must provide and aggregated point of view, focusing on determine whether there are (or not) pre-existing and evidenced patterns of specialization for both science and industry in the Union's regions. Of course, if we had found that there is not, following the research ex-post would have been not just unnecessary, but useless. This logic validates both methodologies and procedures.

Figure 1.5.1. Thesis' methodological path



Soure: Own elaboration

The case methodology, and the methodological procedures (that we introduce here but which will be further developed in the three following chapters) that we have chosen are to be those allowing us to establish some conclusions following the objectives, research questions and propositions that we have presented before.

1.5.1. The case study methodology with a quantitative approach

Taking into account the literature of case study, and according to Yin (1984 and 1994), its methodology must be preferably used when what matters are the “how” and the “why”. In our study, the “why” comes from the ex-ante definition around the efficiency that is aimed through the implementation of the smart specialization strategy, and which has been largely described in all documents referring to this policy. However, in our study we will focus in the “how”; we aim to see, from a top-down perspective, how easily the strategy can be designed according to the current pre-existing specialization trends in the European regions, which must be used to define the priorities of each region towards the implementation of the strategy.

Yin (1984 and 1994) adds that, if we include some case study components, its structure must comprise 5 main points: the research questions, the propositions, the units of analysis, the links between the propositions and the data that we use, and the criteria that we will use to interpret the results. Following this order, and according to the objectives of the thesis, we identify here these 5 points to develop the case study:

Research questions: they were presented in section 1.4 and they aim to be the key elements to define the thesis’ propositions. Research questions have been designed in order to lead the objectives towards these propositions, making it from a clear and comprehensive way, allowing characterizing the main interrogations to which we musty refer.

Propositions: presented also in section 1.4, the thesis proposition’s aim to be the base of the study, being the precepts to be contrasted through the analysis that we will undertake in chapters 2 to 4. These propositions are designed to cover the main issues to which we aim to provide an answer in order to get the main conclusions for our work.

Units of analysis: our units of analysis are the base of our research, and they become the necessary proxies to talk about specialization patterns. Since we aim to find evidences of these trends for both the scientific and the industrial activities, we will use two main observable proxies: the scientific articles classified by research fields and the number of employees by industrial sector.

Links between the propositions and the data: data is completely linked to the propositions, since they have been designed given the available statistics, which has led us to design the main sections of the thesis and be the support for all the rest.

Criteria to interpret the results: the criteria that we will follow is the one that comes from the concept of smart specialization itself, since we will use the definitions and arguments used in the guides and other documents related to this strategy.

Considering Guba and Lincoln (1981), there are different types of case studies, which can be mostly categorized in factual, interpretative or evaluative. According to this classification, our study becomes both factual and interpretative, but not evaluative, since the development of the regional strategies is still to be undertaken. We will focus in facts, since we will analyze data on scientific articles and employees, as proxies for the scientific capacities and the industrial activities in each region, and we will evaluate this data and the results we obtain form its analysis, in order to see whether the pre-existing patterns fit the concept of smart specialization. A similar classification is used by Mariano (1993), dividing the case studies into exploratory, descriptive, interpretative and explanatory. According to this, we may consider our study as descriptive, since we describe, especially in chapter 3, the regions regarding their specialization patterns, and interpretative, given that we aim to give some interpretations to the results that we obtain from our analysis on the available data.

1.5.2. Summary on chapters' methodological procedures

The procedures that will be used for the analysis in each chapter will be described at the beginning of each one. This section only aims to offer a general overview on it.

Chapter 2: Scientific and industrial specialization patterns in the European Union regions

To develop an analysis around the scientific and industrial specialization patterns, we needed a pool of data at a regional level that could be defined as a proxy to identify these patterns. While for the industrial activities we used the number of employees by sector (data available on Eurostat), we found that there was not a proper data base homogeneous enough to compare across the EU regions considering their scientific activities. This is the reason why a new data base, based on the published scientific articles by field, has been created with this purpose. The methodology to create this data base is explained in chapter 2.

We have chosen the Balassa index as a proxy to establish specialization patterns. We have selected this index for it is the most used in the literature, and this can facilitate comparisons with results coming from other studies. Our analysis will be undertaken separately for scientific and industrial activities and we will establish a research field and an industrial sector for each region, according to their specialization patterns.

After this main analysis, we will measure the correlations between the scientific and the industrial activities (using the same data bases), in order to see whether the scientific intensity for a field is related to an industrial sector. To do this study, we will use simple econometric models, which will provide correlation indexes and statistical measures.

Finally, in section 2.4, we will focus more in the concentration aspects. We choose the Gini index as the proxy to measure concentration, since it is a well-known index and the most used for those studies that require concentration analyses. Some articles using the Gini index have been mentioned in subsection 1.3.2.

Chapter 3: Overview of twelve European Union regions in the framework of the smart specialization strategy

Chapter 3 is mostly based on 12 brief study cases on 12 EU regions. These 12 regions are selected according the procedures described in chapter 3's introduction, with the goal of comparing similar regions (in absolute terms related to the number of employees and articles published). The 12 largest regions of the 12 largest states are selected with this goal. We also use Balassa's index to determine their specialization trends when considering only these 12 regions.

We will analyze the main institutions for each region to see how well these patterns in the general purposes of the smart specialization strategy. We will describe and study the main universities and research centers of a region, as well as their industries, we will put some examples on large companies and clusters, and we will take a look at the agencies devoted to promote regional innovation.

At the end of the chapter, we aggregate the information obtained from the individual analyses and we aim to see how ready these regions are to undertake the smart specialization strategy.

Chapter 4: Benchmarking of regional proposals towards the smart specialization strategy

The procedure for this chapter is mostly based on a descriptive approach. We establish 3 main aspects to be analyzed in order to compare among the 30 regions that we evaluate. We pull out information from these 30 regions presentations, which aim to provide the regional first approach to the smart specialization strategy. We also want to see whether these proposals fit in the general framework of the policy, from a more qualitative approach.

2. Analysis of the scientific and industrial specialization patterns in the European Union regions

When referring to the smart specialization strategy (S3) the first question that comes to mind is: "Does data consistently prove the hypothesis that regions are able to specialize according to their critical mass?". Before analyzing any other variable it is obvious that we need to know the specialization potentialities of regions in terms of their scientific production and their industrial activities. There have been some attempts to analyze it from many different point of views: evaluating clusters and concentration, like Sölvell, Ketels and Lindqvist (2008) or Hallet (2000), comparing industrial structures in regions and countries, like Davis and Weinstein (1999), or taking into account the trade models, like De Benedictis, Gallegati and Tamberi, M. (2009) or Rossi-Hansberg (2005). However, none of them deeply compares proxies on non-industrial R&D and industrial activities at the same time. The European Commission has been working on providing better overviews through different reports which establish the basis for further research. Some examples are European Commission (2009a, 2009b, 2010), but still more research is needed.

The main aim of this chapter is to provide a descriptive but also analytic perspective of the European regions' capacities compared to the other, in terms of both absolute and comparative advantage. It first takes into account absolute data (number of scientific articles for each research field and number of workers for each industrial sector) while second evaluates it in relative terms, comparing regions among them, using Balassa's index as a proxy for specialization.

Measuring specialization: the Balassa index

The Balassa index was used by the author from who the index takes its name, B. Balassa, in 1965 when he published *Trade Liberalisation and "Revealed" Comparative Advantage*. This concept of Revealed Comparative Advantage (RCA) is the concept from which the index is developed, aiming to provide a proxy to define in a country would be more specialized according to its exports, compared to the other countries levels for different commodities, i.e. to define its RCA.

Balassa's article analysis and results were completely focused on international trade; however, many authors have adapted Balassa's index for other purposes, always aiming at comparing the specialization compared to others. In our case, we will adapt the index variables to define the proxy that we will use to compare the European regions in terms of their scientific capacities and their industrial activities. The Balassa index (the RCA proxy) is thus the following:

$$RCA_{ir} = \frac{x_{ir}/X_r}{x_{ie}/X_e}$$

RCA_{ir} : RCA (Balassa index) for region *r* and research field or industrial sector *i*
x_{ir} : number of articles or employees in region *r* for a research field or an industrial sector *i*
X_r : total number of articles or employees in a region *r*
x_{ie} : aggregated number of articles or employees in all regions (*e* for Europe) for a research field or an industrial sector *i*
X_e : total number of articles or employees in the aggregated regions

Even if other proxies could be used to measure specialization, we have chosen the Balassa index given its simplicity and concretion at the same time when allocating a research field or an industrial sector to a region. This formula is the simplest one for the Balassa index; some modifications have been introduced by other authors, but we are not using them since it complicates the study and the conclusions would not be different.

Data around scientific and industrial capacities comes from different sources. While for measuring industrial capacities we just need to use available Eurostat data (which is already available at regional level), to analyze research we created a completely new data set, since there was no available data source at regional level. Methodology used for each analysis is described in each section. Regions are described using the NUTS2 classification of Eurostat (except for Germany and the UK, where NUTS1 are used to adapt it to their regional main system). Croatia has not been included, since data is from 2012, before the adhesion of this state to the EU.

Section 2.1 describes, compares and analyses the research capacities of the European Union regions. The section presents a list of twelve main research fields and, using the Balassa index, compares them all across the regions aiming to identify which regions are most specialized in each field. Our goal is to be able to identify which region has a better basis to perform R&D activities in each of the twelve listed research main fields. Section 2.2 follows the same structure, but instead of analyzing the specialization in research we look at the industrial activities of the European regions. Additionally to the evaluations of research capacities and industrial activities independently, this chapter includes an analysis on the existing correlations that appear between both subjects. We aim to analyze if the apparently obvious correlations between scientific fields and industrial sectors do exist. However, as we will see, the correlations are not as obvious as they may seem.

This chapter also includes a brief analysis on the concentration in scientific and industrial activities, since it is important to be concrete when differentiating between specialization and concentration. As we will see, the study of the concentration has had the attention of many researchers in the field of the geography economics in the last years, looking to identify the spillovers derived from the concentration.

At the end of the chapter, and after analyzing all these points, we will provide a general overview for every region, according to their specialization trends. We aim to define which are the main strengths of the regions in terms of research and industrial activities, and identify whether they are to be leaders in the field, doing more basic research, or followers, in charge of developing applications and new technologies in the different sectors. As stated on the introductory chapter, we do not aim to say whether the regions should specialize in the fields we propose or not. We look for identifying potential pre-existing specialization trends in these regions according to the available data and the comparison among them.

2.1. Specialization patterns for scientific activities

Research must be understood as the base on which all the knowledge structure is generated, knowledge that potentially will be transferred to the industry and, in more general terms, the society. It is for this reason that it is necessary to know and to understand which are the research capacities in the European regions, trying to identify their strengths but also their weaknesses regarding the different research fields. This section aims to offer a complete vision, descriptive but detailed, of the research capacities for the European Union regions, using a new obtained data base which has never been used before.

Data base and methodology

Most of the authors who have studied the research capacities related to their location have been taking into account the scientific publications and the authors' institution origin. The problem they have faced is the fact that there is not any available and complete data base, filtered by regional information and research field. Because of this, most of the studies analyze it comparing states or only for a few concrete regions, given the difficulty to access data at disaggregated levels.

The methodology used to obtain the data that we are going to use in the most objective and reliable way is the following. First at all, the information source that we have used is Thomas Reuters' data base, which is taken as a referent by a large number of authors when doing their studies and which is in a leader position for the compilation of information about research. Publications have been filtered by typology and we are only going to take articles to avoid potential duplications and due to the fact that articles represent globally the scientific results. Thomas Reuters' software allows filtering by countries, but not by regions.

In order to obtain regional data, what have been done is to take in consideration the institutions from which authors sign their articles, observing where this institution is located at regional level. We have not taken into account those institutions that have different research centers located in different regions like, for example, CSIC in Spain and CNRS in France. However, in average, the new-obtained data base has, in most of the cases, more than 80% of the total articles of the country where they belong. Thus, for example, if we analyze the Belgian regions, once their articles have been filtered by institutions and these institutions have been associated to their regions, these articles represent around 88% of the scientific production for Belgium, which is statistically strongly representative. It is true that this methodology may present some biases, but from a logical point of view it appears to be the most reliable and concise, and it is the one that has been used by some authors or documentation centers when performing their analysis for a specific region, but it has never been done for this large amount of regions. The period analyzed is 2007 – 2011 (data was obtained in July 2012).

Some regions have not been contemplated for the analysis. The reasons why is that, in order to consider a region, the research performed by the institutions located there had to be of, at least, 500 scientific articles. It appeared to be statistically not significant enough if we compared it to the other regions. This is the reason why we only take into account 169 of the 221 European regions.

Finally, it must be said that this study only analyzes the information contained on the Thomas Reuters' Web of Science, which only takes into account those publications in the fields related to science and technology, excluding those in the fields of social sciences and humanities, which are not in this study since it is more difficult to analyze their impact on the industrial activities, which is the main aim at this point of the study.

The results

Results take into account the methodology specified at the previous introduction, where the concepts of absolute and comparative advantages are described (defining the Balassa index). All the following subsections expose the results for each scientific field that we analyze. First at all, information is presented in tables like this one:

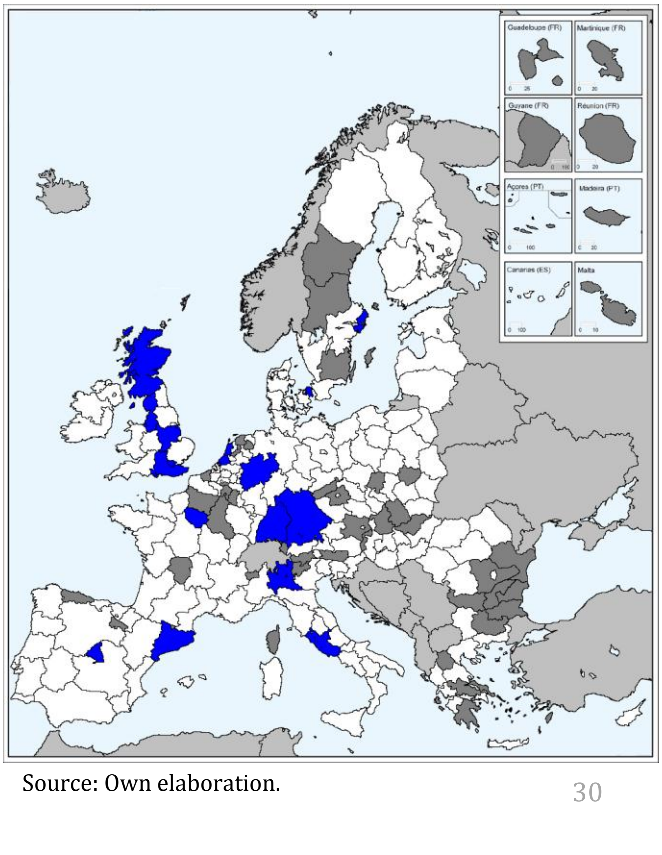
Absolute terms	Comparative Advantage	Absolute + Comparative
It contains the list of the top 10 regions in Europe which have absolute advantage for the research topic on which the analysis is based. Thus, it measures the total output, the quantity.	It contains the list of the top 10 regions in Europe which have comparative advantage (using the Balassa index as a proxy) for the research topic on which the analysis is based. Thus, it measures the specialization.	It contains the list of the regions which are, at the same time, in the top 10% of regions with absolute advantage and in the top 10% of regions with comparative advantage.

After the table it is possible to observe a map, the legend of which is the following:

- Top 10% regions with absolute advantage.
- Top 10% regions with comparative advantage.
- Regions which are in the top 10% for both absolute and comparative advantage.
- Regions not taken into account for the study.

The following map presents the top 10% regions in absolute terms, i.e. the best top 10% regions from an absolute advantage point of view. Thus, these are the regions with a largest mass of scientific publications in the European Union, shaping EU's scientific hubs. For more detailed information check the annexes.

Figure 2.1.0. Top 10% regions performing research in absolute terms (number of scientific articles) 2007 – 2011.



Source: Own elaboration.

As it is observable on the map, the top 10% regions performing scientific research using as a proxy the number of articles are (in order more to less articles), for the period 2007 – 2011:

- Île-de-France (France)
- London (United Kingdom)
- Baden-Württemberg (Germany)
- Bayern (Germany)
- Nordrhein-Westfalen (Germany)
- South East (United Kingdom)
- Scotland (United Kingdom)
- Lombardia (Italy)
- Hovedstaden (Denmark)
- Catalunya (Spain)
- Lazio (Italy)
- East of England (United Kingdom)
- Zuid-Holland (Netherlands)
- Noord-Holland (Netherlands)
- North West (United Kingdom)
- Comunidad de Madrid (Spain)
- Stockholm (Sweden)

2.1.1. Agriculture, food sciences and fisheries

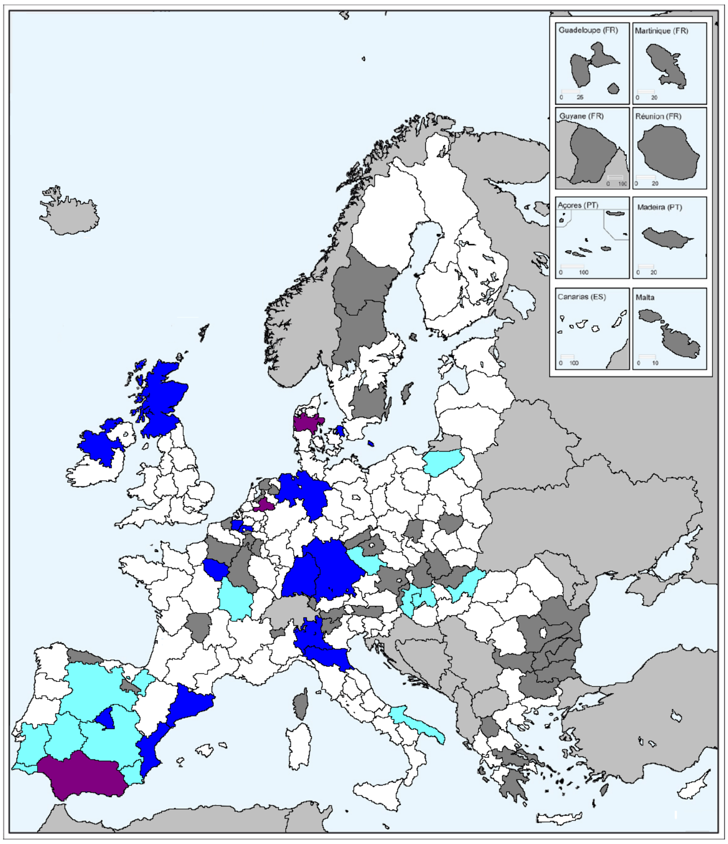
The analysis includes all articles in the fields of sciences and/or technologies related to the agriculture or fisheries, as well as the research devoted to food sciences. In number of regions in absolute terms, Spain, Germany and Italy have the largest share of articles, while in terms of comparative advantage, Spain and Hungary are the most specialized.

Table 2.1.1. Top 10 regions performing research in agriculture, food sciences and fisheries in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Île-de-France (France) ❖ Gelderland (Netherlands) ❖ Andalucía (Spain) ❖ Hovedstaden (Denmark) ❖ Border, Midland and Western (Ireland) ❖ Catalunya (Spain) ❖ Comunidad Valenciana (Spain) ❖ Midtjylland (Denmark) ❖ Baden-Württemberg (Germany) ❖ Prov. Oost-Vlaanderen (Belgium)	❖ Nyugat-Dunántúl (Hungary) ❖ Warminsko-Mazurskie (Poland) ❖ Algarve (Portugal) ❖ Alentejo (Potugal) ❖ Gelderland (Netherlands) ❖ Extremadura (Spain) ❖ Región de Murcia (Spain) ❖ Midtjylland (Denmark) ❖ Castilla-la-Mancha (Spain) ❖ Jihozápad (Czech Republic)	(Regions with the top 10% for both absolute terms and comparative advantage) ❖ Andalucía (Spain) ❖ Gelderland (Netherlands) ❖ Midtjylland (Denmark)

Source: Own compilation and analysis; data from Thomson Reuters – Web of Science data base.

Figure 2.1.1. Top 10% regions performing research in agriculture, food sciences and fisheries (2007-2011). List in annex A.



Source: Own elaboration.

The top 10 regions performing research in these fields aggregate more than 18.000 articles in 5 years, around 31% of the whole mass for the totality of the analyzed European regions. If we extend it not just to the top 10 but to the top 10%, this percentage arises to 44%, which proves that the list of regions provided, as well as the information on the map, is statistically robust enough to state that these regions strongly represent the whole research in the European Union for agriculture, food sciences and fisheries.

In relative terms, it is important to underline that the region of Nyugat-Dunántúl has a Balassa index higher than 12, the region of Warminsko-Mazurskie an index of 8, and the region of Algarve an index of 5.1; the rest of the top 10 regions have indexes from 3.2 to 4.2. Taking into account the top 10% (17 regions), 6 of them are in Spain, which makes this country the leader in this field in relative terms, sharing its success with the Hungarian regions.

2.1.2. Biology sciences, biotechnology and biomedicine

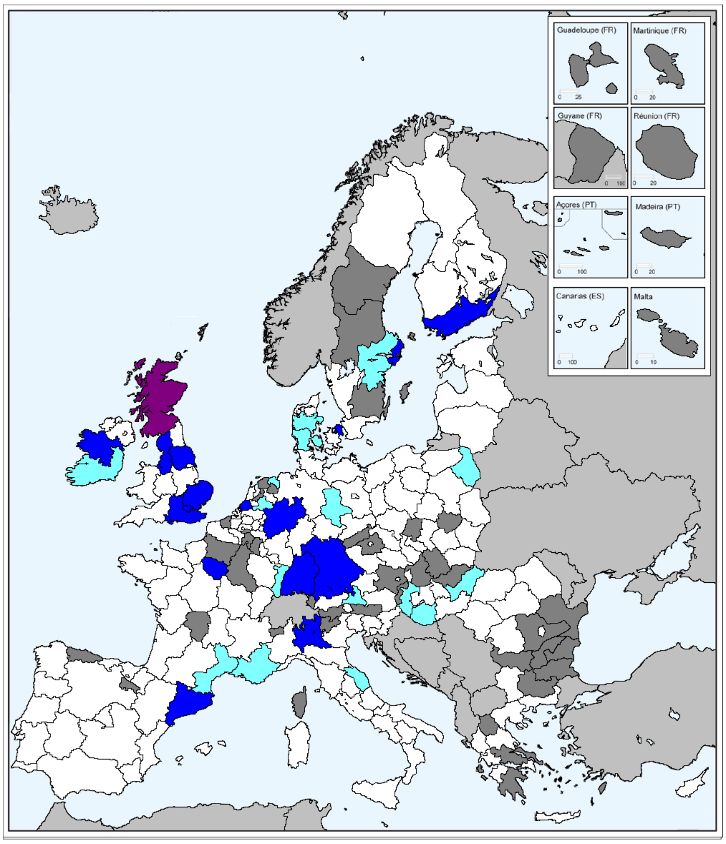
The analysis includes all articles in the fields of biology sciences, including all fields related to biotechnology and biomedicine. Denmark, Germany and the United Kingdom have the largest concentration and specialization rates for these fields (in terms of articles), but it is also important the performance of countries like the Netherlands, Hungary or France.

Table 2.1.2. Top 10 regions performing research in biology sciences, biotechnology and biomedicine in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Île-deFrance (France) ❖ London (United Kingdom) ❖ Bayern (Germany) ❖ Baden-Württemberg (Germany) ❖ Scotland (United Kingdom) ❖ South East (United Kingdom) ❖ Nordrhein-Westfalen (Germany) ❖ Hovedstaden (Denmark) ❖ East of England (United Kingdom) ❖ Catalunya (Spain)	❖ Salzburg (Austria) ❖ Sothern and Eastern (Ireland) ❖ Groningen (Netherlands) ❖ Alsace (France) ❖ Dél-Dunántúl (Hungary) ❖ Nyugat-Dunántúl (Hungary) ❖ Languedoc-Roussillon (France) ❖ Syddanmark (Denmark) ❖ Provence-Alpes-Côte d'Azur (France) ❖ Gelderland (Netherlands)	(Regions with the top 10% for both absolute terms and comparative advantage) ❖ Scotland (United Kingdom)

Source: Own compilation and analysis; data from Thomson Reuters – Web of Science data base.

Figure 2.1.2. Top 10% regions performing research in biology sciences, biotechnology and biomedicine (2007-2011) List in annex A.



Source: Own elaboration.

The top 10 regions performing research in these fields aggregate around 98.000 articles in 5 years, around 31% of the whole mass for the analyzed European regions. If we extend it not just to the top 10 but to the top 10%, this percentage arises to 42%, which proves that the list of regions provided, as well as the information on the map, is statistically robust enough to state that these regions strongly represent the whole research in the European Union for biology sciences, biotechnology and biomedicine.

In relative terms, we must take into account the Balassa index, which shows that the comparative advantage for this research field is much less concentrated. The region with a highest index, Salzburg, presents a value of 1.8, and the rest of the top 10 regions have values from 1.4 to 1.6. This fact must be had in mind when analyzing the leaders and followers for these research fields, since none of the regions presents a large difference compared to the others.

2.1.3. Chemistry

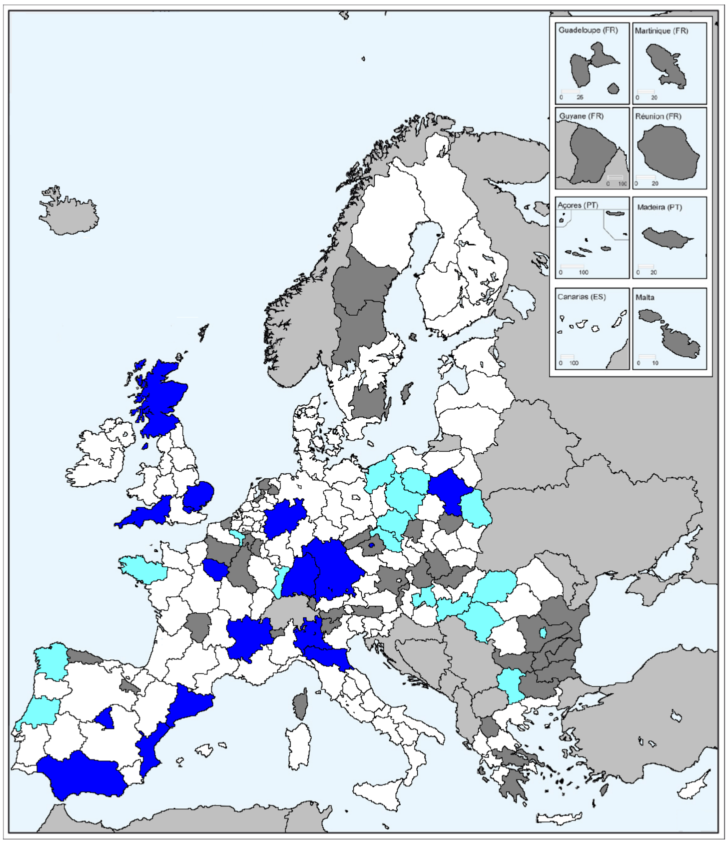
The analysis includes all articles in the field of chemistry. In absolute values, the United Kingdom, Germany and Spain have the largest share of scientific articles, while, in relative terms, Poland and Romania appear to be the most relevant countries. In this field no region has, at the same time, absolute and comparative advantage.

Table 2.1.3. Top 10 regions performing research in chemistry in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Île-deFrance (France)	❖ Severovýchod (Czech Republic)	(Regions with the top 10% for both absolute terms and comparative advantage)
❖ Nordrhein-Westfalen (Germany)	❖ Lubelskie (Poland)	No regions.
❖ Bayern (Germany)	❖ Nord-Vest (Romania)	
❖ Baden-Württemberg (Germany)	❖ Zachodniopomorskie (Poland)	
❖ South East (United Kingdom)	❖ Bretagne (France)	
❖ Catalunya (Spain)	❖ Közép-Dunántúl (Hungary)	
❖ Praha (Czech Republic)	❖ Alsace (France)	
❖ Mazowieckie (Poland)	❖ Prov. Hainaut (Belgium)	
❖ Rhône-Alpes (France)	❖ Wielkopolskie (Poland)	
❖ London (United Kingdom)	❖ Dolnoslaskie (Poland)	

Source: Own compilation and analysis; data from Thomson Reuters – Web of Science data base.

Figure 2.1.3. Top 10% regions performing research in chemistry (2007-2011). List in annex A.



Source: Own elaboration.

The top 10 regions performing research in this field aggregate around 54.300 articles in 5 years, around 25% of the whole mass for the totality of European regions. If we extend it not just to the top 10 but to the top 10%, this percentage arises to 35%. It evidences the advantage of these regions when considering the research in chemistry. Île-de-France has more than 8.000 articles in the field (2007-2008), and the three main regions of Germany performing chemical research aggregate more than 19.000 articles (8.7% of the total scientific production in the field).

In relative terms, the Balassa index shows that, for research in chemistry, the comparative advantage for this research field is more concentrated than in the case for biosciences but less than in agronomy and food sciences. The region with a highest index is Severovýchod with a value larger than 4.6. The other 9 regions on the top 10 have values from 2 to 2.6.

2.1.4. Information and communication technologies (ICTs), computing and imaging

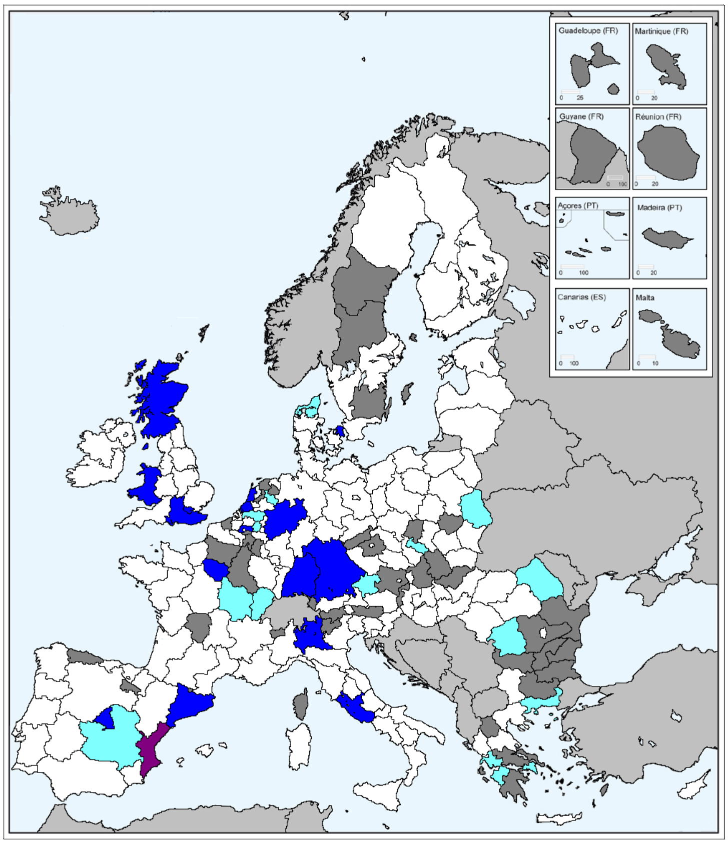
The analysis includes all articles in the fields of information and communication technologies (ICTs), computing and imaging. In absolute terms, the United Kingdom, Germany, Spain, and the Netherlands have the largest share of scientific articles; relatively, Greece, the Netherlands, France, Spain and Romania perform better. Comunidad Valenciana is the only region on the top 10% in absolute and relative terms.

Table 2.1.4. Top 10 regions performing research in ICTs, computing and imaging sciences in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Île de France (France) ❖ London (United Kingdom) ❖ Baden-Württemberg (Germany) ❖ Bayern (Germany) ❖ South East (United Kingdom) ❖ Scotland (United Kingdom) ❖ Nordrhein-Westfalen (Germany) ❖ Lombardia (Italy) ❖ Comunidad de Madrid (Spain) ❖ Catalunya (Spain)	❖ Nordjylland (Denmark) ❖ Voreio Aigaio (Greece) ❖ Lubuskie (Poland) ❖ Kypros (Cyprus) ❖ Nord-Vest (Romania) ❖ Noord-Brabant (Netherlands) ❖ Overijssel (Netherlands) ❖ Prov. Limburg (Belgium) ❖ Dytiki Ellada (Greece) ❖ Anatoliki Makedonia, Thraki (Greece)	(Regions with the top 10% for both absolute terms and comparative advantage) ❖ Comunidad Valenciana (Spain)

Source: Own compilation and analysis from Thomson Reuters – Web of Science data base.

Figure 2.1.4. Top 10% regions performing research in ICTs, computing and imaging sciences (2007-2011). List in annex A.



Source: Own elaboration.

The top 10 regions performing research in this field aggregate around 43.000 articles in 5 years, around 27% of the whole mass for the totality of European regions. If we extend it to the top 10%, this percentage arises to 39%, i.e. there is an important concentration in a few regions of the publications in information and communication technologies (ICTs), being them positively correlated to the main hubs of knowledge in the European Union, which will be analyzed in following sections.

In relative terms, the Balassa index of the three main regions performing research in ICTs has a value higher than 3 (from 3.1 to 3.8 for the region of Nordjylland); the three following regions have indexes from 2.1 to 2.4 and the remaining regions on the top 10% have values from 1.6 up to 1.8. In the case of Comunidad Valenciana (which also appears in the top 10% in absolute terms) the value is around 1.6.

2.1.5. Physics, astrophysics and energy

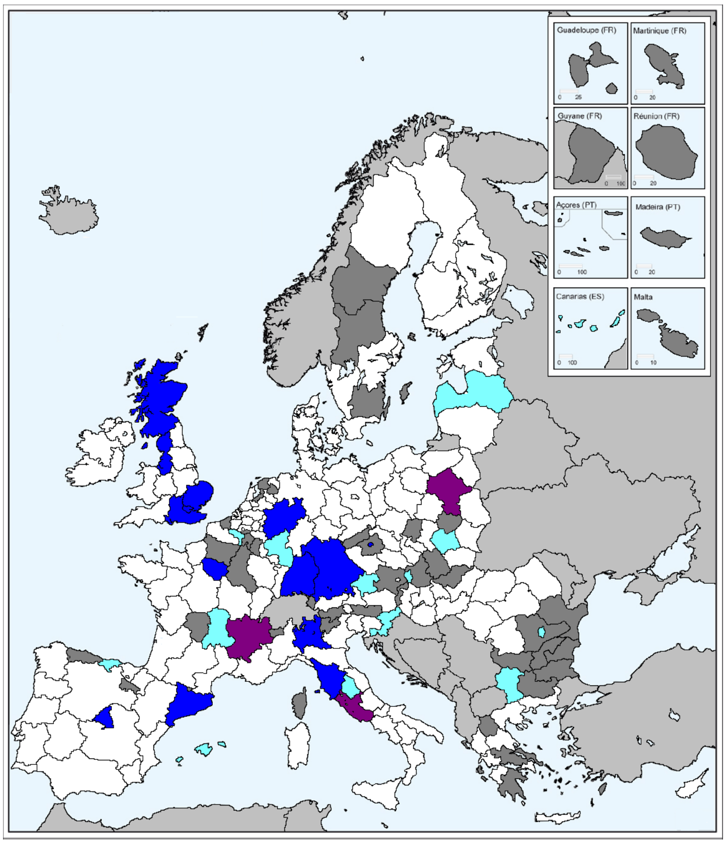
The analysis includes all articles in the fields of physics, astrophysics and energy. In absolute values, the United Kingdom, Germany, France and Italy have the largest share of scientific articles; in relative terms Latvia and Poland, for example, perform better. There are three regions (Lazio, Rhône-Alpes and Mazowieckie) that are on the top 10% in both absolute and relative terms.

Table 2.1.5. Top 10 regions performing research in physics, astrophysics and energy in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Île-de-France (France) ❖ Lazio (Italy) ❖ Nordrhein-Westfalen (Germany) ❖ Baden-Württemberg (Germany) ❖ South East (United Kingdom) ❖ London (United Kingdom) ❖ Bayern (Germany) ❖ Rhône-Alpes (France) ❖ Scotland (United Kingdom) ❖ East of England (United Kingdom)	❖ Lazio (Italy) ❖ Prov. Hainaut (Belgium) ❖ Canarias (Spain) ❖ Oberösterreich (Austria) ❖ Illes Balears (Spain) ❖ Latvija (Latvia) ❖ Rhône-Alpes (France) ❖ Rheinland-Pfalz (Germany) ❖ Auvergne (France) ❖ Bratislavský kraj (Slovakia)	(Regions with the top 10% for both absolute terms and comparative advantage) ❖ Lazio (Italy) ❖ Rhône-Alpes (France) ❖ Mazowieckie (Poland)

Source: Own compilation and analysis from Thomson Reuters – Web of Science data base.

Figure 2.1.5. Top 10% regions performing research in physics, astrophysics and energy (2007-2011). List in annex A.



Source: Own elaboration.

In absolute values, the region of Île-de-France accounts all alone for more than 6% of the scientific production in physics, astrophysics and energy. The top 10 regions performing research in this field aggregate around 124.000 articles in 5 years, around 31% of the whole mass for the totality of the European regions. If we extend it to the top 10%, this percentage arises to 43%, proving the existence of a high concentration in a few regions for this research field, being them positively correlated to the main hubs of knowledge in the European Union, which will be analyzed in following sections.

In relative terms, the largest Balassa index is 2.2 while top 10% ones are between 1.4 and 2.2, which proves less concentration. The regions (Lazio, Rhône-Alpes and Mazowieckie) have both absolute and relative advantage what make them the potential leaders for the research in physics, astrophysics and energy.

2.1.6. Environment and sustainability

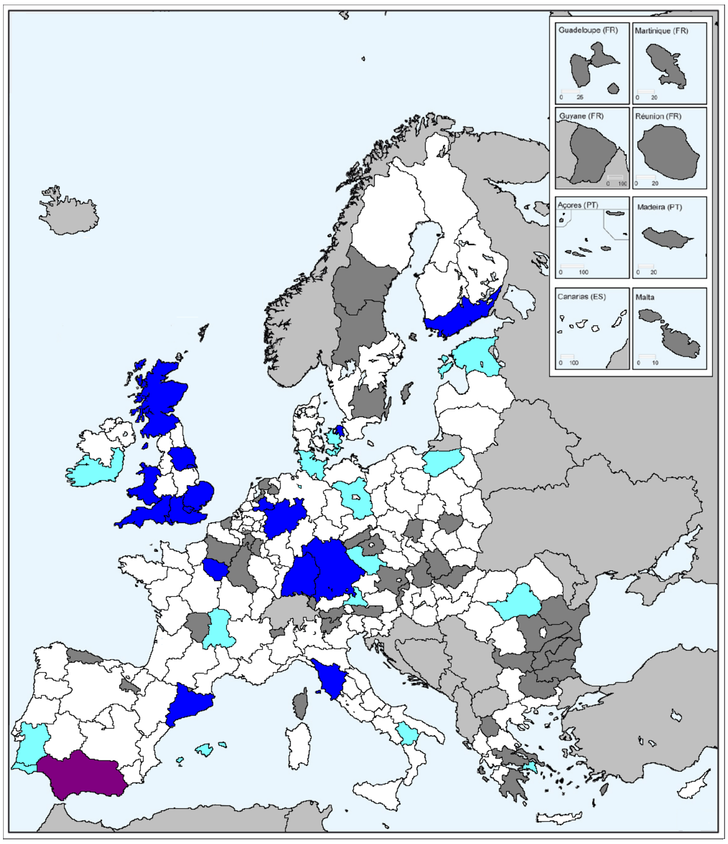
The analysis includes all articles in the fields of environment and sustainability. In absolute values, the United Kingdom and Germany have by far the largest share of scientific articles in this topic while, in relative terms, Portugal, Germany, and Ireland appear to be the most representative. Only the region of Andalucía is on the top 10% in both absolute and relative terms.

Table 2.1.6. Top 10 regions performing research in environment and sustainability in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Île-de-France (France) ❖ Scotland (United Kingdom) ❖ London (United Kingdom) ❖ South East (United Kingdom) ❖ Baden-Württemberg (Germany) ❖ Catalunya (Spain) ❖ Nordrhein-Westfalen (Germany) ❖ Yorkshire and The Humber (United Kingdom) ❖ East of England (United Kingdom) ❖ Andalucía (Spain)	❖ Alentejo (Portugal) ❖ Bremen (Germany) ❖ Algarve (Portugal) ❖ Voreio Aigaio (Greece) ❖ Brandenburg (Germany) ❖ Eesti (Estonia) ❖ Jihozápad (Czech Republic) ❖ Salzburg (Austria) ❖ Warminsko-Mazurskie (Poland) ❖ Sjælland (Denmark)	(Regions with the top 10% for both absolute terms and comparative advantage) ❖ Andalucía (Spain)

Source: Own compilation and analysis from Thomson Reuters – Web of Science data base.

Figure 2.1.6. Top 10% regions performing research in environment and sustainability (2007-2011). List in annex A.



Source: Own elaboration.

In absolute terms, the top 10 regions performing research in this field aggregate around 58.000 articles in 5 years, around 25% of the totality of for the European regions. If take into account the top 10%, this percentage arises to 37%, which shows that also for research in environment and sustainability, the production of scientific articles is especially concentrated in a few regions, even if it is a little less compared to other research fields.

In relative terms, Balassa indexes for the top 10% regions move from 1.7 to 3.7, being above 3.0 only the four most specialized in research in environment and sustainability regions, meaning that there is no region extremely specialized compared to the others in this field. In the case of Andalucía, in the top 10% in both absolute and relative terms, the Balassa index is around 1.7.

2.1.7. Medical sciences

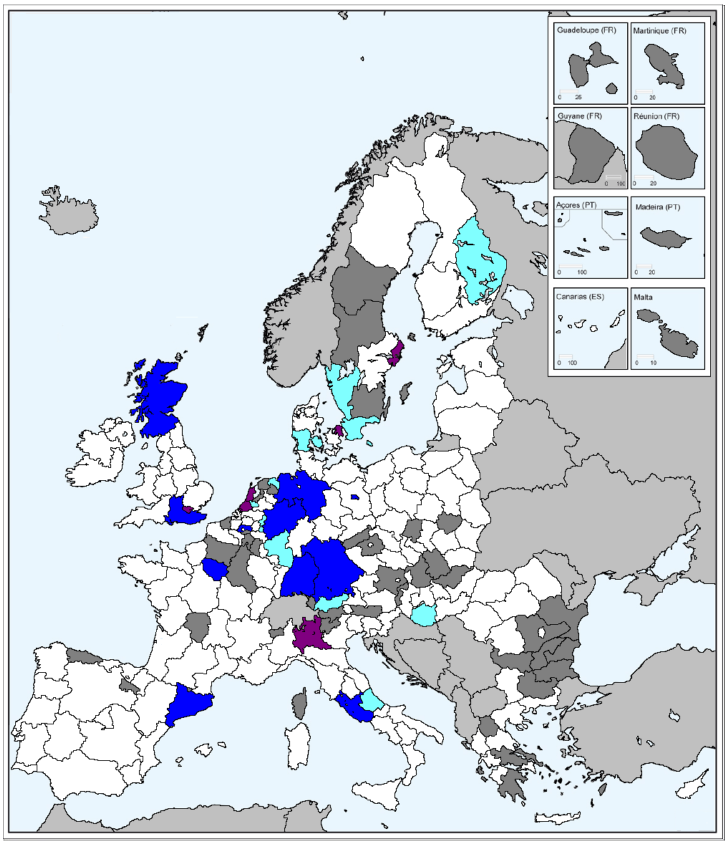
The analysis includes all articles in the fields of medical sciences and human affectations. In absolute terms, Germany, the Netherlands and United Kingdom are the most representative, with the largest share of scientific articles for this topic. In relative terms, the Netherlands, Sweden, Denmark and Italy are those which appear to be more specialized in this topic. Six regions (London, Lombardia, Hovedstaden, Noord-Holland, Zuid-Holland and Stockholm) are in the top 10% for both absolute and comparative advantages.

Table 2.1.7. Top 10 regions performing research in medical sciences in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ London (United Kigndom) ❖ Île-de-France (France) ❖ Bayern (Germany) ❖ Baden-Württemberg (Germany) ❖ Lombardia (Italy) ❖ Nordrhein-Westfalen (Germany) ❖ Hovedstaden (Denmark) ❖ Noord-Holland (Netherlands) ❖ Zuid-Holland (Netherlands) ❖ Stockholm (Sweden)	❖ Limburg (Netherlands) ❖ Dél-Dunántúl (Hungary) ❖ Syddanmark (Denmark) ❖ Noord-Holland (Netherlands) ❖ Utrech (Netherlands) ❖ Abruzzo (Italy) ❖ Stockholm (Sweden) ❖ Tirol (Austria) ❖ Zuid-Holland (Netherlands) ❖ Groningen (Netherlands)	(Regions with the top 10% for both absolute terms and comparative advantage) ❖ London (United Kingdom) ❖ Lombardia (Italy) ❖ Hovedstaden (Denmark) ❖ Noord-Holland (Netherlands) ❖ Zuid-Holland (Netherlands) ❖ Stockholm (Sweden)

Source: Own compilation and analysis from Thomson Reuters – Web of Science data base.

Figure 2.1.7. Top 10% regions performing research in medical sciences (2007-2011). List in annex A.



Source: Own elaboration.

In absolute terms, the top 10 regions performing research in this field aggregate around 190.000 articles in 5 years, by 33% of the totality of the European regions. If we take into account the top 10%, this percentage arises to 46%; these values prove that when referring to the research in medical sciences and human affectations, the production of scientific articles is really concentrated among the top regions performing research in these fields.

In relative terms, Limburg seems to be the most specialized region according to its Balassa index, which value is 2.9, highly above from others. The top 10% regions values go from 1.4 to 2.2. It is important to underline that for medical sciences and human affectations there are six regions which are highly specialized in relative terms and which also have competitive advantage in absolute terms, which makes them a referent on the research in the field.

2.1.8. Mathematics

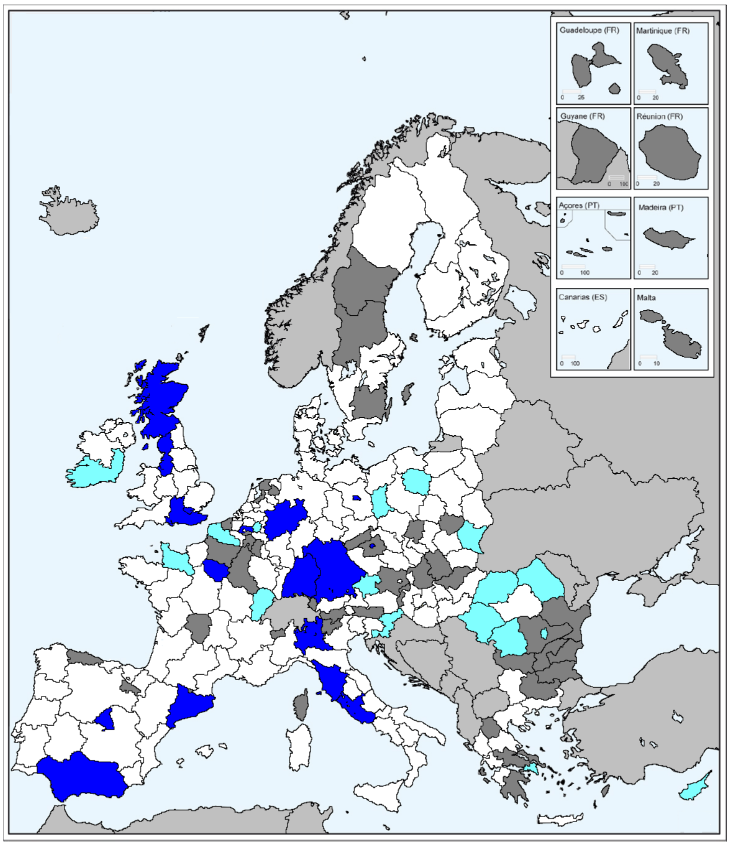
The analysis includes all articles in the field of mathematics. In absolute terms, Germany, Italy, Spain and the United Kingdom are those with a largest number of scientific articles in the field. However, in relative terms, Poland, Romania, Slovenia, Cyprus, France and Ireland are the most representative. No region is in the top 10% for both absolute and comparative advantage.

Table 2.1.8. Top 10 regions performing research in mathematics in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Île-de-France (France) ❖ Nordrhein-Westfalen (Germany) ❖ London (United Kingdom) ❖ South East (United Kingdom) ❖ Catalunya (Spain) ❖ Andalucía (Spain) ❖ Baden-Württemberg (Germany) ❖ Lombardia (Italy) ❖ Scotland (United Kingdom) ❖ Comunidad de Madrid (Spain)	❖ Sud-Vest Oltenia (Romania) ❖ Lubuskie (Poland) ❖ Nord-Vest (Romania) ❖ Vest (Romania) ❖ Voreio Aigaio (Greece) ❖ Oberösterreich (Austria) ❖ Podkarpackie (Poland) ❖ Prov. Limburg (Belgium) ❖ Bucaresti-Ilfov (Romania) ❖ Kypros (Cyprus)	(Regions with the top 10% for both absolute terms and comparative advantage) No regions.

Source: Own compilation and analysis from Thomson Reuters – Web of Science data base.

Figure 2.1.8. Top 10% regions performing research in mathematics (2007-2011). List in annex A.



Source: Own elaboration.

In absolute terms, the top 10 regions performing research in this field aggregate around 24.000 articles in 5 years, by 25% of the totality of for the European regions. If we take into account the top 10%, this percentage arises to 36%; there is a little less concentration on the number of scientific articles for mathematics, even if there is still some, compared to the general trends.

In relative terms, two regions (Sud-Vest Oltenia and Lubuskie) seem to be much more specialized compared to the other taking into account the Balassa index, which has a value around 6.2 for both. The top 10% most specialized regions have values from 2.3 to 3.7, showing that some of the European regions have larger specialization rates and the patterns in mathematics show that this specialization for some of them is higher than in most of the analyzed scientific fields.

2.1.9. Materials sciences

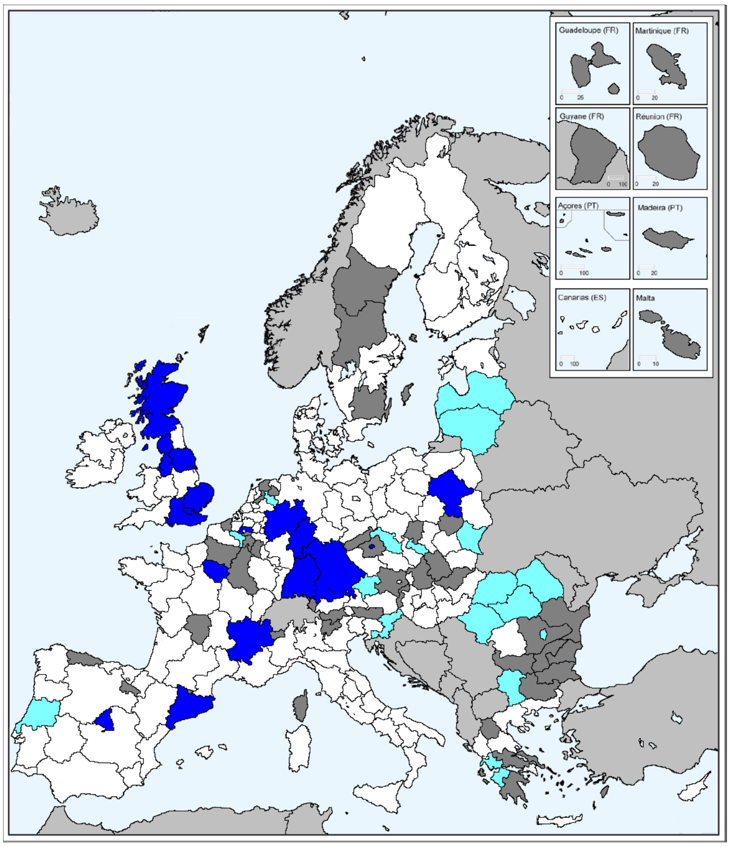
The analysis includes all articles in the field of mathematics. In absolute terms, Germany and the United Kingdom are on the top, but also France and Spain are among the states with a largest number of scientific articles in the topic. On the other hand, in relative terms, Latvia, Lithuania, Romania, and Slovenia are the most representative. No region is in the top 10% for both absolute and comparative advantage.

Table 2.1.9. Top 10 regions performing research in materials sciences in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Île-de-France (France) ❖ Nordrhein-Westfalen (Germany) ❖ Baden-Württemberg (Germany) ❖ Bayern (Germany) ❖ South East (United Kingdom) ❖ Rhône-Alpes (France) ❖ London (United Kingdom) ❖ Mazowieckie (Poland) ❖ Praha (Czech Republic) ❖ Yorkshire and The Humber (United Kingdom)	❖ Nord-Est (Romania) ❖ Severovýchod (Czech Republic) ❖ Podkarpackie (Poland) ❖ Latvija (Latvia) ❖ Prov. Hainaut (Belgium) ❖ Overijssel (Netherlands) ❖ Vest (Romania) ❖ Bucaresti-Ilfov (Romania) ❖ Yugozapaden (Bulgaria) ❖ Oberösterreich (Austria)	(Regions with the top 10% for both absolute terms and comparative advantage) No regions.

Source: Own compilation and analysis from Thomson Reuters – Web of Science data base.

Figure 2.1.9. Top 10% regions performing research in materials sciences (2007-2011). List in annex A.



Source: Own elaboration.

In absolute terms, the top 10 regions performing research in this field aggregate around 33.000 articles in 5 years, around 25% of the totality of for the European regions. Taking into account the top 10%, this percentage arises to 36% (around 47.000 articles); there is less concentration, compared to other scientific fields, for the research in materials sciences. However, following the trends, there is still an important concentration in absolute terms, especially in those regions with higher number of articles published.

In relative terms, one region (Nord-Est) seems to be much more specialized in materials sciences, with a Balassa index of 4.9, while the second most specialized region (Severovýchod) has an index of 3.3. The rest of the top 10% more specialized regions have values from 2.1 to 3.2, which shows that some regions are rather more specialized than others in this field, while no region is on the top 10% for both absolute and comparative advantage.

2.1.10. Animal sciences

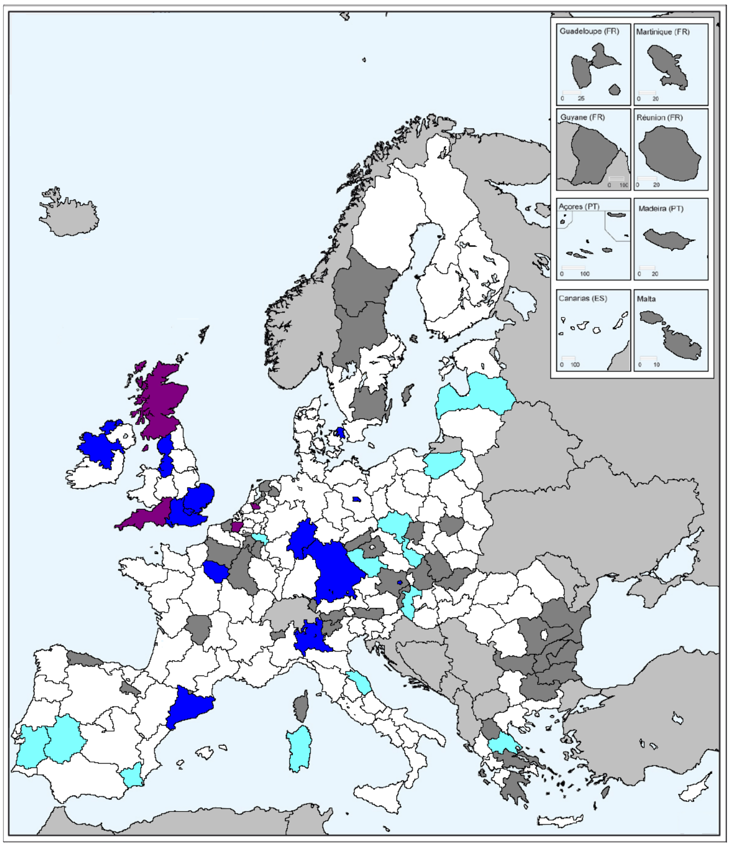
The analysis includes all articles in the field of animal sciences. For this research field, the United Kingdom appears to be the best positioned both in absolute (6 regions) and relative (2 regions) terms. In absolute terms, Germany is also performing better than the average; in relative terms, Poland, Latvia, Italy, Hungary, and Spain are the most specialized. Four regions (Scotland, Province of Oost-Vlaanderen, South West of UK, and Utrech) are in the top 10% for both absolute and comparative advantage.

Table 2.1.10. Top 10 regions performing research in animal sciences in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Scotland (United Kingdom) ❖ Île-de-France (France) ❖ Hovedstaden (Denmark) ❖ Prov. Oost-Vlaanderen (Belgium) ❖ South West (United Kingdom) ❖ London (United Kingdom) ❖ Bayern (Germany) ❖ Catalunya (Spain) ❖ Utrecht (Netherlands) ❖ Lombardia (Italy)	❖ Nyugat-Danántúl (Hungary) ❖ Warminsko-Mazurskie (Poland) ❖ Región de Murcia (Spain) ❖ Jihozápad (Czech Republic) ❖ Prov. Liège (Belgium) ❖ Thessalia (Greece) ❖ Prov. Oost-Vlaanderen (Belgium) ❖ Alentejo (Portugal) ❖ Utrecht (Netherlands) ❖ South West (United Kingdom)	(Regions with the top 10% for both absolute terms and comparative advantage) ❖ Scotland (United Kingdom) ❖ Prov. Oost-Vlaanderen (Belgium) ❖ South West (United Kingdom) ❖ Utrecht (Netherlands)

Source: Own compilation and analysis from Thomson Reuters – Web of Science data base.

Figure 2.1.10. Top 10% regions performing research in animal sciences (2007-2011). List in annex A.



Source: Own elaboration.

Taking into account the absolute values, the top 10 regions performing research in this field aggregate around 11.000 articles in 5 years, around 29% of the totality of for the European regions. If take into account the top 10%, this percentage arises to 40%; the regions which publish the most in animals sciences are Scotland and Île-de-France, with around 1.700 articles each.

In relative values, using the Balassa index as the proxy for specialization, we find that there are two regions highly above the average: Nyugat-Danántúl, with an index of 14.4, and Warminsko-Mazurskie, with an index of 12.5. Only the top 8 regions have Balassa indexes above 3.0, while the rest of the top 10% regions have indexes from 1.9 to 2.6. As mentioned before, four regions from United Kingdom, Belgium, and the Netherlands have advantage in both absolute and comparative terms, meaning that they are leaders in the research devoted to animals sciences.

2.1.11. Physiology and pharmacology

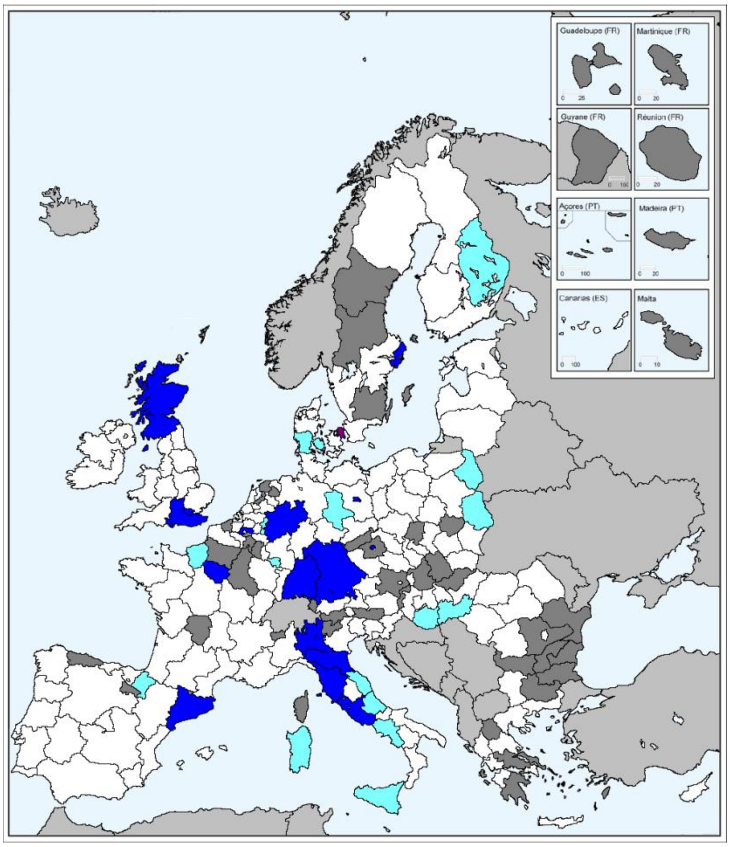
The analysis includes all articles in the fields of physiology and pharmacology. In absolute terms, Italy, Germany, and the United Kingdom are those with a largest number of scientific articles in these fields. However, in relative terms, Italy, Hungary, Denmark, Germany, and Poland appear to be the most specialized. Only the region of Hovedstaden is in the top 10% for both absolute and comparative advantage.

Table 2.1.11. Top 10 regions performing research in physiology and pharmacology in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Île-de-France (France) ❖ London (United Kingdom) ❖ Hovedstaden (Denmark) ❖ Nordrhein-Westfalen (Germany) ❖ Bayern (Germany) ❖ Baden-Württemberg (Germany) ❖ Lombardia (Italy) ❖ Toscana (Italy) ❖ Emilia-Romagna (Italy) ❖ Scotland (United Kingdom)	❖ Dél-Alföld (Hungary) ❖ Marche (Italy) ❖ Abruzzo (Italy) ❖ Podlaskie (Poland) ❖ Sardegna (Italy) ❖ Saarland (Germany) ❖ Limburg (Netherland) ❖ Sachsen-Anhalt (Germany) ❖ Dél-Dunántúl (Hungary) ❖ Lubelskie (Poland)	(Regions with the top 10% for both absolute terms and comparative advantage) ❖ Hovedstaden (Denmark)

Source: Own compilation and analysis from Thomson Reuters – Web of Science data base.

Figure 2.1.11. Top 10% regions performing research in physiology and pharmacology (2007-2011). List in annex A.



Source: Own elaboration.

In absolute terms, the top 10 regions performing research in these fields aggregate around 19.000 articles in 5 years, around 27% of the totality of for the European regions. If take into account the top 10%, this percentage arises to 38% (around 27.000 articles). The number of scientific articles in this field is lower compared to other topics; however, it seems to follow the trends of concentration as the other top regions performing research in these fields.

In relative terms, using the Balassa index as a proxy, no region seems to be highly specialized compared to the others, even if there are, of course, differences among them. The top 10% more specialized regions have indexes from 1.7 to 2.7, which shows that some of the European regions have larger specialization rates and the patterns for engineering, even if, as stated, compared to other research fields, no region has a really high Balassa index in comparison to the others.

2.1.12. Engineering

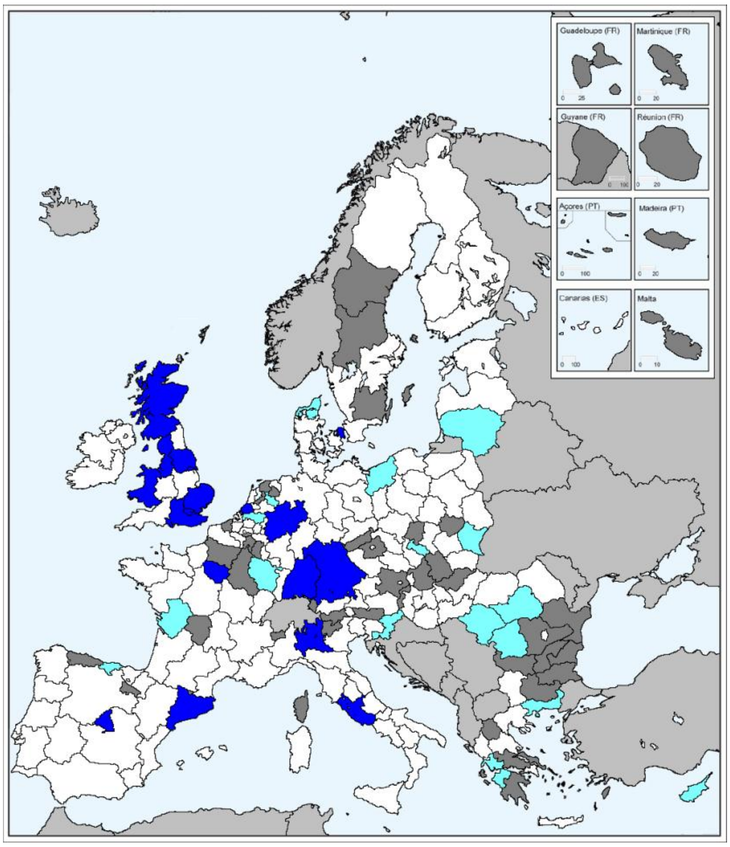
The analysis includes all articles in engineering. If we analyze the results, in absolute terms, the United Kingdom, Germany, Italy, and Spain are the countries with a largest number of scientific articles in this field. If we analyze it in terms of comparative advantage, Lithuania, Romania, Greece, the Netherlands, and France are those best placed in the raking. There is no region in the top 10% for both absolute and comparative advantage.

Table 2.1.12. Top 10 regions performing research in engineering in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2007-2011)

Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ London (United Kingdom) ❖ Île-de-France (France) ❖ South East (United Kingdom) ❖ Scotland (United Kingdom) ❖ Zuid-Holland (Netherlands) ❖ Lombardia (Italy) ❖ Baden-Württemberg (Germany) ❖ Nordrhein-Westfalen (Germany) ❖ East of England (United Kingdom) ❖ Lazio (Italy)	❖ Centru (Romania) ❖ Moravskoslezsko (Czech Republic) ❖ Nordjylland (Denmark) ❖ Zachodniopomorskie (Poland) ❖ Podkarpackie (Poland) ❖ Noord-Brabant (Netherlands) ❖ Vzhodna-Slovenija (Slovenia) ❖ Overijssel (Netherlands) ❖ Sud-Vest Oltenia (Romania) ❖ Lietuva (Lithuania)	(Regions with the top 10% for both absolute terms and comparative advantage) No regions.

Source: Own compilation and analysis from Thomson Reuters – Web of Science data base.

Figure 2.1.12. Top 10% regions performing research in engineering (2007-2011). List in annex A.



Source: Own elaboration.

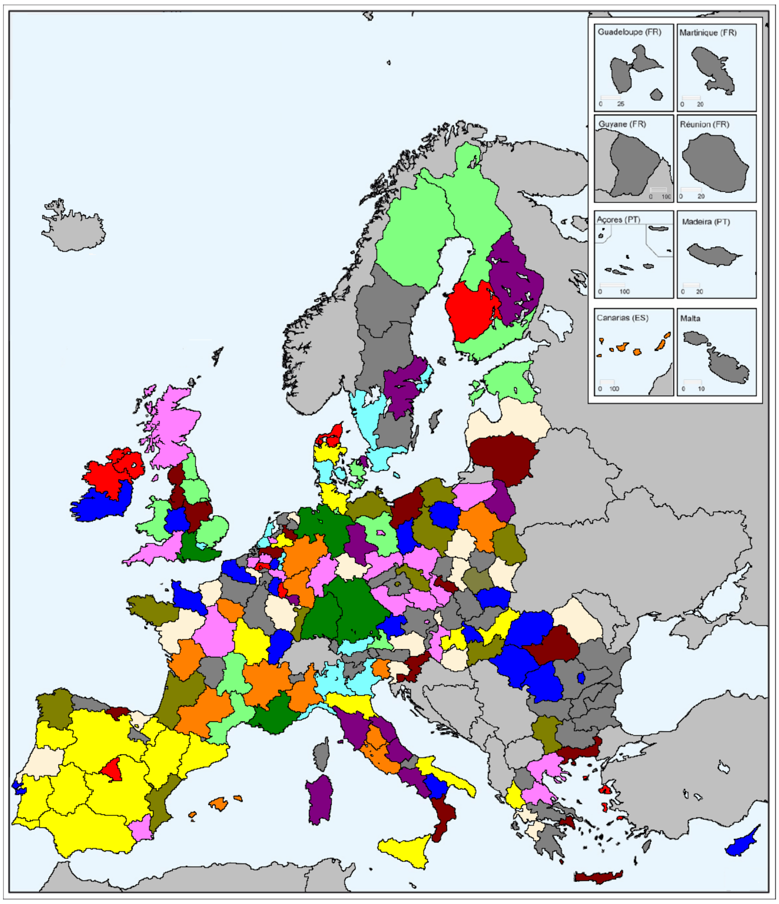
In absolute terms, the top 10 regions performing research in this field aggregate around 49.000 articles for the period 2007 – 2011, around 23% of the global amount of for the European regions. If we take into account the top 10%, this percentage arises to 34% (around 74.000 articles). Scientific articles in engineering follow the trend of concentration of the scientific articles production on the top regions performing research in the field.

If we analyze it in relative terms, the Romanian region Centrum is the most specialized according to the Balassa index, which has a value of 4.3 for that region, while this value decreases to 3.5 for the second more specialized region, Moravskoslezko. The Balassa indexes of the top 10 regions go from 2.4 to the mentioned 4.3, while the value starts at 2.0 if we take into account the most specialized 10%. For the field of engineering, no regions are on the top 10% in both absolute and relative terms.

2.1.13. Analysis on scientific specialization

After analyzing each scientific field independently, it is time to put all the results together in order to decide a specialization pattern for each region. Methodology used to create the map is the following. In the first round we chose for each region the field in which it was more specialized compared to the other fields (in terms of the Balassa index). From the 169 regions taken into account, 132 were elected in the first round. For the other 37 we chose the second field in which they were more specialized, only in those cases in where differences where very little between the field in which they were more specialized and the second. That is because we wanted to provide more uniformity among scientific fields, given that some had many more regions allocated than others. The following map shows the results, the scientific field in which regions are comparatively more specialized according to the methodology we have used. Complete list of regions by scientific field can be found in annex A.

Figure 2.1.13. Scientific fields in which each region is more specialized (2007-2011).



Source: Own elaboration.

Legend of the figure 2.1.13.:

- Agriculture, Food Sciences and Fisheries
- ICTs, Computing and Imaging
- Medical Sciences
- Animal Sciences
- Biology Sciences, Biotechnology and Biomedicine
- Physics, Astrophysics and Energy
- Mathematics
- Physiology and Pharmacology
- Chemistry
- Environment and Sustainability
- Materials Sciences
- Engineering

After the analysis on the map and its implications, there is room for many interpretations and comments to be made regarding the results. The first question that appears is: is the assignment of fields to regions consistent to the results found when analyzing it field by field? The answer is tricky because, as it has been mentioned from section 2.1.1 to 2.1.12, there are research fields where deviations from the mean (in terms of the Balassa index) are much larger than others, and this becomes a statistic problem when we aim to compare both types of analysis. Due to this, we must concentrate now on the argument of the smart specialization strategy, which leads to choose among all fields, taken them all into account at the same time. It must be said, though, that for a large number of regions the specialization chosen coincides with one of the topics in which that region was specialized when analyzing research fields one by one.

If we observe the distribution of the different research fields by regions we see that we find some trends. For example, agriculture, food sciences and fisheries are mainly located in the south of Europe, concretely in the Spanish and Portuguese regions. Biology sciences, biotechnology and biomedicine present lower Balassa indexes, but regions specialized in these fields are important hubs of knowledge. Physics, astrophysics and energy, as well as ICTs and computing sciences appear to be in the most developed regions of the different countries of the EU. Regions specialized in medical sciences are also regions with a high level of scientific capacities in absolute terms. Environmental sciences are especially located in northern Europe. Pharmacology and physiology seem to be more intense in Italy. The rest of the fields do not apparently present any concrete trend in terms of geographic location, even if case by case should be analyzed. Additionally, we need to add that, for many regions, differences on Balassa indexes were so little, and this implies that even if we chose just one scientific field for each one we should consider the possibility of including more research fields for each or some of them, since the smart specialization strategy does not force to choose one independent field, but complementarities must be found among them and one region could be specialized in more than one. However, for our study it was necessary to simplify the analysis in order to be able to generalize with a unique methodology for all regions.

Chapter 3 will provide more detailed information for the main hubs of knowledge, which can be more easily compared due to the fact that their characteristics are more similar than when comparing all the regions at a time. However, we can already say that, in this general analysis, we see that hubs seem to be much less specialized than regions with lower scientific production. The main reason is that the larger the number of published articles the larger equitable distribution of the scientific fields for that region, compared to the average trend for all regions. For example, Île-de-France presents a Balassa index for the field in which it is specialized (physics, astrophysics and energy) of just 1.33 or London (specialized in medical sciences) presents an index of 1.55. In any case the Balassa index is extremely high compared to other regions in the same field for the case of knowledge hubs. That is another argument why these hubs must be independently analyzed.

The main question for which we look for an answer in this section is whether it is possible to find specialization trends in the European regions when we consider their scientific capacities. The answer is yes, but not without nuances. As we see, it is completely possible to identify a field of specialization for each region, and to say if it is high or low specialized using the Balassa index. However, existent differences between the typologies of regions and specialization indexes for the different research fields makes really difficult to compare all regions and scientific topics all together. Further research should provide new methodologies including different and even new variables to make regions comparable according to their individual characteristics. In the meanwhile we need to generalized and to be descriptive with the statistic biases this analysis may present.

2.2. Specialization patterns for industrial activities

After the analysis of the scientific capacities in the regions of the European Union it is time now to focus in their industrial activities, the other side of the coin. Industry has a long and well known tradition in Europe, and the analysis of its characteristics has centered the attention of many economists, aiming to evaluate the capacities, models, and structures on the deep industrial basis of the states integrating the European Union. This section offers a detailed description and analysis of the industrial sectors in the European regions, focusing in the comparative advantages to find potential specialization patterns.

Data base and methodology

As we have mentioned in chapter 1, the study of the industrial specialization among territories is nothing that new, and some articles have been published on this topic, especially for the US and the EU states, but also in more regional terms. Even the European Commission, as we have seen, has published some reports trying to identify the specialization potentialities within the EU. However, it is important to remark that most of these studies are rather based on a concentration argument, giving less importance to the specialization itself. For our study, we are going to use the same methodology that most authors have been applying.

When considering industrial activities instead of scientific capacities, obtaining data becomes much easier. We are going to employ the data coming from the available open source Eurostat, the official statistics office of the European Commission. In their data base we can find the information we need about industrial activities; we are going to use the number of employed people (we will also refer to them as employees, even if there is a distinction between this two concepts on Eurostat) by industrial sector and region as a proxy to measure the industrial activities, given that it fits our research interests and it is the most used indicator when studying this topic. Eurostat defines the number of employed people as 'the total number of persons who work in the observation unit (inclusive of working proprietors, partners working regularly in the unit and unpaid family workers), as well as persons who work outside the unit who belong to it and are paid by it (e.g. sales representatives, delivery personnel, repair and maintenance teams). It excludes manpower supplied to the unit by other enterprises, persons carrying out repair and maintenance work in the enquiry unit on behalf of other enterprises, as well as those on compulsory military service'.

It is important to have in mind that, as it is explained on Eurostat's methodology reports, 'data is generally collected by the National Statistical Institutes (NSI) among enterprises. Data pools are collected through statistical surveys, the business register or administrative sources. The NSIs can use one or several of these sources, according to the survey strategy they have adopted, taking into account the costs, the quality and the response burden on enterprises'. Differences when obtaining data by regional and national administrations makes the comparison more complicated, since it can happen that their methodologies do not perfectly adjust. Better explanatory notes about data obtaining can be found at the Eurostat website. In our analysis, and especially when considering some regions or states, we found that data seems to have large biases coming from different possible problems like incomplete disaggregation of data, unadjusted values, etc. It must be also taken into account that there was no available data for some regions and/or industrial sectors, making even more difficult the comparison and the analysis; for example, no data is available for French regions, excluding them from the analysis. Data used is from 2009, the last available year when data was extracted and analyzed, in June 2012.

The results

Results come from the methodology specified in part 2's introduction, where the concepts of absolute and comparative advantages are described (defining the Balassa index). All the following subsections present the results for each industrial sector analyzed. First of all, information is presented in tables like this one:

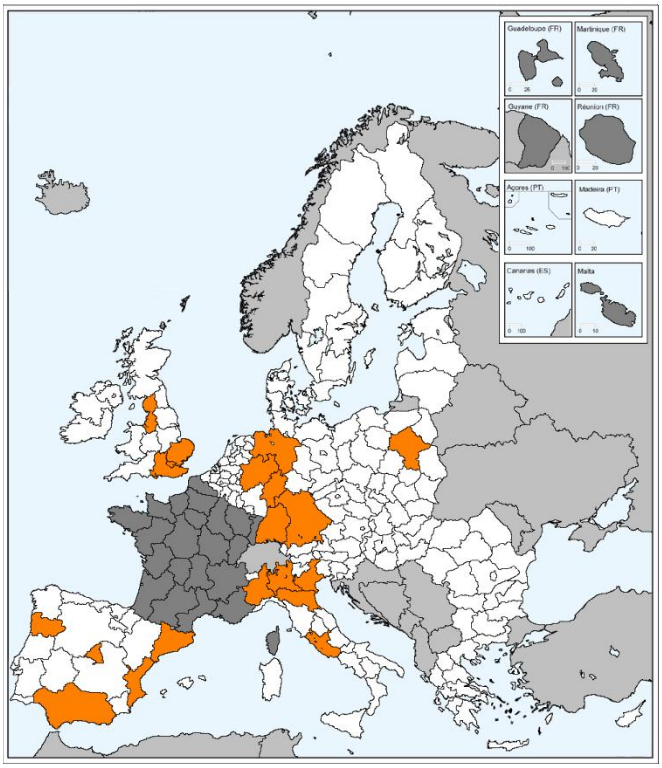
Absolute Advantage	Comparative Advantage	Absolute + Comparative
It contains the list of the top 10 regions in Europe which have absolute advantage for the industrial sector on which the analysis is based. Thus, it measures the total number of emoployees, the quantity.	It contains the list of the top 10 regions in Europe which have comparative advantage (using the Balassa index as a proxy) for the industrial sector on which the analysis is based. Thus, it measures the specialization.	It contains the list of the regions which are, at the same time, in the top 10% of regions with absolute advantage and in the top 10% of regions with comparative advantage.

After the table it is possible to observe a map, the legend of which is the following:

- Top 10% regions with absolute advantage.
- Top 10% regions with comparative advantage.
- Regions which are in the top 10% for both absolute and comparative advantage.
- Regions not taken into account for the study.

The following map presents the top 10% regions in absolute terms, i.e. the best top 10% regions from an absolute advantage point of view. Thus, these are the regions with a largest number of employed persons in the European Union, forming the EU industrial hubs. For more detailed information check the annexes.

Figure 2.2.0. Top 10% regions performing research in absolute terms (number of scientific articles) 2007 – 2011.



As it is observable on the map, the top 10% regions employing people in industry using as a proxy the number of employed person in 2009 in the analyzed regions:

- Nordrhein-Westfalen (Germany)
- Lombardia (Italy)
- Bayern (Germany)
- Baden-Württemberg (Germany)
- Catalunya (Spain)
- Comunidad de Madrid (Spain)
- South East (United Kingdom)
- London (United Kingdom)
- Hessen (Germany)
- Mazowieckie (Poland)
- Veneto (Italy)
- Niedersachsen (Germany)
- Lazio (Italy)
- Andalucía (Spain)
- North West (United Kingdom)
- Emilia-Romagna (Italy)
- Comunidad Valenciana (Spain)
- East of England (United Kingdom)

2.2.1. Food and beverages

This analysis includes the industrial sectors related to food and beverages using the number of employees as a proxy. Data was available for 166 regions. In absolute terms, we find that this industrial sector is especially concentrated in Germany, Spain, Poland, Lithuania and the United Kingdom, while in relative terms we see that Greece seems to be highly specialized in food and beverages, as well as other regions in Ireland or Poland among other.

Table 2.2.1. Top 10 regions with presence of employees in the sectors of food and beverages in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

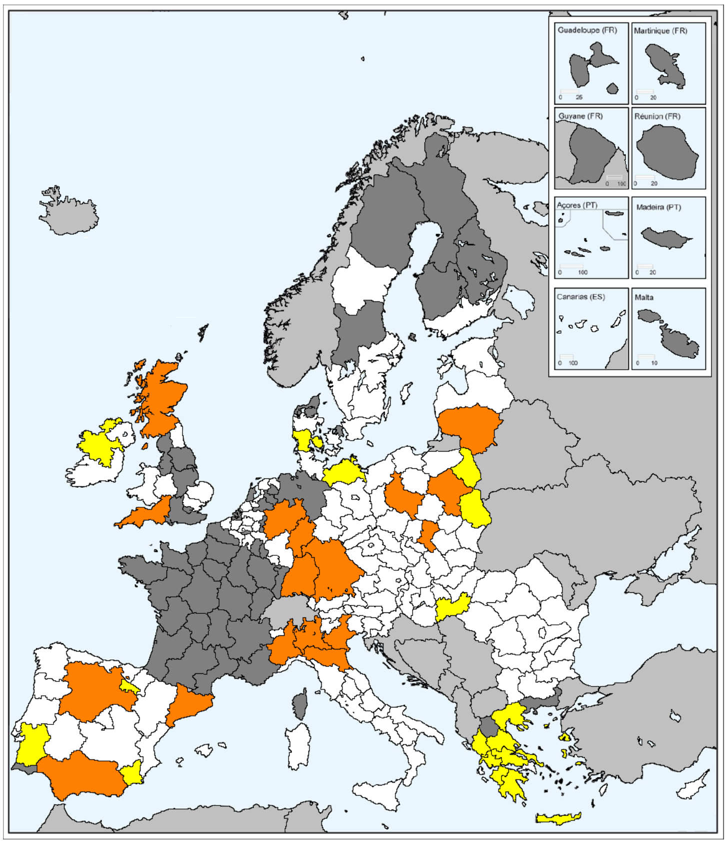
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Bayern (Germany)	❖ Iperios (Greece)	(Regions within the top 10% for both absolute terms and comparative advantage)
❖ Nordrhein-Westfalen (Germany)	❖ Peloponnisos (Greece)	
❖ Catalunya (Spain)	❖ Thessalia (Greece)	No regions for this sector.
❖ Lombardia (Italy)	❖ Kentriki Makedonia (Greece)	
❖ Baden-Württemberg (Germany)	❖ Alentejo (Portugal)	
❖ Emilia-Romagna (Italy)	❖ Kriti (Greece)	
❖ Mazowieckie (Poland)	❖ Dél-Alföld (Hungary)	
❖ Wielkopolskie	❖ Dytiki Ellada (Greece)	
❖ Andalucía (Spain)	❖ Lubelskie (Poland)	
❖ Lietuva (Lithuania)	❖ Podlaskie (Poland)	

Source: Own compilation and analysis; data from Eurostat.

The top 10 regions with a larger number of workers in this sector aggregated in 2009 more than 690.000 employees, around 22% of the totality of European regions. If we extend it not just to the top 10 but to the top 10%, this percentage arises to 31%, which shows that there exists some concentration of the industrial activity for this sector in some regions compared to the others. The average number of employees by region is around 18.700.

In relative terms, the specialization in this industrial sector is highly concentrated in Greece, where almost all of its regions are in the top 10%. Iperios is the most specialized, with a Balassa index of 5.0, followed by Peloponnisos and Thessalia, both with an index of 3.4. Outside Greece, the most specialized region for this sector is Alentejo, with an index 2.9, followed by Dél-Alföld, with an index of 2.7, For this industrial sector, no region was in the 10% for both absolute and comparative advantages,

Figure 2.2.1. Top 10% regions with presence of industrial activities in the sectors of food and beverages (2009). List in annex A.



Source: Own elaboration.

2.2.2. Textile, leather and wearing

This analysis includes the industrial sectors of textile, leather and wearing, using the number of employees as a proxy. Data was available for 140 regions. Regions with absolute but also comparative advantage are highly concentrated in the north of Italy, Romania and Bulgaria and many regions can be found at the same time in the top 10% of regions with higher absolute advantage and in the top 10% of regions with higher comparative advantage, almost all them in the mentioned countries.

Table 2.2.2. Top 10 regions with presence of employees in the sectors of textile, leather and wearing in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

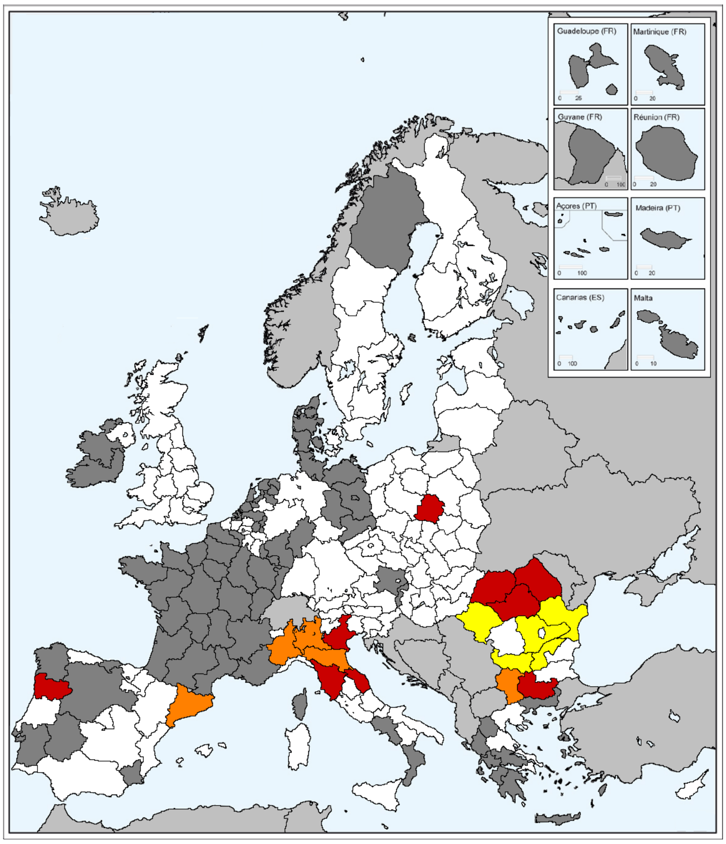
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Norte (Portugal) ❖ Lombardia (Italy) ❖ Toscana (Italy) ❖ Veneto (Italy) ❖ Lódzkie (Poland) ❖ Marche (Poland) ❖ Emilia-Romagna (Italy) ❖ Nord-Vest (Romania) ❖ Yugozapaden (Bulgaria) ❖ Centru (Romania)	❖ Norte (Portugal) ❖ Severozapaden (Bulgaria) ❖ Yuzhen Tsentralen (Bulgaria) ❖ Marche (Italy) ❖ Toscana (Italy) ❖ Severen Tsentralen (Bulgaria) ❖ Lódzkie (Poland) ❖ Nord-Est (Romania) ❖ Vest (Romania) ❖ Nord-Vest (Romania)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Norte (Portugal) ❖ Toscana (Italy) ❖ Veneto (Italy) ❖ Lódzkie (Poland) ❖ Marche (Italy) ❖ Nord-Vest (Romania) ❖ Centru (Romania) ❖ Yuzhen Tsentralen (Bulgaria) ❖ Nord-Est (Romania)

Source: Own compilation and analysis; data from Eurostat.

The top 10 regions with a larger number of employees in this sector aggregate more than 730.000 people, around 38% of the totality of European regions. If we now take into account the top 10%, the percentage is by 46%, proving the existence of a high concentration of industrial activity in these sectors in some European regions, especially in Italy, Romania and Bulgaria, all with a number of employees in the sector highly above the mean, which is around 14.000 workers.

In terms of specialization, the most specialized region in this industrial sector is Norte (Portugal), with a Balassa index of 6.8, followed by the Bulgarian regions of Severozapaden and Yuzhen Tsentralen, with indexes of 5.0 anb 4.9, and the Italian regions of Marche and Toscana, with indexes of 4.6 and 4.3. 9 regions appear in both top 10% list of absolute and comparative advantage, proving that concentration is not only present in absolute terms but also relative.

Figure 2.2.2. Top 10% regions with presence of industrial activities in the sectors of textile, leather and wearing (2009). List in annex A.



Source: Own elaboration.

2.2.3. Wood and furniture, cork and paper

This analysis includes the industrial sectors of wood and furniture, cork and paper, taking into account the number of employees for the comparison. Data was available for 171 regions. Regions with the most comparative advantage are geographically dispersed and they can be found in Germany, Italy, Lithuania, or Poland, among other. In terms of comparative advantage, regions specialized in these sectors are especially concentrated in the northern countries and Eastern Europe.

Table 2.2.3. Top 10 regions with presence of employees in the sectors of wood and furniture, cork and paper in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

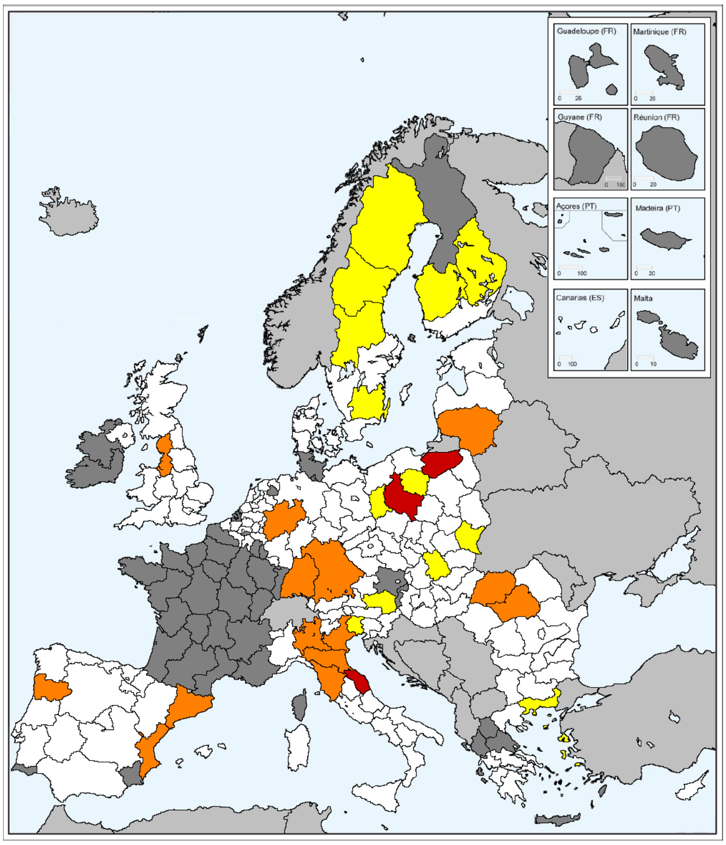
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Nordrhein-Westfalen (Germany) ❖ Lombardia (Italy) ❖ Veneto (Italy) ❖ Wielkopolskie (Poland) ❖ Bayern (Germany) ❖ Baden-Württemberg (Germany) ❖ Norte (Portugal) ❖ Lietuva (Lithuania) ❖ Catalunya (Spain) ❖ Toscana (Italy)	❖ Warminsko-Mazurskie (Poland) ❖ Norra Mellansverige (Sweden) ❖ Småland med öarna (Sweden) ❖ Lubuskie (Poland) ❖ Friuli-Venezia Giulia (Italy) ❖ Stedné Slovensko (Slovakia) ❖ Itä-Suomi (Finland) ❖ Wielkopolskie (Poland) ❖ Mellersta Norrland (Sweden) ❖ Voreio Aigaio (Greece)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Wielkopolskie (Poland) ❖ Warminsko-Mazurskie (Poland) ❖ Marche (Italy)

Source: Own compilation and analysis; data from Eurostat.

The top 10 regions with a larger number of employees in this sector aggregate more than 570.000 workers, around 24% of the totality of European regions. This percentage arises to 33% if we take into account the top 10%. Thus, there is some concentration of these industrial sectors in some regions, even if it seems to be less remarkable compared to other industrial activities. Regions with a larger number of employees are Nordrhein-Westfalen, Lombardia and Veneto.

If we analyze the specialization patterns for these industrial sectors, we see that, according to the Balassa index, the most specialized region is Warmisnko-Mazurskie, with an index of 3.8, followed by the Swedish regions of Norra Mellansverige and Småland med örna, with indexes of 3.6 and 3.7. The other regions on the top 10% have indexes from 2.2 to 3.5. There are three regions on the top 10% for both absolute and comparative advantage.

Figure 2.2.3. Top 10% regions with presence of industrial activities in the sectors of wood and furniture, cork and paper (2009). List in annex A.



Source: Own elaboration.

2.2.4. Manufacture of coke and refined petroleum products

This analysis includes the industrial sector of coke and refined petroleum products manufacturing, using the number of employees as a proxy. This sector seems to be less important in terms of workers. However, some regions seem to be strongly specialized. Data was available only for 92 regions. 6 of the top 10 regions with absolute advantage also appear in the list of those with a larger comparative advantage, and they are geographically distributed among different countries.

Table 2.2.4. Top 10 regions with presence of employees manufacturing coke and refined petroleum products in absolute terms, in comparative advantage and list of the top 10 regions in both absolute and comparative (2009)

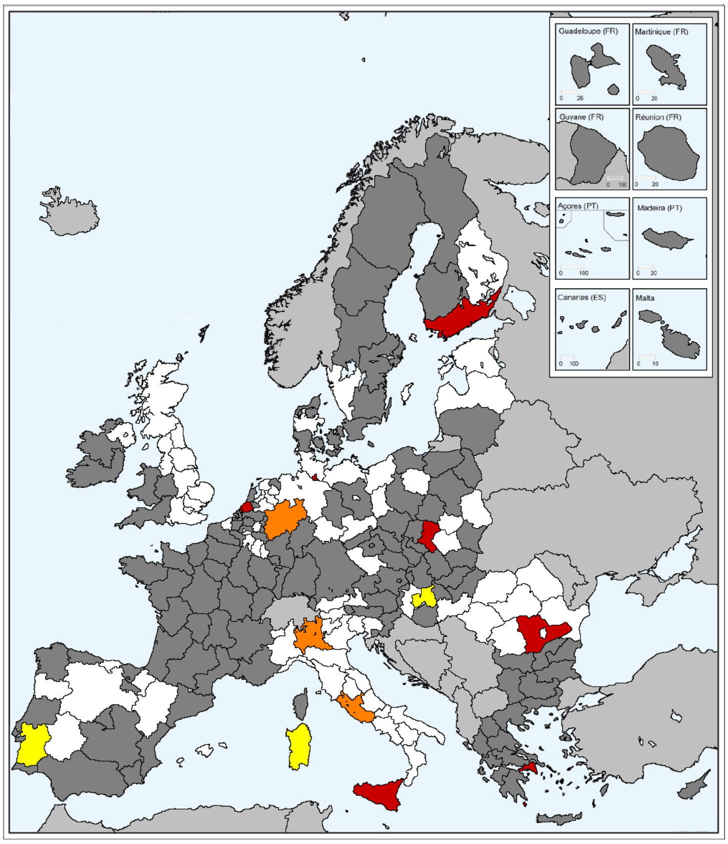
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Nordrhein-Westfalen (Germany) ❖ Zuid-Holland (Netherlands) ❖ Sicilia (Italy) ❖ Hamburg (Germany) ❖ Slaskie (Poland) ❖ Lombardia (Italy) ❖ Sud – Muntenia (Romania) ❖ Etelä-Suomi (Finland) ❖ Attiki (Greece) ❖ Lazio (Italy)	❖ Hamburg (Germany) ❖ Sicilia (Italy) ❖ Zuid-Holland (Netherlands) ❖ Sud – Muntenia (Romania) ❖ Sardegna (Italy) ❖ Alentejo (Portugal) ❖ Slaskie (Poland) ❖ Közép-Dunántúl (Hungary) ❖ Attiki (Greece) ❖ Etelä – Suomi	(Regions within the top 10 for both absolute terms and comparative advantage) ❖ Zuid-Holland (Netherlands) ❖ Sicilia (Italy) ❖ Hamburg (Germany) ❖ Slaskie (Poland) ❖ Sud – Muntenia (Romania) ❖ Etelä-Suomi (Finland) ❖ Attiki (Greece)

Source: Own compilation and analysis; data from Eurostat.

If we analyze the top 10 regions in absolute terms, there are around 38.000 people working in this industrial sector, around 56% of a total of around 68.000 employees. It is easy to conclude that this is a highly concentrated sector, even if we must take into account that available data is scarce compared to other industrial sectors, but this is probably due to the concentration itself. We find largest presence of employees in this sector in the region of Nordrhein-Westfalen.

In terms of specialization, using the Balassa index as a proxy, we find that 6 of the top 10 regions also appear in the top 10 list for absolute advantage. The most specialized region is, by far, Hamburg, with an index of 15.1, followed by Sicilia, with an index of 9.5, Zuid-Holland, with an index of 8.5 and Sus-Muntenia, with an index of 8.4. The rest of the top 10 most specialized regions have values from 5.1 to 6.6, which proves that these regions are highly specialized, far above the average of the analyzed regions.

Figure 2.2.4. Top 10 regions with presence of industrial activities in the sector of manufacture of coke and refined petroleum products (2009). List in annex A.



Source: Own elaboration.

2.2.5. Manufacture of chemicals and chemical products

This analysis includes the industrial sector of manufacture of chemicals and chemical products, measured by the number of employees. Data was available for 180 regions. Industrial activity in this sector is geographically concentrated in central Europe, and it is highly intense in Germany and Italy, but also in regions of the United Kingdom and Spain. In relative terms, specialized regions can be also found in other countries like Belgium, Hungary, Greece or Romania.

Table 2.2.5. Top 10 regions with presence of employees in manufacture of chemicals and chemical products in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

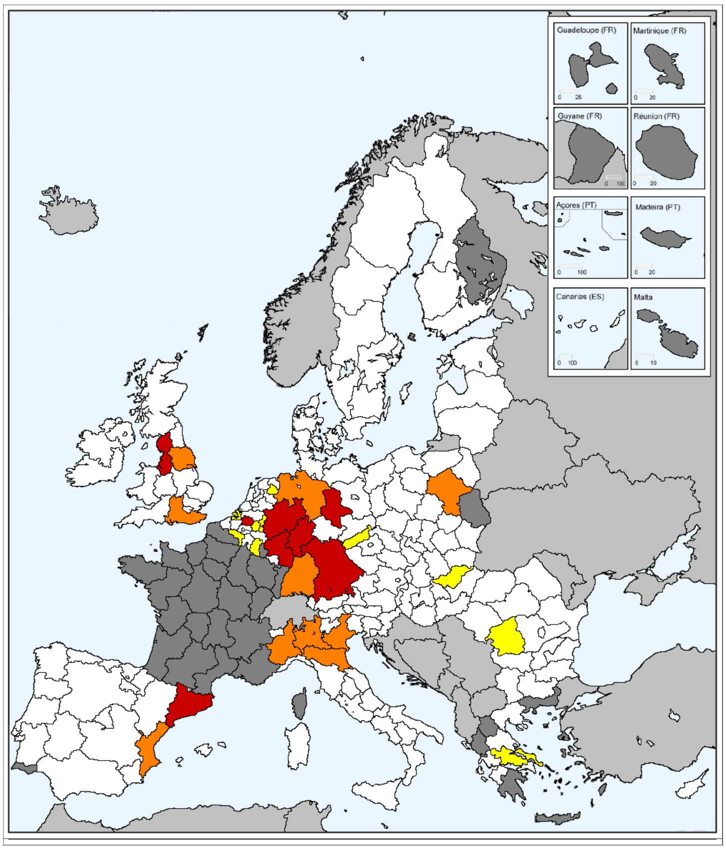
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Nordrhein-Westfalen (Germany) ❖ Bayern (Germany) ❖ Lombardia (Italy) ❖ Rheinland-Pfalz (Germany) ❖ Hessen (Germany) ❖ Catalunya (Spain) ❖ Baden-Württemberg (Germany) ❖ North West (United Kingdom) ❖ Niedersachsen (Germany) ❖ Prov. Antwerpen (Belgium)	❖ Zeeland (Netherlands) ❖ Rheinland-Pfalz (Germany) ❖ Prov. Antwerpen (Belgium) ❖ Limburg (Netherlands) ❖ Sachsen-Anhalt (Germany) ❖ Sterea Ellada (Greece) ❖ Hessen (Germany) ❖ Sud-Vest Oltenia (Romania) ❖ Prov. Hainaut (Belgium) ❖ Észak-Magyarország (Hungary)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Nordrhein-Westfalen (Germany) ❖ Bayern (Germany) ❖ Rheinland-Pfalz (Germany) ❖ Hessen (Germany) ❖ Catalunya (Spain) ❖ North West (United Kingdom) ❖ Prov. Antwerpen (Belgium) ❖ Sachsen-Anhalt (Germany)

Source: Own compilation and analysis; data from Eurostat.

The top 10 regions with a larger number of employees in this sector aggregate more than 390.000 workers, around 40% of the total; this percentage arises to 50% if we take into account the top 10% (18 regions), all them far above of the average of around 5.500 employees per region. Nordrhein-Westfalen has the larger number of workers, with more than 85.000 people employed, being Germany the leader in this sector, with 7 regions in the top 10%.

In relative terms, the most specialized region in this sector is Zeeland, with a Balassa index of 5.3, followed by Rheinland-Pfalz with an index of 4.5 and the Province of Antwepen with an index of 4.0. In general, specialization rates are less heterogeneous for this sector. As we can see in the map, many regions on the top 10% for absolute advantage are also in the list of the most specialized regions, and they are mostly concentrated in the center of Europe.

Figure 2.2.5. Top 10% regions with presence of industrial activities in the sector of manufacture of chemicals and chemical products (2009). List in annex A.



Source: Own elaboration.

2.2.6. Manufacture of basic pharmaceutical products and pharmaceutical preparations

This analysis includes the industrial sector of manufacturing of pharmaceutical products and preparations, measured by the number of employees. Data was available for 134 regions. This sector seems to be especially located in central Europe, considering regions in absolute and relative terms, with a few exceptions.

Table 2.2.6. Top 10 regions with presence of employees in manufacture of pharmaceutical products and preparations in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

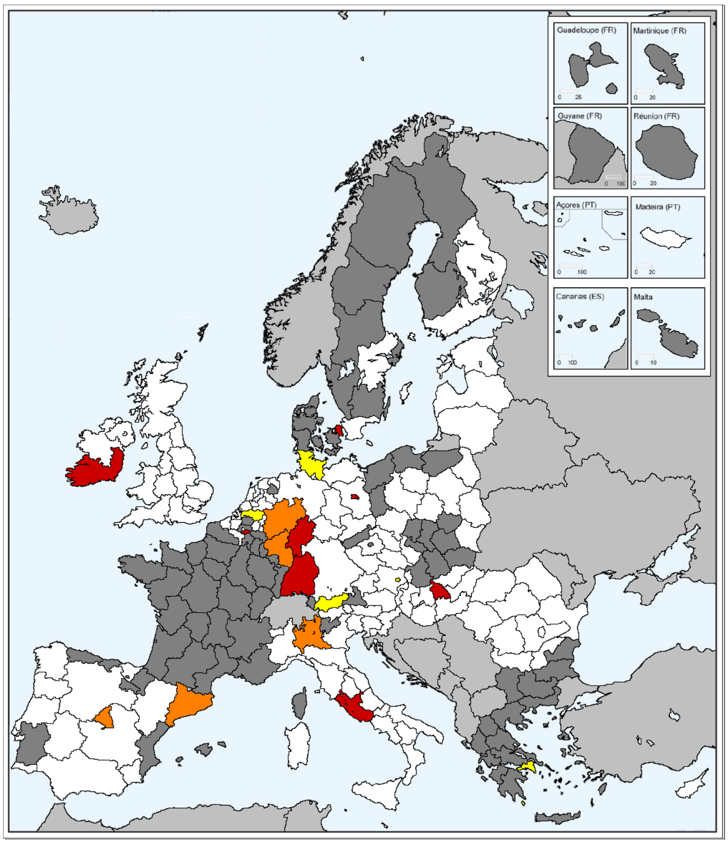
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Baden-Württemberg (Germany) ❖ Lombardia (Italy) ❖ Hessen (Germany) ❖ Catalunya (Spain) ❖ Lazio (Italy) ❖ Southern and Eastern (Ireland) ❖ Nordrhein-Westfalen (Germany) ❖ Hovedstaden (Denmark) ❖ Comunidad de Madrid (Spain) ❖ Rheinland-Pfalz (Germany)	❖ Prov. Brabant Wallon (Belgium) ❖ Hovedstaden (Denmark) ❖ Southern and Eastern (Ireland) ❖ Berlin (Germany) ❖ Tirol (Austria) ❖ Baden-Württemberg (Germany) ❖ Hessen (Germany) ❖ Schleswig-Holstein (Germany) ❖ Közép-Magyarország (Hungary) ❖ Noord-Brabant (Netherlands)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Baden-Württemberg (Germany) ❖ Hessen (Germany) ❖ Lazio (Italy) ❖ Southern and Eastern (Ireland) ❖ Hovedstaden (Denmark) ❖ Közép-Magyarország (Hungary) ❖ Prov. Brabant Wallon (Belgium) ❖ Berlin (Germany)

Source: Own compilation and analysis; data from Eurostat.

The top 10 regions with a larger number of employees in this sector aggregate more than 174.000 people, around 44% of the workers in this industrial sector, which signals the concentration of the activity in a few regions, especially in Germany. All regions in the top 10% for absolute terms are, at least, three times above the average, which is around 2.900 people working in this sector in each region.

In terms of specialization, using Balassa's index as a proxy, we find that the Province of Brabant Wallon is highly specialized compared to the other, with an index of 17.3, followed by Hovedstaden, with an index of 7.1 and Southern and Eastern of Ireland, with an index of 6.4. Other regions in the top 10 have indexes from 2.6 to 4.6. 7 of the 13 regions included in the top 10% lists appear in both absolute and comparative ones. It proves the concentration of these industrial activities in a few regions.

Figure 2.2.6. Top 10% regions with presence of industrial activities in the sector of manufacture of pharmaceutical products and preparations (2009). List in annex A.



Source: Own elaboration.

2.2.7. Non-metallic minerals and products

This analysis includes the industrial sector of non-metallic minerals, in terms of number of employees per region. Data was available for 184 regions. In absolute terms, industrial activity in this sector is concentrated in Germany, Italy, Poland, the United Kingdom, and Spain. On the other hand, in relative terms, Czech Republic appears to be the most specialized country, but also Slovakia, Greece or Hungary.

Table 2.2.7. Top 10 regions with presence of employees in the sector of non-metallic minerals and products in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

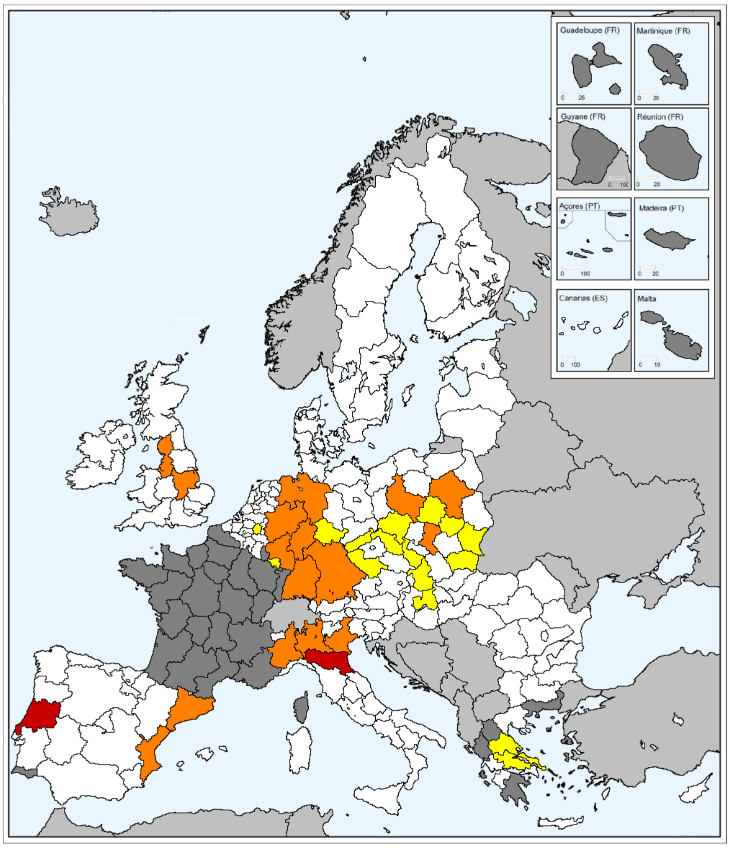
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Bayern (Germany) ❖ Nordrhein-Westfalen (Germany) ❖ Lombardia (Italy) ❖ Baden-Württemberg (Germany) ❖ Emilia-Romagna (Italy) ❖ Niedersachsen (Germany) ❖ Veneto (Italy) ❖ Comunidad Valenciana (Spain) ❖ Catalunya (Spain) ❖ Slaskie (Poland)	❖ Sterea Ellada (Greece) ❖ Západné Slovensko (Slovakia) ❖ Severovýchod (Czech Republic) ❖ Podkarpackie (Poland) ❖ Strední Morava (Czech Republic) ❖ Swietokrzskie (Poland) ❖ Centro (Portugal) ❖ Thüringen (Germany) ❖ Közép-Dunántúl (Hungary) ❖ Severozápad (Czech Republic)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Emilia-Romagna (Italy) ❖ Centro (Portugal)

Source: Own compilation and analysis; data from Eurostat.

In the top 10 regions with a largest number of employees there are around 700.000 people working in this sector. This amount represents around 27% of total, 37% if we take into account the top 10%. Bayern is the region with a largest number of workers in this sector, with more than 114.000 people employed. In general, south-eastern regions of Germany define the main hub of employment for this industrial activity.

In relative terms, most of the top 10% specialized regions are located in Eastern Europe, even if the most specialized one is Sterea Ellada, with a Balassa index of 2.7. In general, Balassa indexes present less deviations from the mean, with no region highly above the rest in terms of specialization in this sector. The regions of Centro and Emilia-Romagna are those included in the top 10% list for both absolute and comparative advantage and their Balassa indexes are 2.0 and 1.6.

Figure 2.2.7. Top 10% regions with presence of industrial activities in the sector of non-metallic minerals and products (2009). List in annex A.



Source: Own elaboration.

2.2.8. Basic metals and metal products

This analysis includes the industrial sectors of basic metals and metal products, in terms of number of employees per region. Data was scarce and only available for 76 regions, which makes the analysis more restrictive. For both absolute terms, employment in these sectors is especially concentrated in Germany and Italy, even if some other regions appear in the top 10 lists.

Table 2.2.8. Top 10 regions with presence of employees in the sectors of basic metals and metal products in absolute terms, in comparative advantage and list of the top 10 regions in both absolute and comparative (2009)

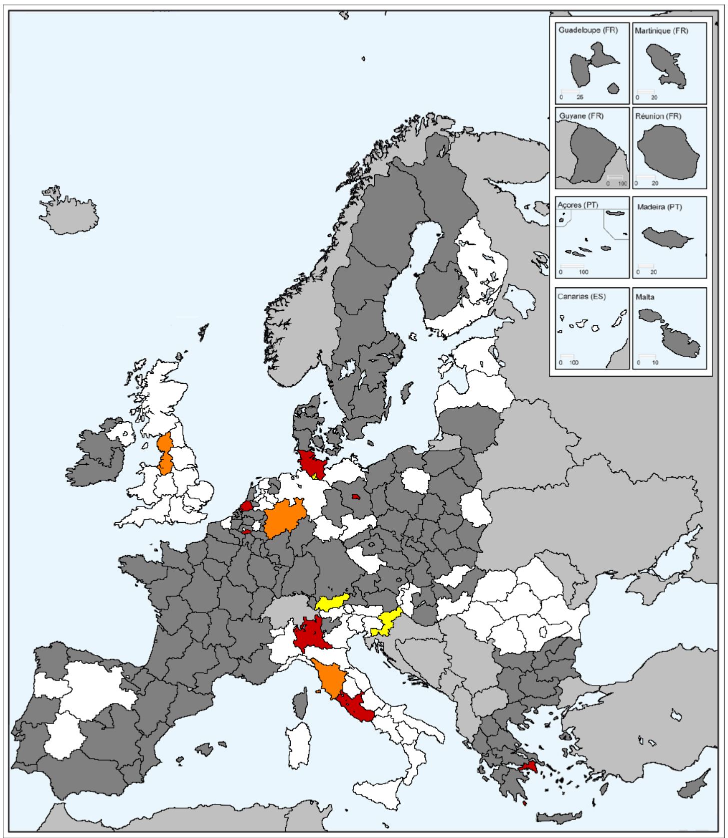
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Lombardia (Italy) ❖ Nordrhein-Westfalen (Germany) ❖ Lazio (Italy) ❖ Prov. Brabant Wallon (Belgium) ❖ Berlin (Germany) ❖ Attiki (Greece) ❖ North West (United Kingdom) ❖ Zuid-Holland (Netherlands) ❖ Toscana (Italy) ❖ Schleswig-Holstein (Germany)	❖ Prov. Brabant Wallon (Belgium) ❖ Berlin (Germany) ❖ Schleswig-Holstein (Germany) ❖ Attiki (Greece) ❖ Tirol (Austria) ❖ Lazio (Italy) ❖ Hamburg (Germany) ❖ Zuid-Holland (Netherlands) ❖ Lombardia (Italy) ❖ Vzhodna Slovenija (Slovenia)	(Regions within the top 10 for both absolute terms and comparative advantage) ❖ Lombardia (Italy) ❖ Lazio (Italy) ❖ Prov. Brabant Wallon (Belgium) ❖ Berlin (Germany) ❖ Attiki (Greece) ❖ Zuid-Holland (Netherlands) ❖ Schleswig-Holstein (Germany)

Source: Own compilation and analysis; data from Eurostat.

The top 10 regions in absolute number of employees aggregate around 127.000 workers, around 52% of the global amount. However, we must have in mind the lower number of regions from which data was available, and the potential biases this fact may present. The region with a higher number of employees in this sector is Lombardia, with around 30.000 people, followed by Nordrhein-Westfalen with around 21.000 workers.

In relative terms, the Province of Brabant Wallon is highly specialized, above the mean, with a Balassa index of 28.0. That leads to think that other biases can be present when analyzing the data for this industrial sector, since we do not have data from many regions. The second most specialized region is Belin, with an index of 7.5, followed by Schleswig-Holstein and Attiki, with indexes of 5.7. 7 of the 10 top regions are in both lists for absolute and comparative advantage.

Figure 2.2.8. Top 10 regions with presence of industrial activities in the sectors of basic metals and metal products (2009). List in annex A.



Source: Own elaboration.

2.2.9. Computer, electric, electronic and optical products

This analysis includes the industrial sector of computer, electric, electronic and optical products, in terms of number of employees per region. Data was available for 179 regions. In absolute terms, industrial activity in this sector is concentrated in Germany, Italy, Poland, the United Kingdom, and Spain, while in relative terms, specialized regions are more distributed, and especially located in Czech Republic, Belgium, Netherlands, Germany, or Greece, among other.

Table 2.2.9. Top 10 regions in the sector of computer, electric, electronic and optical products, in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

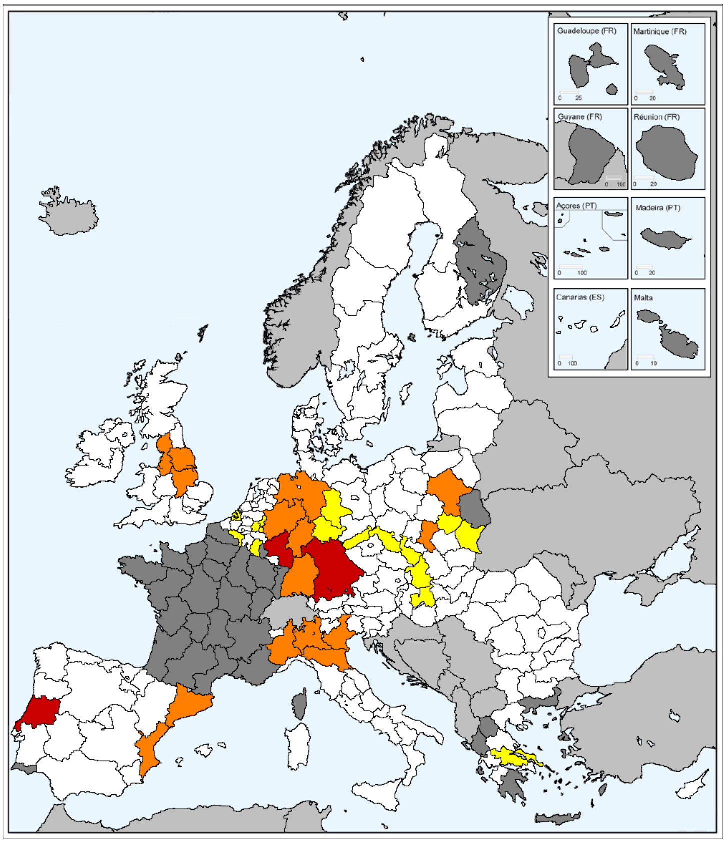
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Nordrhein-Westfalen (Germany) ❖ Bayern (Germany) ❖ Lombardia (Italy) ❖ Baden-Württemberg (Germany) ❖ Rheinland-Pfalz (Germany) ❖ Niedersachsen (Germany) ❖ Hessen (Germany) ❖ Catalunya (Spain) ❖ Emilia-Romagna (Italy) ❖ Veneto (Italy)	❖ Sterea Ellada (Greece) ❖ Rheinland-Pfalz (Germany) ❖ Západné Slovenso (Slovakia) ❖ Severozápad (Czech Republic) ❖ Podkarpackie (Poland) ❖ Stredni Morava (Czech Republic) ❖ Limburg (Netherlands) ❖ Prov. Limburg (Belgium) ❖ Severovýchod (Czech Republic) ❖ Zeeland (Netherlands)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Bayern (Germany) ❖ Rheinland-Pfalz (Germany) ❖ Centro (Portugal)

Source: Own compilation and analysis; data from Eurostat.

Top 10 regions with a largest number of employees in this sector aggregate more than 1.050.000 people working in these industries, around 29% of the total, 40% if we take into account the top 10%. This is an important concentration of the activity in this sector, especially in the center of the EU, being Nordrhein-Westfalen the region with a larger number of workers in the sector, more than 180.000.

In terms of specialization, if we use the Balassa index as a proxy, we find that the most specialized region in this sector is Sterea Ellada, with an index of 2.6, followed by Rheinland-Pfalz, with an index of 2.3 and Západné Slovensko, with an index of 2.2. The rest of the top 10% most specialized regions have indexes from 1.5 to 1.9. Thus, deviation from the mean value of the index is lower than in other sectors, with no region highly specialized compared to the rest. Three regions appear in the top 10% list for both absolute and comparative advantages.

Figure 2.2.9. Top 10% regions with presence of industrial activities in the sector of computer, electric, electronic and optical products (2009). List in annex A.



Source: Own elaboration.

2.2.10. Motor vehicles and transport equipment

This analysis includes the industrial the sectors of motor vehicles and transport equipment, in terms of number of employees per region. Data was scarce and only available for 76 regions, which makes the analysis more restrictive. For both absolute terms, employment in these sectors is concentrated in especially concentrated in Germany, Italy and Slovenia.

Table 2.2.10. Top 10 regions in the sectors of motor vehicles and transport equipment in absolute terms, in comparative advantage and list of the top 10 regions in both absolute and comparative (2009)

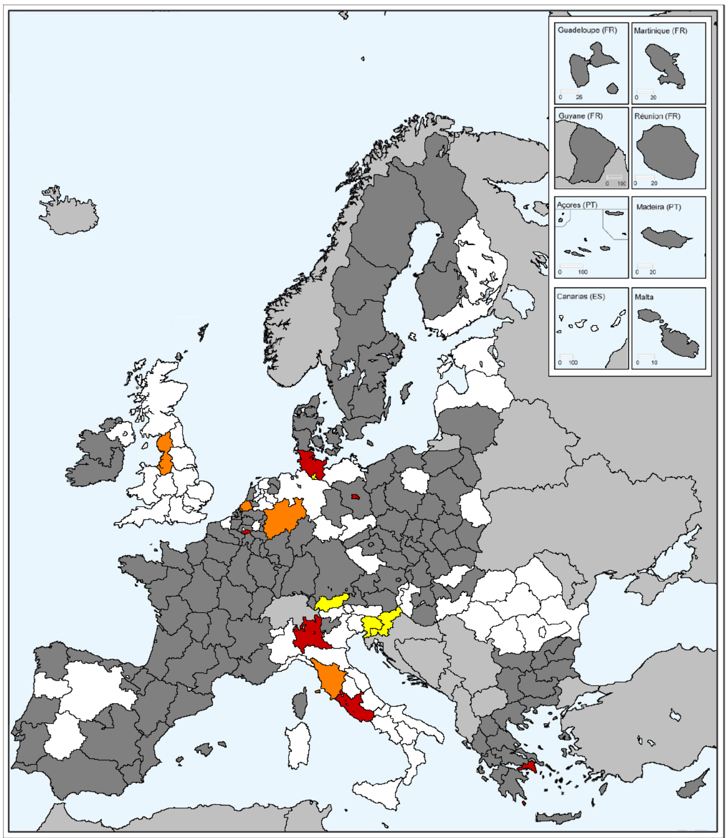
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Lombardia (Italy) ❖ Nordrhein-Westfalen (Germany) ❖ Lazio (Italy) ❖ Prov. Brabant Wallon (Beligium) ❖ Berlin (Germany) ❖ Attiki (Greece) ❖ North West (United Kingdom) ❖ Zuid-Holland (Netherlands) ❖ Toscana (Italy) ❖ Schleswig-Holstein (Germany)	❖ Prov. Brabant Wallon (Belgium) ❖ Berlin (Germany) ❖ Tirol (Austria) ❖ Schleswig-Holstein (Germany) ❖ Attiki (Greece) ❖ Lazio (Italy) ❖ Lombardia (Italy) ❖ Vzhodna Slovenija (Slovenia) ❖ Zahodna Slovenija (Slovenia) ❖ Hamburg (Germany)	(Regions within the top 10 for both absolute terms and comparative advantage) ❖ Lombardia (Italy) ❖ Lazio (Italy) ❖ Prov. Brabant Wallon (Belgium) ❖ Berlin (Germany) ❖ Attiki (Greece) ❖ Schleswig-Holstein (Germany)

Source: Own compilation and analysis; data from Eurostat.

The top 10 regions in absolute number of employees aggregate around 127.000 workers, around 30% of the global amount. However, we must have in mind the small number of regions for which data was available, and the potential biases this fact may present. The region with a higher number of employees in this sector is Lombardia, with around 29.000 people, followed by Nordrhein-Westfalen with around 21.000 workers.

In relative terms, the Province of Brabant Wallon is highly specialized above the mean, with a Balassa index of 32.0. That leads to think that other biases can be present when analyzing the data for this industrial sector, since we do not have data from many regions, especially due to the fact that patterns for these sectors are exactly the same than the case for the basic metals and metal products. We face thus a problem with data that can be hardly identified since data base is given.

Figure 2.2.10. Top 10 regions with presence of industrial activities in the sectors of motor vehicles and transport equipment (2009). List in annex A.



Source: Own elaboration.

2.2.11. Electricity, gas, steam and air conditioning supply

This analysis includes the industrial sectors of electricity, gas steam and air conditioning supply, in terms of number of employees per region. Data was available for 174 regions. In absolute terms, industrial activity in this sector is concentrated in Germany, Lithuania, United Kingdom, and Romania, while in relative terms, specialization regions are more concentrated in Eastern Europe, especially in Poland, Romania, and Bulgaria.

Table 2.2.11. Top 10 regions in the sectors of electricity, gas, steam, and air conditioning supply, in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

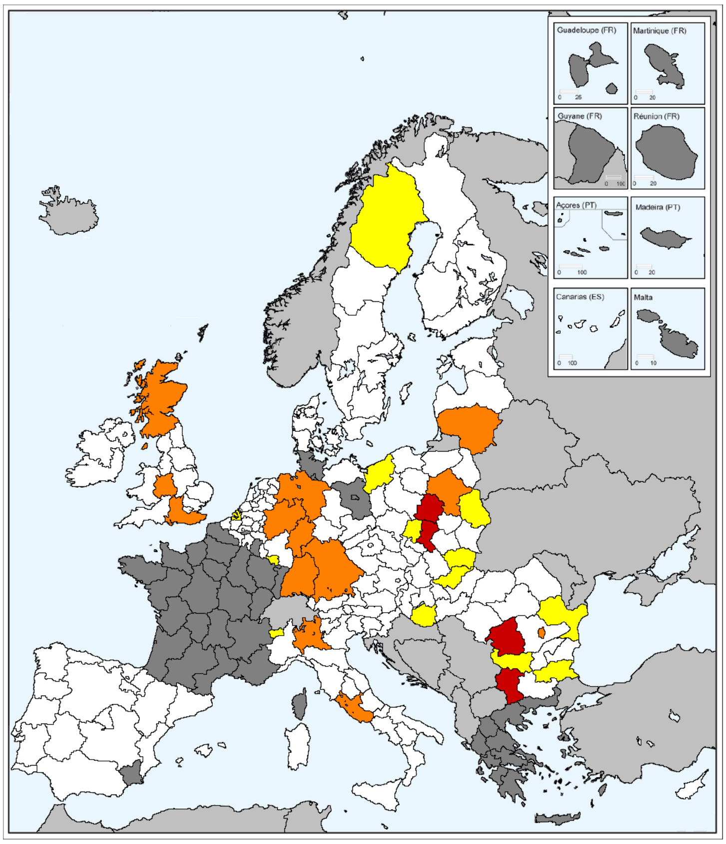
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Nordrhein-Westfalen (Germany) ❖ Baden-Württemberg (Germany) ❖ Bayern (Germany) ❖ Slaskie (Poland) ❖ Mazowieckie (Poland) ❖ Niedersachsen (Germany) ❖ Bucaresti – Ilfov (Romania) ❖ Lietuva (Lithuania) ❖ Yugozapaden (Bulgaria) ❖ Lombardia (Italy)	❖ Sud-Vest Oltenia (Romania) ❖ Zeeland (Netherlands) ❖ Severozapaden (Bulgaria) ❖ Východné Slovensko (Slovakia) ❖ Yugoiztochen (Bulgaria) ❖ Dél-Dunántúl (Hungary) ❖ Opolskie (Poland) ❖ Övre Norrland (Sweden) ❖ Észak-Magyarország (Hungary) ❖ Slaskie (Poland)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Slaskie (Poland) ❖ Yugozapaden (Bulgaria) ❖ Sud-Vest Oltenia (Romania) ❖ Lódzkie (Poland)

Source: Own compilation and analysis; data from Eurostat.

If we take into account the top 10 regions with a largest number of employees in these sectors, we find that they aggregate around 250.000 workers, 26% of the total for the analyzed European regions. This percentage arises to 36% when considering the top 10%, with more than 343.147 employees, in regions distributed all along Europe, not only in the center as it seems to be the common for industrial activities.

Using the Balassa index as the proxy for the definition of specialization patterns, we find that the most specialized region for this sector is the Romanian region of Sud-Vest Oltenia, with an index of 4.1, followed by Zeeland, with an index of 3.5 and Severozapaden, with an index of 3.1. The other top 10% regions in relative terms have Balassa indexes from 2.0 to 2.6. There are four regions (in Poland, Romania and Bulgaria) which are found in the top 10% list for both absolute and relative advantages compared to the other.

Figure 2.2.11. Top 10% regions with presence of industrial activities in the sectors electricity, gas, steam, and air conditioning supply (2009). List in annex A.



Source: Own elaboration.

2.2.12. Water supply, waste management and remediation activities

This analysis includes the industrial sectors of water supply, waste management and remediation activities, in terms of number of employees per region. Data was available for 183 regions. In absolute terms, industrial activity in this sector is especially concentrated in United Kingdom, Italy, Spain, and Romania; in relative terms, most of the top 10% most specialized regions can be found in the south-east of Europe.

Table 2.2.12. Top 10 regions in the sectors of water supply, waste management and remediation activities, in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

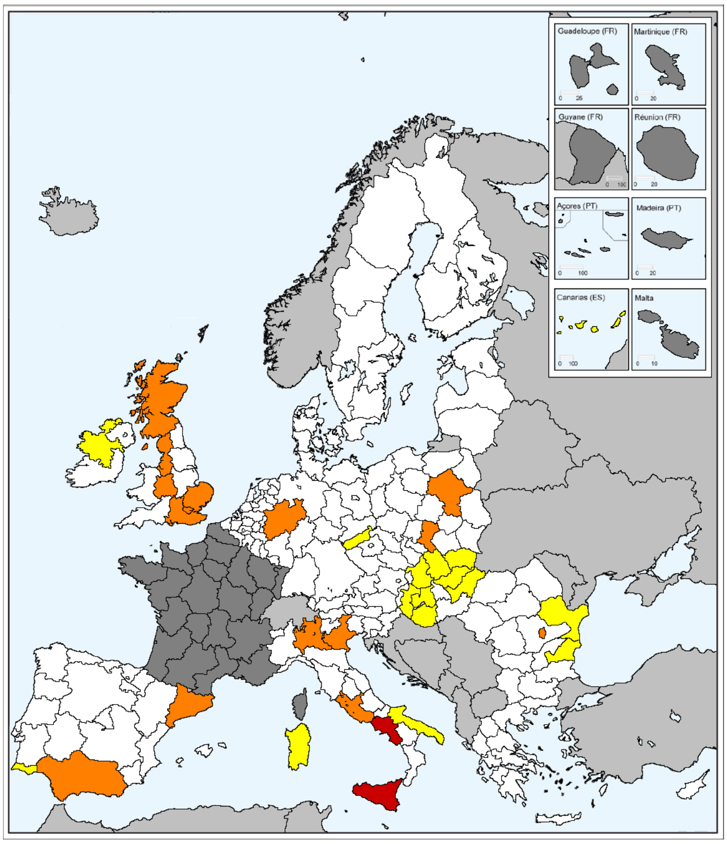
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Nordrhein-Westfalen (Germany) ❖ South East (United Kingdom) ❖ Lombardia (Italy) ❖ Campania (Italy) ❖ Andalucía (Spain) ❖ Slaskie (Poland) ❖ Lazio (Italy) ❖ Catalunya (Spain) ❖ Sicilia (Italy) ❖ Bucaresti – Ilfov (Romania)	❖ Východné Slovensko (Slovakia) ❖ Dél-Dunántúl (Hungary) ❖ Sicilia (Italy) ❖ Campania (Italy) ❖ Stredné Slovensko (Slovakia) ❖ Sud-Est (Romania) ❖ Észak-Magyarország (Hungary) ❖ Algarve (Portugal) ❖ Sardegna (Italy) ❖ Border, Midland and Western (Ireland)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Campania (Italy) ❖ Sicilia (Italy)

Source: Own compilation and analysis; data from Eurostat.

Top 10 regions with a largest number of employees in this sector aggregate more than 210.000 people working in these industries, around 29% of the total, 31% if we take into account the top 10% regions. Nordrhein-Westfalen is, by far, the region with a largest number of employees, with around 41.000 people working in the sector, followed by South East of England, with around 23.000 employees.

In terms of specialization, if we use the Balassa index as a proxy, we find that the most specialized region in this sector is Východné Slovensko, with an index of 3.2, followed by Dél-Dunántúl and Sicilia, with indexes of 2.5 and 2.2. Slovakia appears to be the most specialized, with 3 of its 4 regions in the top 10% list of specialized regions in the sector. Only two regions, both Italian, Campania and Sicilia, are found in the top 10% list for both absolute and relative advantages.

Figure 2.2.12. Top 10% regions with presence of industrial activities in the sectors of water supply, waste management and remediation activities (2009). List in annex A.



Source: Own elaboration.

2.2.13. Construction

This analysis includes the construction sector, in terms of number of employees per region. Data was available for 196 regions, the largest sample, compared to the rest of industrial sector. In absolute terms, industrial activity in this sector is especially concentrated in the main European economies: Spain, Italy, United Kingdom, and Germany; in relative terms, most specialized regions are concentrated in Southern Europe, especially in Greece, Portugal, and Spain.

Table 2.2.13. Top 10 regions in the construction sector, in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

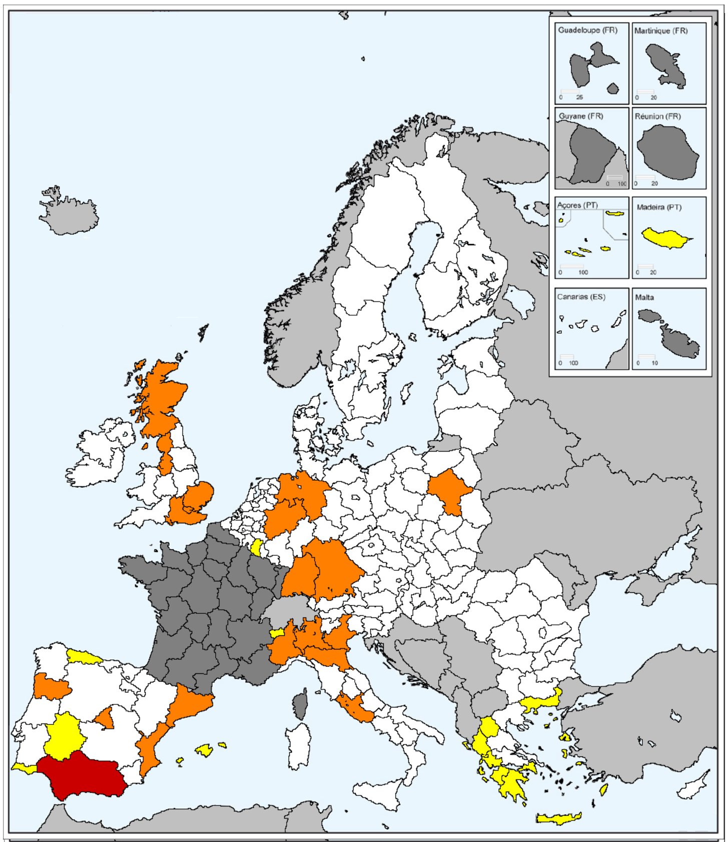
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Lombardia (Italy) ❖ Catalunya (Spain) ❖ Nordrhein-Westfalen (Germany) ❖ Andalucía (Spain) ❖ Bayern (Germany) ❖ Comunidad de Madrid (Spain) ❖ South East (United Kingdom) ❖ Baden-Württemberg (Germany) ❖ Comunidad Valenciana (Spain) ❖ Veneto (Italy)	❖ Dytiki Makedonia (Greece) ❖ Anatoliki Makedonia, Thraki (Greece) ❖ Ionia Nisia (Greece) ❖ Notio Aigaio (Greece) ❖ Algarve (Portugal) ❖ Kriti (Greece) ❖ Voreio Aigaio (Greece) ❖ Região Autónoma dos Açores (Portugal) ❖ Região Autónoma da Madeira (Portugal) ❖ Peloponnisos (Greece)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Andalucía (Spain)

Source: Own compilation and analysis; data from Eurostat.

There are around 2 million and a half employees working in construction in the top 10 regions with the largest absolute advantage, around 21% of the total (around 12.1 million people). This percentage is around 34% when we consider the top 10% regions with a largest number of employees in construction, taking into account the 196 analyzed regions. Construction activities appear to be especially concentrated in center – west Europe.

Using the Balassa index as the specialization proxy, we can say Dytiki Makedonia is the most specialized region, with an index of 3.5, followed by three other Greek regions: Anatoliki Makedonia and Thraki, Ionia Nisia, and Notio Aigaio, with indexes around 3.0 – 3.1. Portuguese, Greek, and Spanish regions are those with the highest values in their specialization indexes. Only Andalucía appears in the lists of top 10% regions with advantage for both absolute and relative terms.

Figure 2.2.13. Top 10% regions with presence of industrial activities in the construction sector (2009). List in annex A.



Source: Own elaboration.

2.2.14. Transportation and storage

This analysis includes the transportation and storage sectors, in terms of number of employees per region. Data was available for 183 regions. In absolute terms, industrial activity in this sector can be mainly found in Germany, United Kingdom, Spain, and Italy, while in relative terms most specialized regions are more spread and can be found in a larger number of European countries.

Table 2.2.14. Top 10 regions in the transportation and storage sectors, in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

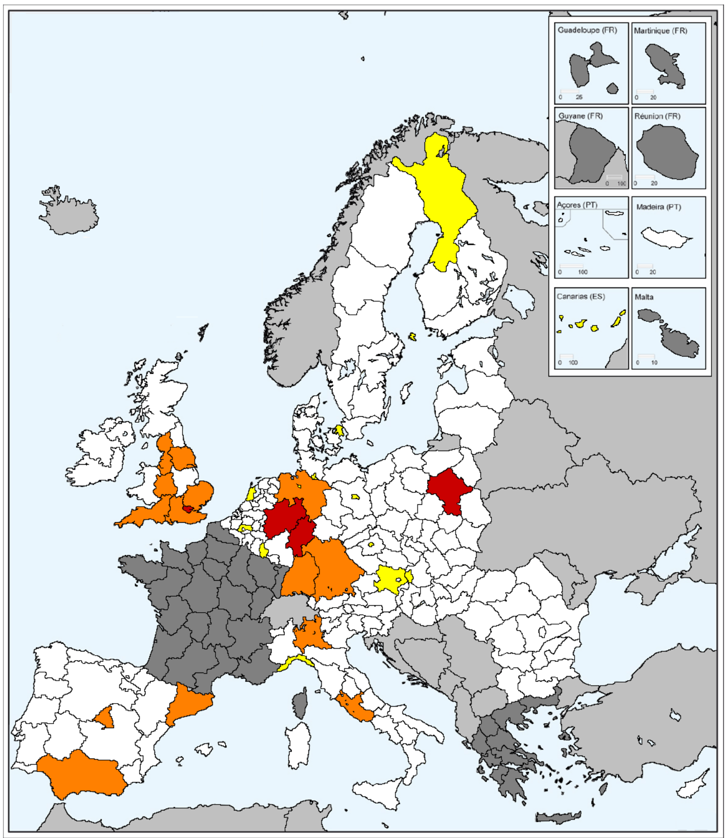
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ Nordrhein-Westfalen (Germany) ❖ Hessen (Germany) ❖ London (United Kingdom) ❖ Lombardia (Italy) ❖ Bayern (Germany) ❖ Mazowieckie (Poland) ❖ Catalunya (Spain) ❖ Comunidad de Madrid (Spain) ❖ Baden-Württemberg (Germany) ❖ Niedersachen (Germany)	❖ Åland (Finland) ❖ Bremen (Germany) ❖ Hamburg (Germany) ❖ Bratislavský kraj (Slovakia) ❖ Noord-Holland (Netherlands) ❖ Liguria (Italy) ❖ Hessen (Germany) ❖ Canarias (Spain) ❖ Pohjois-Suomi (Finland) ❖ Prov. Vlaams-Brabant (Belgium)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ Nordrhein-Westfalen (Germany) ❖ Hessen (Germany) ❖ London (United Kingdom) ❖ Mazowieckie (Poland)

Source: Own compilation and analysis; data from Eurostat.

Top 10 regions with a larger number of employees in these sectors aggregate around 2.3 million workers, which represents by 26% of the total number of employees in these sectors from the 183 analyzed regions. This percentage arises to 37% (more than 3.3 million employees) if we take into account the top 10%. The region with a largest number of workers is, by far, Nordrhein-Westfalen, with more than half a million people working in these sectors.

In relative terms, the most specialized region, using the Balassa index as the indicator, is the Finish region of Åland, with an index of 3.3, followed by Bremen, with an index of 3.1. The other regions on the top 10% list have indexes from 1.4 to 2.2. Nordrhein-Westfalen, Hessen, London, and Mazowieckie are the regions appearing in both lists for absolute and comparative advantage, becoming the leaders for these industrial sectors in the EU.

Figure 2.2.14. Top 10% regions with presence of industrial activities in the transportation and storage sectors (2009). List in annex A.



Source: Own elaboration.

2.2.15. Information and communication products and technologies

This analysis includes the transportation and storage sectors, in terms of number of employees per region. Data was available for 183 regions. In absolute terms, industrial activity in this sector can be mainly found in Germany, United Kingdom, Spain, and Italy, while in relative terms most specialized regions are more spread and can be found in a larger number of EU countries.

Table 2.2.15. Top 10 regions in the sector of information and communication products and technologies, in absolute terms, in comparative advantage and list of the top 10% regions in both absolute and comparative (2009)

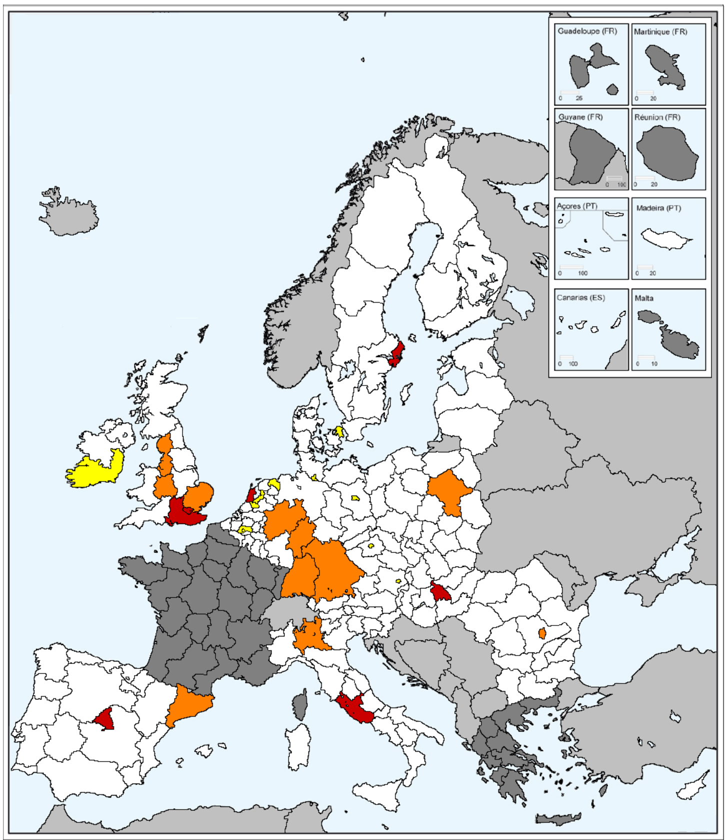
Absolute Advantage	Comparative Advantage	Absolute + Comparative
❖ London (United Kingdom) ❖ Nordrhein-Westfalen (Germany) ❖ South East (United Kingdom) ❖ Comunidad de Madrid (Spain) ❖ Bayern (Germany) ❖ Lombardia (Italy) ❖ Baden-Württemberg (Germany) ❖ Lazio (Italy) ❖ Hessen (Germany) ❖ Mazowieckie (Poland)	❖ London (United Kingdom) ❖ Région de Bruxelles-Capitale (Belgium) ❖ Stockholm (Sweden) ❖ Utrecht (Netherlands) ❖ Hovedstaden (Denmark) ❖ South East (United Kingdom) ❖ Wien (Austria) ❖ Noord-Holland (Netherlands) ❖ Comunidad de Madrid (Spain) ❖ Praha (Czech Republic)	(Regions within the top 10% for both absolute terms and comparative advantage) ❖ London (United Kingdom) ❖ South-East (United Kingdom) ❖ Comunidad de Madrid (Spain) ❖ Lazio (Italy) ❖ Stockholm (Sweden) ❖ Közép-Magyarország (Hungary) ❖ Noord-Holland (Netherlands)

Source: Own compilation and analysis; data from Eurostat.

Top 10 regions with a larger number of employees in this sector aggregate around 1.8 million workers, which represents by 37% of the total number of employees in these sectors from the 183 analyzed regions. This percentage arises to 50% and around 2.4 million people if we take into account the top 10%, evidencing an important concentration pattern. The region with a largest number of workers is London, with more than 300.000 people working in this sector.

In relative terms, the two most specialized regions using the Balassa index are London and Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest, both with an index of 3.6, followed by Stockholm, with an index of 3.0, and Utrecht, with an index of 2.9. Other regions in the top 10% list for comparative advantage have Balassa indexes from 1.8 to 2.7. 6 regions appear in the lists of top 10% regions with advantage for both absolute and relative terms.

Figure 2.2.15. Top 10% regions with presence of industrial activities in the sector of information and communication products and technologies (2009). List in annex A.

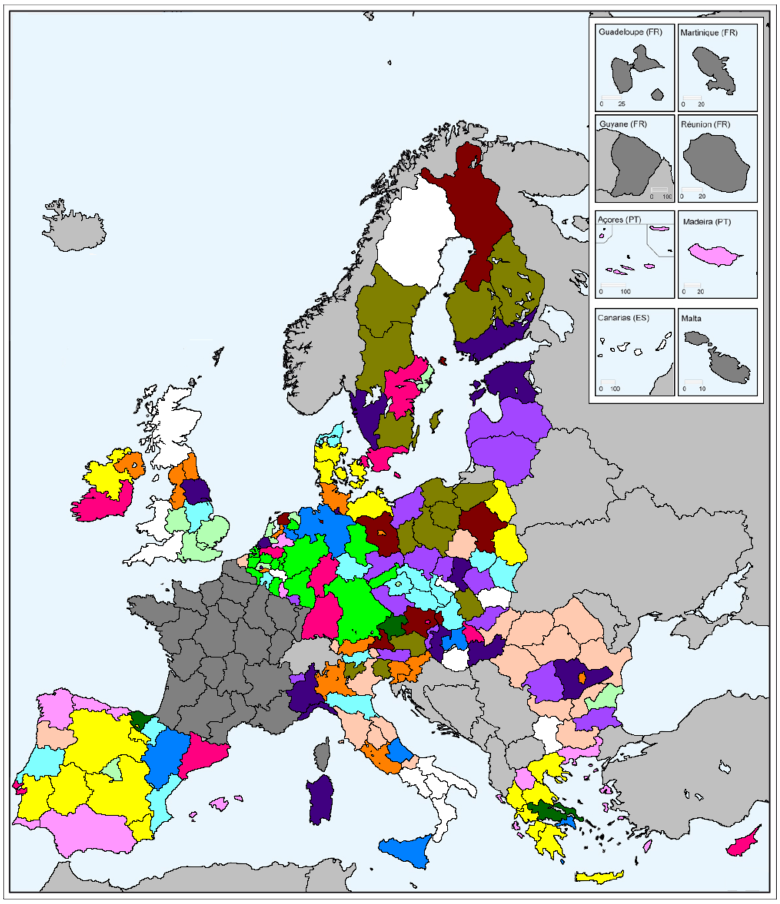


Source: Own elaboration.

2.2.16. Analysis on industrial activities

After analyzing each industrial sector independently, now we will put all the results together in order to define a specialization pattern for each region. The methodology used to create map is the following. In the first round we chose for each region the sector in which it was more specialized compared to the other fields (in terms of the Balassa index). From the 194 regions taken into account, 169 were elected in the first round. For the other 25 we chose the second field in which they were more specialized, only in those cases in where differences where very little between the field in which they were more specialized and the second. That is because we wanted to provide more uniformity among scientific fields, given that some had many more regions allocated than others. The following map shows the results, the scientific field in which regions are comparatively more specialized according to the methodology we have used. Complete list of regions by industrial sector can be found in annex A.

Figure 2.2.16. Industrial activity in which each region is more specialized (2009)



Source: Own elaboration.

Legend of the figure 2.2.16.:

- Food and Beverages
- Manufacture of Chemicals and Chemical Prod.
- Computer, Electric, Electron. and Optical Prod.
- Construction
- Textile, Leather and Wearing
- Manuf. of Basic Pharma. Products and Preparations
- Motor Vehicles and Transport Equipment
- Transportation and Storage

Wood and Furniture, Cork and Paper	Non-Metallic Minerals and Products	Electricity, Gas, Steam and Air Cond. Supply	Info. and Communic. Products and Technologies
Manuf. of Coke and Refined Petroleum Prod.	Basic Metals and Metal Products	Water Supply, Waste Manag. and Remediation Act.	

Before we analyze the map, it is important to mention that the date used, referring to Eurostat as the source, presents some biases. The most obvious is the fact that there is not data for French regions, while France represents an important share of the whole production of the European Union. Another bias is the strong correlation between values for the same region in different industrial sectors, which makes data less accurate and the analysis less concrete. A third bias is the fact that the regions where data is available are not the same for all industrial sectors, which creates comparison problems among them. For example, data is available for 196 regions when considering the construction sector, while it is only possible to have data from 76 regions when analyzing basic metals and metal products or motor vehicles and transport equipment. This data problem, coming from the source (Eurostat) complicates a little the whole analysis, but there is still room for the following conclusions.

If we focus on our main interest, evaluate whether exist or not specialization trends among the EU regions, we are in position to state that, as we can observe, it is possible to determine which region should specialize in which industrial sector; however, differences in the Balassa indexes are very important, much more than in the case of the scientific research analysis (probably due to the larger presence of biases on data). One more time, as we mentioned when analyzing the research trends, we see that comparing some regions appears to be complicated when those regions are very different due to their size, capacities, investments, and other variables, exogenous in our analysis. That is the main reason why another evaluation must be made, comparing regions which are similar in terms of the mentioned variables.

The map of the allocation of industries according to their specialization patterns present some trends that can be observed. For example, regions specialized in food and beverages are mainly in Spain, Greece and Denmark; Romanian regions appear to be specialized in textile, leather and wearing industries; wood and furniture, cork and paper industries seem to have more presence in Finland, Sweden and Poland, in terms of specialization; chemical and chemical products and manufactures are more present, according to the Balassa indexes, in the regions of the center-north of Europe, especially in Germany and Belgium. On the other hand, some industries doesn't seem to have any concrete geographic distribution in terms of specialization, like the manufacturing of coke and refined petroleum products, the industries of basic metals, metal products or the non-metallic minerals and products, the transportation and storage industries, or the water supply, waste management and remediation activities companies.

Concentration effects can also have an important presence on the analysis, which lead us back to the discussion on whether so different regions can be compared or not. Regions with a larger presence of industries (measured by the number of employees) show, in general terms, lower rates of specialization in one sector or another, while regions with lower presence of industrial activities usually have higher Balassa indexes for one or two sectors. This is the main reason why, as can be observed in Annex A, in the list of the most specialized regions for each sector usually there is usually much more presence of those regions with lower rates of industrial activities. Section 2.4. presents some notes on the effects of concentration in front of specialization, concepts that, as we see, are usually correlated.

Chapter 3, where only 12 regions are considered, and they all are pretty similar in terms of the presence of research and industrial activities, will offer a more reliable point of view. As it will be seen, doing this concrete comparison, instead of a general one, changes the results and makes the hypotheses of potential specialization trends more measurable.

2.3. Correlations between scientific capacities and industrial activities in the European regions

After the independent analyses for scientific capacities (in terms of published articles) and the industrial activities (in terms of employees) in the European regions, now it is time to evaluate the interactions that science and industry present. Logic tells us that some research fields should be positively correlated with some industrial sectors; for instance, we could expect a positive correlation between agriculture, food sciences and fisheries (research fields) and the industrial sector of food and beverages. However, not all the logic relations that we could think of take place in reality.

The following table shows the correlations between scientific capacities (using data defined in section 2.1) and industrial activities (using data defined in section 2.2). Regressions on the table have been obtained by Ordinary Less Squared (OLS) method, where the independent variable has been for each case an industrial sector and the independent variables have been the different scientific fields. The number of regions taken into account has been 169 for all regressions; however, since availability of data for each industrial sector is different, in each line it is possible to see the size of the sample that has been used for that concrete regression). The regressions we present exclude heteroscedasticity and potential autocorrelation does not affect the purposes for the analysis.

Table 2.3.1. Correlations between scientific production (research fields) and industrial sectors by OLS. Dependent variable: rows; independent variables: columns. Full regressions are available in Annex B.

	Constant	Agriculture, food sciences and fisheries	Biology Sciences, Biotechnology and Biomedicine	Chemistry	ICTs , Computing, and Imaging	Physics, Astrophysics and Energy	Environment and Sustainability
Food and beverages (n=131)	9255,29 ***	6,11433	-5,16555 *	14,9330 ***	-4,47135	0,281378	-3,79869
Textiles, wearing and leather (n=108)	6345,62 *	10,9056	-10,2913 *	7,11810	-11,4212	-1,42521	-9,64912 **
Wood and furniture, cork and paper (n=140)	7952,16 ***	9,03620 **	-3,62822	6,79099 **	-8,01957	0,997430	-4,56928 *
Coke and refined petroleum products (n=74)	63.0517	0.020503	-1.03669 ***	0.650679	-0.87441	0.149175	0.641963 **
Chemical products (n=143)	114.146	1.94909	-2.32330	5.40646 ***	-6.19592 **	0.964969	-1.92036
Pharmaceutical products (n=112)	29.7882	1.98284	-1.96282 **	0.539506	1.77804	0.963994 ***	-0.60944
Rubber, plastic and non-metallic minerals (n=145)	5429.73 ***	7.85213 *	-5.26403 **	13.5496 ***	-8.48759 *	1.70342	-6.07026 ***
Basic metals and metal products (n=133)	6969.29 **	12.6517	-14.1183 **	8.07858	-36.5539 ***	13.3110 ***	-6.83444
Computer, electric, electronic and optical products (n=136)	3380.38 *	5.20979	0.859375	12.7548 ***	1.77147	2.88199 **	-7.37512 ***
Motor vehicles and transport equipment (n=119)	6239.76 *	5.67379	4.53661	13.8646 **	-1.74662	2.31525	-4.72063
Electricity, gas, steam and air conditioning supply (n=137)	2124.34 ***	-0.55351	-0.36709	1.74724	-4.53356 **	0.989133 **	-1.55697 *
Water supply, sewerage, waste management etc. (n=141)	2524.47 ***	-0.03644	-0.63327	0.342964	-4.31552 ***	0.646968 *	-1.09349
Construction (n=151)	19657.5 ***	23.4946 **	-18.4139 **	35.9321 ***	-19.1566	5.12912 *	-5.54447
Transportation and storage (n=143)	8128.59 *	2.19229	-14.5027 *	11.5431	-34.6614 ***	8.90349 ***	-0.77721
Information and communication products and technologies (n=143)	-1248.96	-14.6835 **	4.42705	-7.48671	13.7540	6.24665 ***	-4.38902

Source: Own elaboration.

(Continuation of table 2.3.1)

	Medical Sciences and Health affectations	Mathematics	Materials	Animal sciences	Physiology and Pharmacology	Engineering and Mechanics	R-squared adjusted
Food and beverages (n=131)	3,65260 ***	0,212924	0,611394	13,3209 *	-19,9889 **	0,818618	0,576056
Textiles, wearing and leather (n=108)	4,68292 **	4,46137	6,25414	27,2384	-3,54834	11,0353	0,149567
Wood and furniture, cork and paper (n=140)	3,23675 ***	5,71806	4,51825	7,97422	-20,2485 **	2,22186	0,314518
Coke and refined petroleum products (n=74)	0.421535 ***	-0.50100	0.466195	-0.37573	-0.96331	0.303695	0.376859
Chemical products (n=143)	2.67693 ***	4.12220	5.03669	4.05005	-11.3549 **	-1.88123	0.519778
Pharmaceutical products (n=112)	0.370229	-0.39100	1.18374	0.619653	3.45928	-1.14863	0.417462
Rubber, plastic and non-metallic minerals (n=145)	4.11607 ***	0.032925	5.03019	10.3307	-17.9918 **	-0.00973	0.530881
Basic metals and metal products (n=133)	12.0031 ***	26.5736 **	-2.63717	1.85380	-48.9252 ***	9.15674	0.577672
Computer, electric, electronic and optical products (n=136)	3.34463 ***	-8.23861	8.60572	2.08200	-21.3393 **	-9.72486 ***	0.612399
Motor vehicles and transport equipment (n=119)	3.04707	-12.2376	12.1924	-16.5860	-23.6346	-11.1850 **	0.439518
Electricity, gas, steam and air conditioning supply (n=137)	1.03373 ***	5.86862 **	6.30214 ***	1.96896	-6.45727 **	-2.05822 *	0.591933
Water supply, sewerage, waste management etc. (n=141)	0.538503 *	10.4533 ***	1.02866	3.27865	-3.55520	1.26359	0.603522
Construction (n=151)	9.54163 ***	44.1083 **	-19.2742	35.4608	-73.1565 ***	22.2081 ***	0.702763
Transportation and storage (n=143)	12.8546 ***	62.0058 ***	31.2677 **	13.3710	-60.9279 ***	-4.71055	0.728953
Information and communication products and technologies (n=143)	3.53454 **	39.5252 ***	16.7214 *	-3.36834	-27.5319 *	-12.5304 **	0.807548

Source: Own elaboration.

Results in the table are presented in the standard way. Values in the cells represent the variation amount of the dependent variable when independent ones do change. Significance of these values is represented by the stars below, when one star represents significance for 90%, two stars for 95% and three stars for 99%, using the common methodology. Last column of the table shows the value of the R-square adjusted, which represents the significance of the whole regression. The variation of this value from one industrial sector to another is high, as shown by values on the table.

2.3.1. Analysis by industrial sector

i) Food and beverages: There is a strong positive correlation, as expected, with the research field on agriculture, food sciences and fisheries. It is even stronger the correlation with chemistry, which seems also obvious, and animal sciences, due to that both agrofood and animal health usually present some links in research.

ii) Textiles, wearing and leather: Here we find also logical relations between research fields and this sector. Strong positive correlations coming from the research in animal sciences (probably due to the use of leathers), materials, engineering and chemistry, all three key elements for the manufacturing of textiles (cloths materials, dyes, etc.)

iii) Wood and furniture, cork and paper: Strong correlation with chemistry, which seems logical, but on the other hand there is a negative correlation with environment and sustainability, i.e. the more research in this field, the less presence of industries in the sector, while this relation shouldn't be negative but positive. However, context might be influenced by other undefined circumstances.

iv) Coke and refined petroleum products: For these regressions, changes on independent variables do not seem to make big changes on the dependent. Chemistry is the most influent variable in a positive way, which seems logic given the industrial sector and its characteristics.

v) Chemical products: There is a strong correlation with research in chemistry, as expected, but also a strong positive correlation with materials, which could also be intuited. Other correlations, positive or negative, have no concrete logic and they seem merely random.

vi) Pharmaceutical products: As expected, the main positive correlation with this industrial sector is the variable representing research in physiology and pharmacology, but also the research in chemistry, another highly related research field. Other independent variables present low values and they do not seem to have consistent relations with this sector.

vii) Rubber, plastic and non-metallic minerals: The main variables affecting the activity in this industrial sector are those representing research in chemistry and materials, among others, but only these two seem to have a clear and logical correlation with the sector, since research in agrofood and animal sciences do not apparently imply big changes for this sector.

viii) Basic metals and metal products: Surprisingly, research in materials sciences present a negative value when correlating it with this industrial sector, while the opposite effect should be expected. Physics and energy, on the other hand, present a strong positive correlation with the dependent variable and, given the study of some fields in physics that could have some logic.

ix) Computer, electronic and optical products: Strong positive correlation with research in materials, as expected, and also some positive correlation with research in ICTs, computing and imaging, even if it should be larger. There is a negative correlation with research in engineering, which does not seem so logical. The incidence of the rest of independent variables seems to be inconsequential.

x) Motor vehicles and transport equipment: The strongest positive correlations for this industrial sector are research in chemistry in the first position and materials; the second one seems to have more sense. However, it could be expected to find research in engineering on the list, but we find it to have a strong negative correlation.

xi) Electricity, gas, steam and air conditioning supply: In general terms, independent variables have no evident incidence on this industrial sector. The strongest positive correlation is the research in materials, which is logic given the sector.

xii) Water supply, sewerage, waste management, etc.: Here we find that the strongest and statistically most significant variable representing a research field is mathematics; however, the implications of this topic cannot be easily attributed when taking into account an industrial sector.

xiii) Construction: Research in engineering, as it could be expected, is one of the main research fields with a strong positive correlation with this industrial sector. Other strong positive values seem to be just trivial, since it is difficult to relate constructions to research fields like agrofood, animal sciences or mathematics.

xiv) Transportation and storage: Research in materials, if we do not take into account research in mathematics due to the complexity in analyzing its implications for industrial purposes in this sector, is the research field with the largest positive correlation to the transportation and storage sector. Other research fields seem not to be representative due to its value or topic.

xv) Information and communication products and technologies: As expected, and if one more time we do not take into account mathematics, research fields with a strongest positive correlation with information and communication products and technologies sector are ICTs, computing and imaging and materials sciences.

2.3.2. Final remarks and conclusions

The main aim of this section was to evaluate whether correlations between scientific fields and industrial sectors were coherent and consistent to the expected or logical. This is important when determining the relevance of the connections between research and industry, and the implications it may have for policies definition around the concept of the smart specialization strategy, which enhances the collaboration between both sides of the innovation process.

It has been proved, and it can be easily observed on the section's table, that some of these logical correlations are there indeed. However, only some of the observed values are significant enough and there are some unexpected correlations, some of them mentioned in the analysis on the previous sub-section. This leads us to think that, even if there are some coherent and strong correlations, some other are whether disjointed or too weak to be statistically significant. Thus, when analyzing the results coming from these regressions we must take into account that, in practice, research and industrial activities in the same regions may present nothing but some random effects when looking at their connectivity.

Tables with the complete information for all regressions can be found in Annex B. Observing the results and the significance values, we see that there are important disparities among different correlations. For example, adjusted R-squared for the sector of textiles, wearing and leather has a value of 0.150, while for information and communication technologies and products it reaches a value of 0.808, meaning that, for this regression, data set fits pretty well. Most regressions, though, present adjusted R-squared values of around 0.5, a little higher in some cases.

Literature analyzing connectivity between research and industry is very scarce, especially if we want to consider regions and it will be highly desirable to analyze in detail its implications, in particular when designing policies aiming the promotion of public-private partnerships to develop R&D and innovations, where research centers and groups from universities work together to achieve better products, processes and/or services. The present work wants to take into account these implications, but from a general point of view, since it seems logical when considering connectivity under the smart specialization strategy. However, further research should be done to find new methodologies to analyze how well research capacities of a region fits the industrial activities present in it, establishing new proxies or computational methods allowing an easier but concrete comparison among different territories, not just from a descriptive point of view, but also from an analytical one, allowing to be more precise and find standardized methods leading to better conclusions.

2.4. A note on concentration vs. specialization

Specialization and concentration are and have been concepts highly related. Hallet (2000), for example, takes in consideration and analyzes the implications of these two concepts in the EU. Among other results, he founds that the industry (measured for 17 sectors in terms of added value) with a higher concentration degree is the agriculture and food manufacturing one. He also proves that scale economies are concentrated just in a few regions. This is just a case that shows that research and industrial activities have been agglomerating in specific areas in the world's geography and, of course, also in the European Union, where we find regions and areas, usually associated to important cities, that have a larger activity. Our aim is to know if this concentration is more present in some research fields or industrial activities than in others, and also if it is more evident when we consider absolute data or when we analyze the specialization.

When measuring concentration, most authors tend to use the Gini coefficient. For example, Aiginger and Rossi-Hansberg (2006) use this coefficient to measure specialization and concentration in the US and the EU; Paulize, Pons and Tirado (1999) use it to compare industrial activities in the Spanish provinces; Feldkircher and Polasek (2006) analyze the relation between specialization and concentration for Austria and its border regions; De Benedictis, Gallegati and Tamberi (2009) use the Gini coefficient to relate the specialization rate to a country's development rate; Combes and Overman (2003), analyze the connections among cities, universities, industries and employment to understand the spatial distribution of economic activities in Europe using the Gini coefficient; etc.

Many examples can be provided on how the Gini coefficient (or index) can help to analyze concentration and specialization. The most common way to measure the coefficient is by using the following formula (where G_s is the Gini index for an industrial sector or scientific field *s*, and *x* are the observations):

$$G_s = \frac{2\sum_{i=1}^{n} i x_i}{n\sum_{i=1}^{n} x_i} - \frac{n+1}{n}$$

The Gini coefficient is related to the Lorenz curve, which represents the distance from the sample to the equality line; i.e. a coefficient of 0.00 would mean that there's no distance from the sample to the equality (where the weight of the industrial or scientific activity would be perfectly distributed among regions in the same proportion). The larger the coefficient, the bigger the distance from de Lorenz curve and thus from the equality, meaning that larger coefficients represent more concentration in a few regions. Lorenz curves for all industrial sectors and research fields can be found in annex C.

2.4.1. Concentration in scientific activities

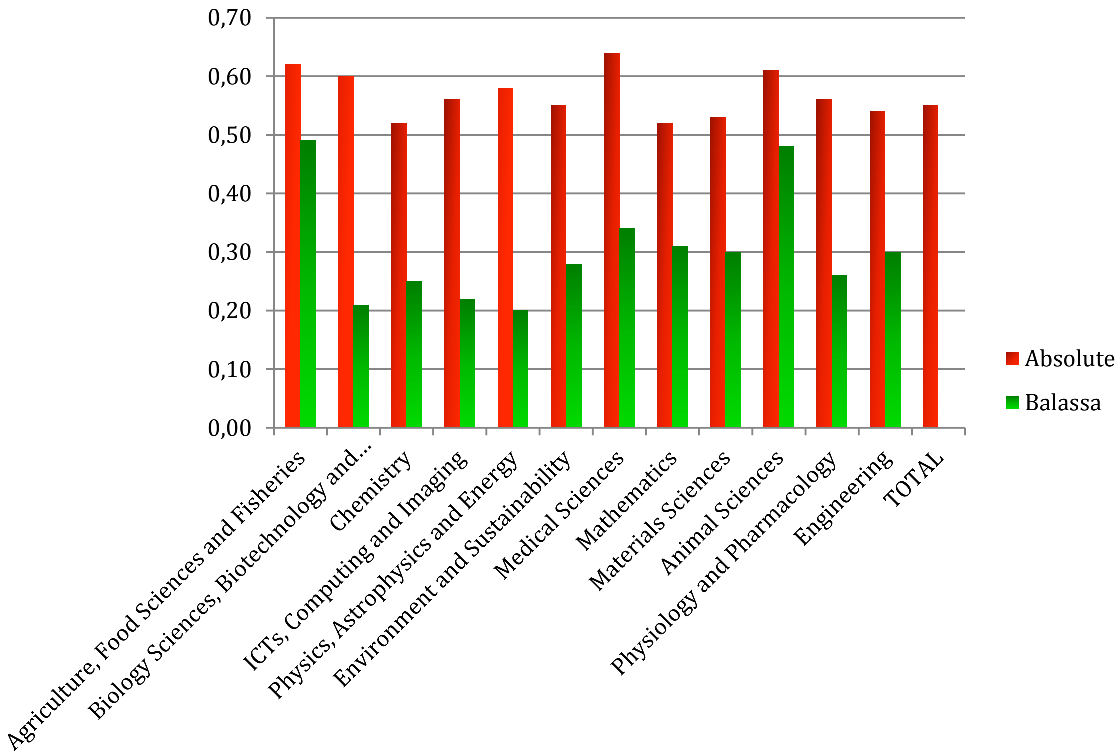
The following table and figure present the Gini coefficients for the scientific fields (measured in terms of scientific articles for the period 2007 – 2011). We easily observe that there is an important concentration for both absolute and relative measures being higher for absolute ones. This has its logic, since if we consider the absolute terms we take in consideration the geographic concentration of industrial and scientific activities in specific regions. On the other hand, specialization in specific scientific fields is much more distributed among the European regions even if there are some exceptions for specific research areas.

Table 2.4.1. Gini indexes for research fields in absolute and relative terms

Scientific research fields	Obs.	Coeff. Gini Absolute	Coeff. Gini Relative
Agriculture, Food Sciences and Fisheries	169	0.62	0.49
Biology Sciences, Biotechnology and Biomedicine	169	0.60	0.21
Chemistry	169	0.52	0.25
ICTs, Computing and Imaging	169	0.56	0.22
Physics, Astrophysics and Energy	169	0.58	0.20
Environment and Sustainability	169	0.55	0.28
Medical Sciences	169	0.64	0.34
Mathematics	169	0.52	0.31
Materials Sciences	169	0.53	0.30
Animal Sciences	169	0.61	0.48
Physiology and Pharmacology	169	0.56	0.26
Engineering	169	0.54	0.30
TOTAL	169	0.55	X

Source: Own elaboration

Figure 2.4.1. Gini indexes for research fields in absolute and relative terms



Source: Own elaboration

As we can see, for absolute terms, the mean is by around 0.55 and the coefficient for all research fields is comprised, in average, between 0.50 and 0.60. The only exceptions are agriculture, food sciences and fisheries, environment and sustainability and animal sciences, with coefficients above 0.60. However, in terms of Balassa's index, when we measure the concentration of the specialized regions in a field in a few regions, Gini indexes present larger disparities among them. For example, specialization in agriculture, food science and fisheries, as well as animal sciences, seems to be much more obvious than in the case of, for example biosciences, meaning that specialization trends for this field are shared by a larger number of regions.

Concentration, when considering research activities, must be understood as the location of the main R&D institutions of the different European regions. We should not be surprised to see that there exist important concentration trends for every field given that most of these institutions tend to be located in what is called knowledge hubs, close to main cities of the different regions, with a few number of exceptions for specific cases where these hubs are located outside the main urban areas.

2.4.2. Concentration in industrial activities

The following table and figure present the Gini coefficients for the industrial sectors (measured in terms of employees in each sector in 2009). As well as in the case of the scientific fields we observe that there are important concentration rates for each industrial sector, even if these indexes are much more different among them. When we consider the specialization indexes these divergences are even clearer.

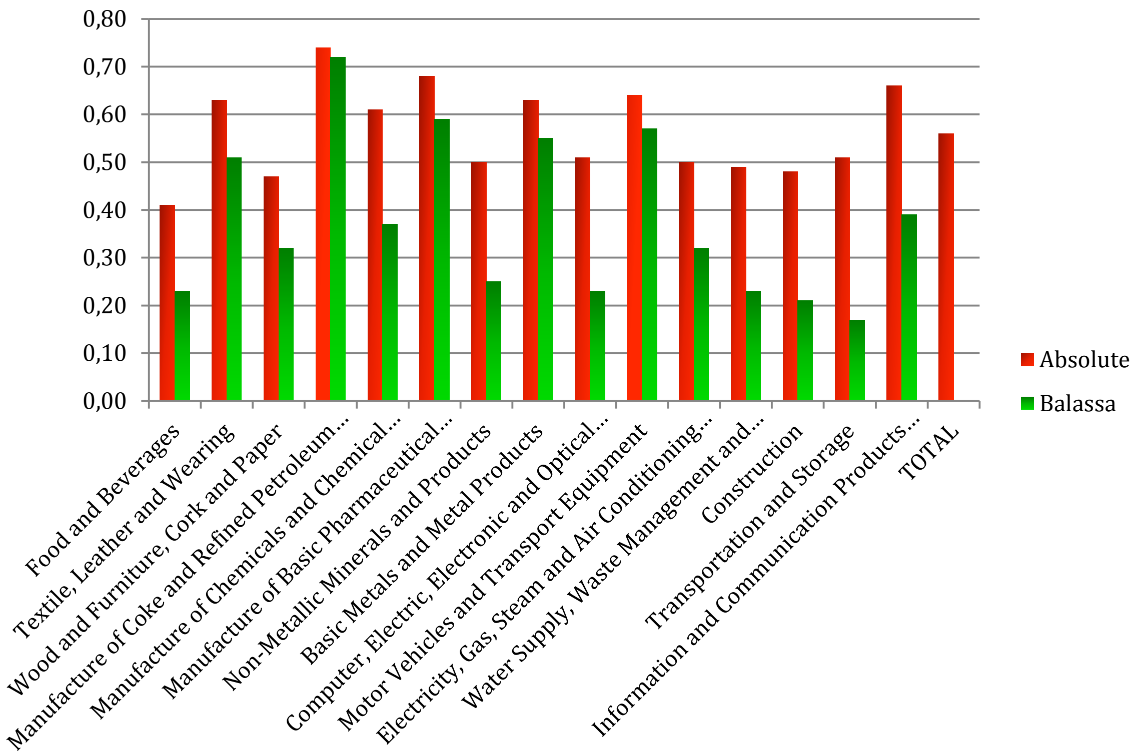
Note that the sample, the number of observations for each sector, is different, given the available data at Eurostat. The biases that we detected when analyzing the presence of industrial activities and specialization rates in section 2.2 are still present since the sample is the same, so we need to have in mind that these problems in data may present potential deviations when analyzing the concentration rates too.

Table 2.4.2. Gini indexes for industrial sectors in absolute and relative terms

Scientific research fields	Obs.	Coeff. Gini Absolute	Coeff. Gini Relative
Food and Beverages	166	0.41	0.23
Textile, Leather and Wearing	140	0.63	0.51
Wood and Furniture, Cork and Paper	171	0.47	0.32
Manufacture of Coke and Refined Petroleum Products	92	0.74	0.72
Manufacture of Chemicals and Chemical Products	180	0.61	0.37
Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations	134	0.68	0.59
Non-Metallic Minerals and Products	184	0.50	0.25
Basic Metals and Metal Products	76	0.63	0.55
Computer, Electric, Electronic and Optical Products	179	0.51	0.23
Motor Vehicles and Transport Equipment	76	0.64	0.57
Electricity, Gas, Steam and Air Conditioning Supply	174	0.50	0.32
Water Supply, Waste Management and Remediation Activities	183	0.49	0.23
Construction	196	0.48	0.21
Transportation and Storage	183	0.51	0.17
Information and Communication Products and Technologies	183	0.66	0.39
TOTAL	222	0.56	X

Source: Own elaboration

Figure 2.4.2. Gini indexes for industrial sectors in absolute and relative terms



Source: Own elaboration

In absolute terms, Gini indexes present higher deviations from the mean than in the case of the research activities. Indexes are comprised between 0.41 and 0.74 (the mean is 0.56). The lower index is for industries in the food and beverages sectors, which means that there is less concentration than in other cases. The highest index is for the sector of manufactures of coke and refined petroleum products, with a much higher concentration index. Other very concentrated sectors are, for example, the manufactures of chemicals and chemical products or the information and communication products and technologies.

If we consider the specialization patterns, in terms of the Balassa index, we see that specialization is also pretty concentrated in a few regions, more or less according to the presence of concentration in absolute terms, but with some differences. Thus, in terms of specialization rates, the most concentrated sectors are the manufactures of coke and refined petroleum products, followed by the manufacture of basic pharmaceutical products and pharmaceutical preparations, while the less concentrated sectors are food and beverages, construction, and transportation and storage, which has a Gini index of 0.17.

2.4.3. Summarized conclusions

We can briefly say that, as in the other sections of this chapter, we can see that even if we can identify some trends, it is difficult to generalize or be able to find generic models. However, having a look on these concentration patterns in front of the specialization trends show us that this concentration idea is present for all the scientific fields and all the industrial sectors that we have analyzed and it is thus not an exogenous variable when we develop our analysis and it must be taken into account to understand the conclusions that we obtain.

2.5. Aggergated remarks and conclusions

In this chapter we have been describing and analyzing the scientific capacities and the industrial activities of the European Union regions, trying to identify preexisting trends of specialization which may serve as the base for the definition of the application of the Smart Specialization Strategy (S3). We have also taken a look on the concept of concentration, as a topic directly related to the specialization, and to the connections between the research and the industrial activities. In all sections we have concluded that some trends seem to appear when analyzing all these topics. However, we have also concluded that none of them seem to be strong enough to determine whether there exist well-based trends or not. We thus need, first at all, to see whether the general specialization patterns found match with those coming from the relative advantage for each research field and industrial sector; i.e. if for example region A, when considering research in agriculture, food sciences and fisheries, has relative advantage compared to all others, it may has (or not) relative advantage in the same research field when we consider all the fields, but maybe this region is going to be more specialized in biosciences, which creates a bias between the two types of analysis. Following tables try to analyze this situation for each European region, trying to identify which are really strong patterns and which are not.

2.5.1. Specialization in terms of scientific capacities

When analyzing the research capacities of the European regions in section 2.1 we have first evaluated 12 research fields independently to see which are the most specialized regions for each one. At the end of the section we have also tried to distribute each region according to their specialization patterns when considering all the fields at the same time. Thus, the question is: are those regions most specialized in a field, when this is considered independently, also specialized in the same sector when we compare them all? If our analysis show that a region should specialize in field A but when we take a look on that field A it doesn't appear in the top regions performing research in this field, then we could say that the election of that field for that region is not that consistent.

Table 2.5.1 aims to put these two analyses (field by field independently and all fields together) together to identify robustness on the conclusions. Rows present all the European Union regions (except those we did not take into account given that there was no significant data available as we commented in section 2.1); columns represent the analyzed research fields. Letters represent the following fields:

A.- Agriculture, food sciences and fisheries
B.- Biology sciences, biotechnology and biomedicine
C.- Chemistry
D.- Information and communication technologies, computing and imaging
E.- Physics, astrophysics and energy
F.- Environment and sustainability
G.- Medical sciences
H.- Mathematics
I.- Materials sciences
J.- Animals sciences
K.- Physiology and pharmacology
L.- Engineering

Numbers in every cell make reference to the percentile in which the region in the row appears for the research field in the column, where 1 means that a region is in the top 10% for that research field (analyzed independently) and 2 means that it is between the top 10% and the top 20% and so on. For example, the Région de Bruxelles-Capitale has a value of 8 in chemistry; it means that when considering only the research in chemistry, this region appears to be in the percentile that goes from the 70% to the 80% which means that this region is far from being one of the most specialized regions in this research field.

The cells painted green make reference to the research field in which the region of the row is specialized according to the analysis where all fields are taken into account at the same time, i.e. the field in which that region should be specialized when we compare its performance in all the fields at the same time. If the painted cell coincides with a number 1 (meaning that that region is in the top 10% of regions performing research in that field) we will be able to say that the region is indeed specialized in that field with statistical robustness; otherwise this robustness is lower. As we will see in the table, in general terms, painted cells are those with a number 1 (even if in some cases it can be 2, 3, 4 or even 5). Dark green cells show coincidences of number 1 with painted cell, meaning that the region is in the top 10% of most specialized regions for that research field and at the same time that region seems to be specialized in that field when we compare it with the others.

Table 2.5.1. Specialization factors in terms of research capacities in the European Union regions (2007-2011)

		A	B	C	D	F	G	H	I	J	K	L	M
Belgium	Région de Bruxelles-Capitale	8	3	8	2	4	6	4	5	9	7	3	6
	Prov. Antwerpen	7	5	7	7	6	3	2	8	7	2	3	9
	Prov. Limburg	8	8	6	1	6	9	7	1	2	3	6	4
	Prov. Oost-Vlaanderen	2	2	8	8	9	3	5	6	7	1	6	5
	Prov. Vlaams-Brabant	3	6	7	3	7	8	3	5	5	7	2	4
	Prov. Hainaut	10	9	1	7	1	10	9	9	1	7	9	8
	Prov. Liège	3	4	7	9	5	3	5	9	6	1	3	5
Bulgaria	Yugozapaden	9	7	1	5	1	6	9	7	1	4	5	6
Czech Republic	Praha	6	5	2	9	2	4	7	4	3	4	3	7
	Jihozápad	1	2	4	9	8	1	10	3	4	1	8	9
	Severovýchod	4	9	1	10	8	10	9	10	1	10	8	3
	Jihovýchod	5	4	4	7	7	2	7	4	3	2	7	4
	Strední Morava	5	3	2	3	5	3	6	3	9	1	2	9
	Moravskoslezsko	10	10	4	1	8	2	10	2	1	10	10	1
Denmark	Hovedstaden	3	2	9	5	9	6	1	10	9	3	1	7
	Sjælland	3	2	3	3	6	1	7	9	8	7	3	9
	Syddanmark	7	1	9	6	10	9	1	10	10	7	1	10
	Midtjylland	1	1	8	7	9	2	3	9	9	2	2	10
	Nordjylland	7	10	10	1	9	9	7	9	9	10	5	1
Germany	Baden-Württemberg	5	3	7	5	3	7	3	8	6	8	5	8
	Bayern	6	3	5	5	5	9	2	9	6	5	5	9
	Berlin	6	4	6	5	5	8	2	5	9	2	3	9
	Brandenburg	5	4	3	9	3	1	9	4	7	4	9	10
	Bremen	8	9	6	5	7	1	8	7	5	8	9	6
	Hamburg	6	5	9	6	3	2	2	9	8	5	8	10
	Hessen	7	3	6	8	4	8	3	8	3	2	3	8
	Mecklenburg-Vorpommern	6	3	2	8	6	5	2	10	9	6	3	9
	Niedersachsen	3	2	7	8	7	4	2	8	7	5	5	8

Table 2.5.1. Continues from the prevuious page

		A	B	C	D	F	G	H	I	J	K	L	M
Germany	Nordrhein-Westfalen	7	5	5	8	2	8	3	6	5	7	5	8
	Rheinland-Pfalz	9	5	6	10	1	10	1	10	4	7	3	10
	Saarland	10	2	4	3	7	10	2	5	3	10	1	8
	Sachsen	7	5	6	7	5	9	2	9	3	3	7	7
	Sachsen-Anhalt	2	1	5	10	7	8	3	9	2	8	1	9
	Schleswig-Holstein	2	7	6	10	9	1	3	8	6	4	6	10
	Thüringen	9	3	4	8	5	7	4	8	2	6	3	10
Estonia	Eesti	3	4	6	8	7	1	7	8	6	2	5	6
Ireland	Border, Midland and Western	2	3	7	3	7	7	5	7	5	3	7	5
	Southern and Eastern	4	1	10	6	10	1	6	1	6	8	9	7
Greece	Anatoliki Makedonia, Thraki	2	9	10	1	10	2	2	10	10	9	7	1
	Kentriki Makedonia	4	9	6	3	8	3	4	10	4	2	5	2
	Thessalia	3	2	10	4	10	4	3	10	10	1	2	2
	Ipeiros	2	7	4	6	6	5	4	6	3	10	8	6
	Dytiki Ellada	8	8	4	1	6	6	7	7	1	9	8	1
	Attiki	3	9	8	3	6	6	3	6	6	9	5	2
	Voreio Aigaio	4	10	10	1	9	1	10	1	10	8	10	2
	Kriti	7	7	7	2	4	3	4	7	5	8	8	4
Spain	Galicia	2	6	1	7	8	3	7	5	6	5	6	3
	Cantabria	9	9	10	2	1	5	6	2	8	10	8	1
	País Vasco	5	8	2	3	2	7	7	5	2	7	8	4
	Comunidad Foral de Navarra	1	5	9	2	10	9	2	4	9	6	1	3
	Aragón	2	8	2	4	3	7	8	2	5	2	9	3
	Comunidad de Madrid	3	6	6	2	4	5	6	4	5	4	6	4
	Castilla y León	1	3	5	4	6	4	7	5	7	2	5	5
	Castilla-la-Mancha	1	9	2	1	9	3	9	4	8	4	9	2
	Extremadura	1	6	3	7	8	3	8	5	9	1	4	2
	Catalunya	3	5	5	4	7	4	4	5	8	3	6	7
	Comunidad Valenciana	2	7	2	1	5	6	8	4	5	7	9	3
	Illes Balears	5	4	6	6	1	1	8	8	8	9	3	9
	Andalucía	1	8	3	2	9	1	8	2	6	3	7	3
	Región de Murcia	1	3	4	3	10	4	5	2	10	1	4	8
	Canarias	4	8	5	8	1	3	8	3	8	2	3	8
France	Île de France	3	2	8	8	2	6	5	4	7	5	7	8
	Haute-Normandie	7	6	2	10	9	7	4	2	2	9	1	6
	Centre	6	4	5	9	4	5	5	3	5	2	2	7
	Basse-Normandie	7	8	3	2	3	6	6	1	4	8	4	6
	Bourgogne	1	2	2	1	8	4	8	4	4	5	4	9
	Nord - Pas-de-Calais	10	5	4	2	7	4	7	1	3	9	4	4
	Lorraine	3	8	2	6	5	3	9	6	2	10	9	1
	Alsace	9	1	1	9	4	8	6	4	3	6	4	9
	Franche-Comté	8	10	5	1	3	4	6	1	5	8	7	5
	Pays de la Loire	6	6	4	4	4	7	5	4	2	8	2	5
	Bretagne	6	7	1	3	9	4	8	2	2	4	7	6
	Poitou-Charentes	7	8	3	9	6	6	7	3	3	7	3	1
	Aquitaine	5	6	2	7	4	5	6	3	3	9	5	7
	Midi-Pyrénées	6	5	4	4	2	5	8	2	4	6	7	4
	Rhône-Alpes	9	6	3	6	1	7	7	6	2	7	8	5
	Auvergne	4	8	4	6	1	1	9	2	3	9	8	6
	Languedoc-Roussillon	4	1	4	10	6	2	7	6	2	5	6	7
	Provence-Alpes-Côte d'Azur	8	1	8	6	2	5	5	3	7	8	4	8

Table 2.5.1. Continues from the prevuious page

		A	B	C	D	F	G	H	I	J	K	L	M
Italy	Piemonte	4	7	6	4	2	7	4	5	4	4	5	9
	Liguria	9	7	8	7	3	6	2	8	8	8	4	4
	Lombardia	5	6	9	4	8	9	1	6	9	5	3	6
	Veneto	4	6	9	7	3	8	2	7	9	4	5	6
	Friuli-Venezia Giulia	2	8	5	6	2	7	5	4	8	5	4	4
	Emilia-Romagna	2	6	6	8	5	8	3	7	7	3	2	6
	Toscana	5	7	7	5	4	3	3	4	9	4	2	7
	Umbria	2	8	5	9	1	8	4	6	7	2	2	7
	Marche	2	1	5	6	8	4	6	7	7	1	1	5
	Lazio	7	7	9	7	1	9	5	6	10	7	5	6
	Abruzzo	9	7	9	4	9	9	1	5	10	10	1	6
	Campania	3	4	8	7	4	9	4	6	8	4	1	3
	Puglia	1	6	8	10	3	6	3	6	8	3	2	9
	Basilicata	2	8	4	4	3	1	10	2	8	2	9	3
	Calabria	4	9	2	3	2	5	9	3	4	7	4	2
	Sicilia	2	8	5	9	5	6	4	5	6	3	1	5
	Sardegna	2	6	3	10	6	6	5	8	6	1	1	7
Cyprus	Kypros	8	10	6	1	2	8	9	1	4	10	10	1
Latvia	Latvija	9	9	5	6	1	10	9	6	1	9	8	2
Lithuania	Lietuva	5	10	6	2	4	9	8	2	1	1	10	1
Luxemb.	Luxembourg	4	8	8	3	7	2	5	2	4	10	7	5
Hungary	Közép-Magyarország	3	4	4	5	3	6	6	3	6	3	4	8
	Közép-Dunántúl	1	9	1	4	6	2	10	2	8	4	10	2
	Nyugat-Dunántúl	1	1	10	10	10	2	9	10	10	1	9	10
	Dél-Dunántúl	6	1	5	10	10	10	1	10	10	6	1	10
	Észak-Alföld	1	1	4	9	7	9	2	2	10	5	2	10
	Dél-Alföld	6	3	1	9	8	9	3	3	7	8	1	10
Netherlands	Groningen	10	1	9	8	7	10	1	9	9	3	2	9
	Overijssel	9	9	4	1	2	8	9	8	1	10	10	1
	Gelderland	1	1	10	9	10	2	2	9	10	3	6	10
	Utrecht	5	3	9	8	10	4	1	10	10	1	2	10
	Noord-Holland	9	6	9	3	9	8	1	7	8	8	6	7
	Zuid-Holland	10	5	9	4	9	8	1	9	8	9	7	3
	Noord-Brabant	10	10	3	1	2	10	8	2	3	10	10	1
	Limburg	9	4	10	5	10	10	1	8	10	9	1	10
Austria	Wien	8	4	7	7	5	4	3	4	6	2	7	7
	Steiermark	8	5	5	6	7	7	3	4	3	9	5	5
	Oberösterreich	10	9	3	1	1	10	10	1	1	10	10	2
	Salzburg	4	1	10	2	10	1	4	7	10	4	6	10
	Tirol	8	3	9	5	8	4	1	10	9	9	2	10
Poland	Lódzkie	5	7	2	9	8	10	4	5	2	7	3	3
	Mazowieckie	4	7	2	6	1	5	8	5	2	5	7	5
	Malopolskie	7	8	3	9	1	5	6	3	3	6	2	5
	Slaskie	10	9	3	4	3	5	6	5	2	8	6	3
	Lubelskie	6	5	1	10	4	7	6	9	3	3	1	8
	Podkarpackie	10	9	2	7	6	10	10	1	1	10	10	1
	Podlaskie	9	1	10	7	8	9	2	3	7	6	1	4
	Wielkopolskie	4	7	1	5	5	4	7	3	3	2	6	6
	Zachodniopomorskie	8	10	1	9	3	4	10	5	7	4	10	1
	Lubuskie	8	10	10	1	2	10	10	1	7	3	9	2

Table 2.5.1. Continues from the prevuious page

		A	B	C	D	F	G	H	I	J	K	L	M
Poland	Dolnoslaskie	5	9	1	4	4	8	8	4	2	1	8	2
	Kujawsko-Pomorskie	6	7	1	2	2	8	8	1	5	6	7	9
	Warminsko-Mazurskie	1	3	10	10	10	1	9	9	10	1	8	9
	Pomorskie	6	4	2	7	9	5	5	6	4	5	3	3
Portugal	Norte	2	2	3	9	8	6	7	8	2	3	5	2
	Algarve	1	2	7	9	10	1	9	7	10	2	7	8
	Centro	4	8	1	7	4	3	9	4	1	7	8	3
	Lisboa	3	5	3	6	3	2	9	3	5	6	8	3
	Alentejo	1	9	5	10	8	1	10	3	9	1	9	7
Romania	Nord-Vest	9	10	1	1	5	9	10	1	1	6	10	5
	Centru	10	10	10	2	9	1	10	2	1	9	10	1
	Nord-Est	10	10	2	2	3	6	10	1	1	8	10	3
	Bucuresti - Ilfov	10	10	1	2	1	10	10	1	1	10	9	2
	Sud-Vest Oltenia	9	10	3	1	8	9	10	1	4	10	10	1
	Vest	9	10	1	3	2	10	10	1	1	9	10	1
Slovenia	Vzhodna Slovenija	4	10	7	2	1	10	9	1	1	9	8	1
	Zahodna Slovenija	7	7	3	5	2	9	7	3	2	5	5	2
Slovakia	Bratislavský kraj	5	4	3	9	1	7	8	6	2	2	2	7
Finland	Východné Slovensko	8	7	5	10	2	4	8	2	3	5	7	2
	Itä-Suomi	3	5	9	3	10	2	1	10	9	5	1	9
	Etelä-Suomi	4	2	8	5	6	3	4	9	6	4	6	8
	Länsi-Suomi	8	6	8	2	5	8	2	7	6	7	7	4
	Pohjois-Suomi	7	3	10	3	9	2	3	8	8	4	8	6
Sweden	Stockholm	10	2	9	8	8	7	1	10	7	8	3	8
	Östra Mellansverige	10	1	8	8	5	7	2	9	5	6	2	8
	Sydsverige	5	2	7	8	7	5	1	10	8	6	6	8
	Västsverige	8	6	8	8	7	5	1	9	5	8	6	4
	Övre Norrland	8	3	9	9	9	2	3	7	5	9	9	4
United Kingdom	North East	6	5	6	8	4	2	5	8	6	5	9	7
	North West	9	3	8	5	4	5	5	6	4	4	4	4
	Yorkshire and The Humber	7	4	7	5	6	2	6	7	4	6	9	3
	East Midlands	6	5	7	4	5	7	5	6	4	6	4	2
	West Midlands	8	4	8	6	4	8	4	3	4	7	6	4
	East of England	7	2	7	5	3	3	6	8	4	3	9	4
	London	10	2	10	4	7	7	1	8	9	6	4	7
	South East	7	2	6	4	3	6	6	7	5	6	8	5
	South West	6	4	7	6	6	2	6	5	6	1	4	5
	Wales	5	4	9	3	10	3	4	7	5	5	4	3
	Scotland	5	1	8	5	6	3	5	7	7	1	6	6
	Northern Ireland	3	6	7	2	5	5	4	10	7	3	4	5

Source: Own elaboration

Taking a look at the table, we can easily see that the question "are there existing patterns of specialization in the scientific research fields?" has a rather obvious answer: yes. Additionally, we can also state that these patterns appear to be consistent due to the reasons we mentioned before: in most of the cases a region that appears to be specialized in a research field, when we comparing the intensity in this field compared to the other, is also found among the top regions for that concrete research field. This proves the existence of some trends and patterns of specialization in the European Union even if they present some problems that we describe at the end of this section.

Subsection 2.1.13 provides more concrete remarks regarding the distribution of regions according to the research fields in which they're most specialized but, additionally to that information, we now can state that this distribution is robust. However, it is true that our data is not complete and it does not include the whole amount of scientific articles, even if it includes a large proportion of them and it provides a proper perspective of the existent trends. Chapter 3 will analyze the data more in detail for specific regions making the study more concrete.

2.5.2. Specialization in terms of industrial activities

In section 2.2 we analyzed the industrial activities of the European regions, dividing the industrial sectors in 15, using as a reference the sectors that appear at the Eurostat database, aggregating some of them in order to reduce the number. As we did for the scientific research, we also tried to distribute each region according to their specialization patterns when considering all the sectors at the same time. The question is one more time: are those regions most specialized in a sector, when it is considered independently, also specialized in the same sector when we look at the performance of that region comparing all sectors? If a region is specialized in a field in both analyses then we can say that the election of that field is consistent.

As we did for the scientific capacities, table 2.5.2 aims to put these two analyzes together to identify robustness on the conclusions coming from section 2.2. Rows show all the European Union regions; columns represent the analyzed sectors. Letters represent the following sectors:

A.- Food and beverages
B.- Textile, leather and wearing
C.- Wood and furniture, cork and paper
D.- Manufacture of coke and refined petroleum products
E.- Manufacture of chemicals and chemical products
F.- Manufacture of basic pharmaceutical products and pharmaceutical preparations
G.- Non-metallic materials and products
H.- Basic metals and metal products
I.- Computer, electric, electronic and optical products
J.- Motor vehicles and transport equipment
K.- Electricity, gas, steam and air conditioning supply
L.- Water supply, sewerage, waste management and remediation activities
M.- Construction
N.- Transportation and storage
O.- Information and communication products and technologies

As in table 5.2.1, numbers in every cell make reference to the percentile in which the region in the row is for the sector in the column, where 1 means that a region is in the first top 10% for that sector, and 10 would be that that region is in the last 10%.

The cells painted in orange make reference to the industrial sector in which the region of the row is specialized according to the analysis where all sectors are taken into account at the same time, meaning that the sector in which a region should be specialized when we compare its performance in all the sectors at the same time. If a painted cell coincides with a number 1 in it (meaning that that region is in the top 10% of regions most specialized in that sector) we can say that that region is significantly specialized in that sector. Dark orange cells show coincidences of number 1 with painted cells, meaning that the region is in the 10% of most specialized regions in that industrial sector and, at the same time, that that region is specialized in that sector when comparing them all. Cells with an X represent regions with no data for the industrial sector in the column.

Table 2.5.2. Specialization factors in terms of industrial activities in the European Union regions (2009)

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Belgium	Région de Bruxelles-Capitale	10	X	10	1	3	4	10	3	10	3	3	X	9	7	1
	Prov. Antwerpen	5	9	9	X	1	X	9	X	2	X	9	6	8	3	4
	Prov. Limburg	6	X	5	4	1	10	1	9	1	10	6	7	4	10	6
	Prov. Oost-Vlaanderen	3	4	7	X	2	9	5	X	3	X	5	7	4	7	6
	Prov. Vlaams-Brabant	3	10	9	X	4	X	9	X	8	X	8	9	9	1	1
	Prov. West-Vlaanderen	2	2	4	4	5	8	6	8	6	9	9	7	5	10	9
	Prov. Brabant Wallon	X	10	X	4	5	1	10	1	10	1	X	X	10	10	4
	Prov. Hainaut	7	X	8	X	1	2	4	X	1	X	6	4	5	3	8
	Prov. Liège	3	8	9	X	3	X	5	X	4	X	4	2	3	6	7
	Prov. Luxembourg	X	10	X	3	1	X	2	X	1	X	X	5	1	10	6
	Prov. Namur	4	10	10	3	8	X	2	X	3	X	2	2	3	10	4
Bulgaria	Severozapaden	2	1	6	X	10	5	4	X	6	X	1	2	10	10	10
	Severen tsentralen	2	1	3	X	3	4	3	X	3	X	8	4	10	8	10
	Severoiztochen	3	2	7	X	2	X	5	X	3	X	5	1	6	7	10
	Yugoiztochen	2	2	7	X	8	X	6	X	7	X	1	3	3	9	10
	Yugozapaden	7	2	9	X	10	X	9	X	9	X	1	5	6	6	2
	Yuzhen tsentralen	2	1	4	X	4	X	5	X	5	X	7	4	10	10	10
Czech Republic	Praha	10	8	9	X	9	X	9	X	10	X	5	5	6	1	1
	Strední Cechy	6	7	4	X	2	4	2	X	2	X	8	3	7	5	9
	Jihozápad	5	5	2	8	8	10	1	9	3	10	3	3	6	6	9
	Severozápad	8	5	5	X	1	X	1	X	1	X	4	1	7	8	10
	Severovýchod	7	3	4	X	4	7	1	X	1	X	8	3	7	9	9
	Jihovýchod	5	4	3	X	9	3	3	X	4	X	7	3	5	8	5
	Strední Morava	5	4	3	X	3	8	1	X	1	X	7	4	7	10	9
	Moravskoslezsko	5	6	4	X	6	X	5	X	5	X	3	2	5	4	7
Denmark	Hovedstaden	X	10	10	X	3	1	10	X	9	X	7	10	9	1	1
	Sjælland	3	10	10	X	3	X	4	X	4	X	5	5	3	5	7
	Syddanmark	1	X	6	X	5	X	7	X	6	X	4	7	5	3	5
	Midtjylland	2	X	3	8	6	X	7	X	7	X	7	9	5	6	3
	Nordjylland	X	X	3	X	9	X	3	X	5	X	6	4	3	5	3
Germany	Baden-Württemberg	7	6	5	X	2	1	3	X	2	X	3	9	9	7	2
	Bayern	6	6	7	X	1	6	2	X	1	X	5	10	9	7	2
	Berlin	10	X	10	8	8	1	10	1	10	1	X	X	8	1	1
	Brandenburg	7	X	6	X	2	6	6	X	5	X	X	X	3	2	6
	Bremen	X	X	10	X	7	X	10	X	10	X	X	X	10	1	3
	Hamburg	X	X	X	1	5	7	10	1	10	2	X	X	10	1	1
	Hessen	9	X	9	X	1	1	6	X	3	X	5	10	10	1	2
	Mecklenburg-Vorpommern	1	X	8	8	7	7	8	8	9	9	4	2	5	2	7
	Niedersachsen	X	9	8	2	2	5	2	4	2	5	4	7	6	2	5

Table 2.5.2. Continues from the prevuious page

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Germany	Nordrhein-Westfalen	8	8	7	2	1	4	7	3	3	4	3	7	10	1	2
	Rheinland-Pfalz	9	X	7	X	1	2	2	X	1	X	5	6	10	6	5
	Saarland	3	X	10	X	8	X	1	X	2	X	1	6	7	7	3
	Sachsen	9	X	7	8	4	3	5	5	4	2	3	4	3	5	5
	Sachsen-Anhalt	3	X	8	X	1	2	4	X	1	X	3	4	5	7	10
	Schleswig-Holstein	4	X	X	1	3	1	7	1	6	1	X	X	9	2	3
	Thüringen	5	8	7	X	5	6	1	6	1	6	5	5	6	9	6
Estonia	Eesti	7	3	2	1	7	9	8	4	8	7	3	7	8	5	4
Ireland	Border, Midland and Western	1	X	X	X	3	2	2	X	2	X	10	1	8	5	4
	Southern and Eastern	4	X	X	X	5	1	10	X	8	X	10	7	9	2	1
Greece	Anatoliki Makedonia, Thraki	X	X	1	X	X	X	X	X	X	X	X	5	1	X	X
	Kentriki Makedonia	1	2	5	X	3	X	2	X	2	X	X	10	2	X	X
	Dytiki Makedonia	X	X	X	X	X	X	X	X	X	X	X	8	1	X	X
	Thessalia	1	3	X	X	8	X	1	X	2	X	X	8	2	X	X
	Ipeiros	1	X	X	X	X	X	X	X	X	X	X	10	1	X	X
	Ionia Nisia	4	X	X	X	4	X	X	X	X	X	X	4	1	X	X
	Dytiki Ellada	1	X	5	X	8	X	5	X	6	X	X	9	1	X	X
	Sterea Ellada	1	X	3	X	1	X	1	X	1	X	X	10	4	X	X
	Peloponnisos	1	X	2	X	X	X	X	X	X	X	X	9	1	X	X
	Attiki	3	3	5	X	4	1	6	1	6	1	X	X	2	X	X
	Voreio Aigaio	1	X	1	X	X	X	X	X	X	X	X	X	1	X	X
	Notio Aigaio	6	X	X	X	X	X	9	X	X	X	X	2	1	X	X
	Kriti	1	X	X	X	X	X	3	X	X	X	X	X	1	X	X
Spain	Galicia	4	X	5	X	9	8	6	X	7	X	9	9	2	5	7
	Principado de Asturias	6	8	9	X	6	X	7	X	7	X	8	6	2	7	6
	Cantabria	5	X	8	8	2	X	6	X	4	X	8	5	2	7	9
	País Vasco	8	9	6	X	5	7	3	X	4	X	10	8	2	7	5
	Comunidad Foral de Navarra	2	8	5	9	6	X	3	X	4	X	8	10	3	8	9
	La Rioja	1	3	3	X	6	X	2	X	2	X	10	10	4	10	10
	Aragón	8	6	4	9	4	4	5	5	5	5	9	10	2	6	7
	Comunidad de Madrid	10	8	9	X	9	2	10	X	10	X	9	8	3	3	1
	Castilla y León	2	X	7	9	8	5	4	6	5	6	8	10	2	8	9
	Castilla-la Mancha	4	5	4	X	5	7	5	X	5	X	6	9	2	8	10
	Extremadura	2	X	8	9	10	10	8	9	9	X	7	8	1	8	9
	Catalunya	6	5	8	X	1	2	8	X	5	X	9	8	4	6	4
	Comunidad Valenciana	8	4	5	X	4	X	2	X	2	X	9	8	4	7	8
	Illes Balears	10	7	9	9	10	X	10	X	10	X	9	3	1	2	5
	Andalucía	7	7	8	X	7	9	9	X	9	X	9	3	1	5	6
	Región de Murcia	1	X	X	X	3	6	7	X	6	X	X	5	2	6	9
	Canarias	8	X	10	X	10	X	10	X	10	X	9	1	2	1	7
Italy	Piemonte	6	3	8	2	4	6	4	5	3	5	7	5	6	8	3
	Valle d'Aosta / Vallée d'Aoste	8	9	7	3	10	10	10	9	10	10	1	6	1	7	4

Table 2.5.2. Continues from the prevuious page

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Italy	Liguria	8	9	10	1	7	7	9	4	9	6	7	2	4	1	5
	Lombardia	9	2	6	2	2	2	5	2	3	1	9	9	8	9	4
	Provincia Autonoma Bolzano	4	9	2	9	7	10	8	10	9	10	4	8	2	7	5
	Provincia Autonoma Trento	8	4	3	3	6	X	3	X	4	X	6	7	3	9	5
	Veneto	8	1	2	2	6	6	3	6	3	7	9	7	7	10	6
	Friuli-Venezia Giulia	9	7	1	3	8	8	4	8	5	8	9	7	6	8	5
	Emilia-Romagna	4	3	6	3	4	6	1	6	2	6	8	9	7	8	6
	Toscana	10	1	4	2	7	3	7	2	7	2	9	6	6	9	6
	Umbria	6	2	4	3	6	8	4	8	5	9	8	5	4	9	7
	Marche	9	1	1	2	9	6	4	5	5	5	10	7	8	10	8
	Lazio	10	8	10	1	9	1	9	1	10	1	6	5	6	4	1
	Abruzzo	6	2	5	2	8	5	3	4	4	4	9	6	5	9	8
	Molise	3	3	8	9	9	9	6	9	7	10	7	9	2	9	8
	Campania	6	X	8	2	9	7	8	6	8	7	8	1	3	3	5
	Puglia	7	2	5	2	9	9	7	7	8	3	8	1	3	9	7
	Basilicata	5	7	4	2	10	8	5	7	7	8	7	2	2	9	7
	Calabria	6	X	9	2	10	10	7	8	8	10	6	2	2	4	5
	Sicilia	7	8	9	1	8	6	7	2	8	3	7	1	3	6	6
	Sardegna	7	9	8	1	6	10	8	3	8	7	6	1	2	6	6
Cyprus	Kypros	2	8	6	X	9	3	8	X	8	X	7	10	3	5	4
Latvia	Latvija	5	4	2	4	8	5	9	6	10	5	2	5	9	2	5
Lithuania	Lietuva	3	3	2	X	7	8	8	X	8	X	2	4	8	3	6
Luxemb.	Luxembourg	X	X	X	10	X	X	X	X	X	X	8	9	1	1	2
Hungary	Közép-Magyarország	8	7	9	X	8	1	8	X	8	X	7	3	8	2	1
	Közép-Dunántúl	6	6	6	1	6	4	1	2	1	2	2	1	9	7	8
	Nyugat-Dunántúl	5	3	3	2	9	6	2	5	4	6	7	1	10	4	8
	Dél-Dunántúl	3	3	7	X	10	9	6	X	8	X	1	1	8	4	7
	Észak-Magyarország	5	5	7	X	1	6	4	X	2	X	1	1	9	4	9
	Észak-Alföld	2	2	7	X	10	2	4	X	6	X	6	1	9	4	8
	Dél-Alföld	1	4	6	1	8	9	4	5	5	7	5	2	10	6	8
Netherlands	Groningen	7	X	4	X	2	9	9	X	7	X	4	6	7	7	1
	Friesland	X	X	4	10	8	8	6	8	7	9	7	5	2	2	4
	Drenthe	X	X	X	10	1	X	7	X	5	X	2	2	2	3	4
	Overijssel	X	X	5	2	3	7	4	5	3	7	6	9	3	5	4
	Gelderland	X	7	4	3	5	7	7	8	7	8	7	6	3	3	3
	Flevoland	2	X	9	10	5	4	10	4	9	4	8	7	7	4	1
	Utrecht	8	X	10	X	7	9	10	X	10	X	10	10	5	4	1
	Noord-Holland	X	X	10	X	6	3	10	X	10	X	8	3	8	1	1
	Zuid-Holland	9	X	10	1	3	4	10	1	9	2	9	7	4	2	2
	Zeeland	X	X	X	X	1	10	10	X	1	X	8	7	5	2	9
	Noord-Brabant	5	X	6	X	2	1	8	X	6	X	10	8	4	4	4
	Limburg	7	X	7	X	1	9	3	X	1	X	8	5	9	3	4

Table 2.5.2. Continues from the prevuious page

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Austria	Burgenland	3	4	X	10	9	5	4	6	6	6	3	3	3	8	7
	Niederösterreich	4	7	X	X	3	7	4	X	3	X	6	6	5	2	7
	Wien	10	10	10	X	7	1	10	X	10	X	2	8	6	2	1
	Kärnten	8	7	3	X	7	3	3	X	4	X	2	8	4	6	6
	Steiermark	7	6	1	X	9	4	5	X	6	X	4	6	5	5	5
	Oberösterreich	5	7	2	10	2	5	2	X	2	X	7	9	7	7	7
	Salzburg	7	7	2	10	7	X	7	X	7	X	4	9	4	2	6
	Tirol	8	8	4	X	9	1	2	1	3	1	5	9	8	5	8
	Vorarlberg	4	2	3	X	10	X	5	X	7	X	3	10	7	4	8
Poland	Lódzkie	3	1	5	X	7	3	1	X	2	X	1	X	10	10	9
	Mazowieckie	6	6	8	X	4	3	8	X	7	X	4	7	9	1	2
	Malopolskie	4	4	4	2	5	X	4	X	5	X	3	4	5	8	5
	Slaskie	5	5	8	1	5	X	2	X	3	X	1	2	6	6	7
	Lubelskie	1	4	2	3	X	5	5	5	X	6	1	5	6	5	8
	Podkarpackie	4	6	2	X	3	5	1	X	1	X	3	6	9	10	10
	Swietokrzyskie	4	5	5	3	10	X	1	X	1	X	2	4	7	7	10
	Podlaskie	1	5	1	X	10	X	2	X	4	X	2	6	8	8	10
	Wielkopolskie	2	4	1	X	7	5	3	X	5	X	5	7	8	9	8
	Zachodniopomorskie	3	6	2	2	3	X	6	X	5	X	1	2	7	5	8
	Lubuskie	5	3	1	3	6	X	2	X	3	X	4	3	9	9	10
	Dolnoslaskie	8	4	3	X	4	3	1	X	2	X	2	3	7	8	6
	Opolskie	2	5	2	X	2	X	4	X	2	X	1	4	7	10	10
	Kujawsko-Pomorskie	3	4	1	3	2	8	3	7	2	8	4	5	8	10	10
	Warminsko-Mazurskie	2	5	1	X	10	X	2	X	4	X	4	3	9	10	10
	Pomorskie	4	5	2	X	6	X	5	X	6	X	3	4	6	6	6
Portugal	Norte	8	1	3	3	9	8	8	8	9	9	10	9	4	10	10
	Algarve	X	9	X	X	X	10	X	X	X	X	10	1	1	9	10
	Centro	5	3	3	X	8	8	1	X	1	X	10	8	4	10	9
	Lisboa	8	X	9	X	6	2	9	X	9	X	8	6	3	3	2
	Alentejo	1	X	5	1	4	X	6	X	6	X	10	6	3	10	10
	Região Autónoma dos Açores	X	X	X	X	X	10	X	X	X	X	2	6	1	4	8
	Região Autónoma da Madeira	X	X	X	X	X	10	X	X	X	X	1	5	1	3	8
Romania	Nord-Vest	6	1	2	3	10	7	5	7	7	8	5	4	8	8	8
	Centru	4	1	2	3	4	6	7	7	6	7	2	3	9	9	9
	Nord-Est	4	1	3	1	5	4	9	3	9	3	3	2	8	10	9
	Sud-Est	3	1	7	1	10	10	8	7	9	9	1	1	8	4	10
	Sud - Muntenia	2	1	6	1	5	8	6	2	7	4	4	2	8	8	10
	Bucuresti - Ilfov	8	4	10	3	8	4	9	4	9	4	2	2	7	6	2
	Sud-Vest Oltenia	6	2	8	3	1	10	6	9	3	10	1	3	8	8	10
	Vest	6	1	4	4	9	9	6	9	7	10	2	2	8	7	7
Slovenia	Vzhodna Slovenija	8	3	2	X	4	2	3	2	3	2	4	4	7	9	9
	Zahodna Slovenija	9	5	5	10	5	2	7	2	6	2	5	6	5	6	4

Table 2.5.2. Continues from the prevuious page

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Slovakia	Bratislavský kraj	10	9	10	X	8	9	8	X	8	X	2	6	10	1	2
	Západné Slovensko	3	2	3	X	2	X	1	X	1	X	2	1	10	10	10
	Stredné Slovensko	7	4	1	X	7	X	3	X	4	X	2	1	9	9	9
	Východné Slovensko	4	2	7	X	6	X	1	X	2	X	1	1	10	9	9
Finland	Itä-Suomi	X	6	1	10	X	3	5	3	X	3	6	8	3	3	5
	Etelä-Suomi	8	10	5	1	3	4	9	2	8	3	6	10	7	3	2
	Länsi-Suomi	X	6	1	X	5	X	3	X	4	X	5	10	6	5	3
	Pohjois-Suomi	X	7	X	X	4	X	9	X	8	X	4	7	2	1	3
	Åland	X	10	X	10	X	10	9	10	X	X	7	10	10	1	4
Sweden	Stockholm	10	10	10	X	7	X	10	X	10	X	6	10	6	2	1
	Östra Mellansverige	9	9	5	X	2	2	8	X	7	X	3	8	4	4	3
	Småland med öarna	9	10	1	X	9	X	2	X	4	X	4	10	9	5	4
	Sydsverige	5	10	6	X	2	2	6	X	5	X	6	9	6	4	3
	Västsverige	8	7	3	1	4	X	8	X	7	X	4	9	7	2	3
	Norra Mellansverige	X	10	1	X	10	X	10	X	9	X	3	9	4	4	4
	Mellersta Norrland	10	10	1	X	3	X	10	X	8	X	2	9	6	3	3
	Övre Norrland	X	X	1	X	9	X	9	X	9	X	1	10	4	2	2
United Kingdom	North East	9	8	7	2	2	3	7	3	5	2	3	8	5	6	3
	North West	X	6	6	2	1	3	7	3	4	3	6	5	5	5	2
	Yorkshire and The Humber	X	6	6	1	2	6	5	4	4	5	5	7	7	3	2
	East Midlands	X	5	6	7	4	7	3	7	3	8	5	4	6	4	3
	West Midlands	7	9	8	X	7	8	6	X	7	X	5	3	6	3	2
	East of England	9	9	9	2	6	4	8	3	8	4	9	4	4	3	2
	London	X	8	10	4	10	9	10	9	10	10	10	8	9	1	1
	South East	X	9	9	2	5	5	10	5	9	5	6	4	5	5	1
	South West	7	8	8	X	6	5	7	X	8	X	6	3	4	3	2
	Wales	6	9	6	X	3	3	6	X	6	X	5	2	5	6	3
	Scotland	6	6	9	3	6	7	10	7	9	8	3	3	4	4	3
	Northern Ireland	2	7	6	3	7	3	4	3	6	3	9	8	5	8	3

Source: Own elaboration

Again, what we were wondering was whether there were evident patterns of specialization or in terms of industry in the European regions. The answer seems to be the same as in the case of the scientific activities: yes. However, as it was mentioned in section 2.2, data was not that consistent and, for some industrial sectors, there is an important lack of data, making the analysis more complicated and less statistically significant. For example, France, with no data at all for its regions, has not been included in the analysis.

Regarding the table, we can also state that there are evident existing patterns of specialization in the European regions when considering their industries. Furthermore, we can say that these patterns are consistent given that in most of the cases a region appearing to be specialized in an industrial sector, when comparing the intensity in this sector compared to the rest, we also find that this region is among the top regions for that sector in concrete.

More detailed conclusions were provided in section 2.2.16 on the distribution of regions according to the industrial sectors in which they should specialize in, confirming now that the patterns are robust. Nevertheless, it is important to mention one more time that problems in data may affect the results and their interpretations, but it's the best available source and it is the one that has been used for many authors analyzing concentration and specialization in the European states and regions. As well as for the scientific capacities, chapter 3 will enter more in detail in specific regions to provide a more accurate analysis of them.

2.5.3. Concluding questions

After the considerations devoted to the scientific capacities and the industrial activities of the European regions in the previous subsections, now we aim to provide general conclusions to the analyses that have been undertaken. The following questions (and, of course, their related answers) should present the main deductions and conclusions obtained in this chapter, which aimed to identify weather it is possible or not to identify preexisting patterns of specialization in the European regions that may lead to proper top-down approaches when creating policies and regulations according to the smart specialization strategy.

To the question '*Are there specialization trends in the European regions?*', the answer is '*Yes*'. After the analysis provided in the previous sections we can state that it is possible to identify specialization trends in the EU regions for both scientific and industrial activities. However, as we have seen, the specialization patters are much more present in some regions, meaning that some regions have larger rates of specialization in a field or sector compared to the others; in general terms, little regions (in terms of number or scientific articles or employees) present larger specialization indexes compare to those regions with a larger intensity of research and/or industrial activities. Sections 2.1 and 2.2 show the evidence behind these facts, as well as an overview of the main trains. The question is: now that the regional governments and other agents are involved in the definition of their smart specialization strategies, will they have in mind these general overviews when defining their main strengths? Further studies should be carried out in the future to be able to answer this question, integrating other variables that could help to have an improved overview. In the chapter 3 we will be able to enter more in detail in the specialization trends of some regions in order to see if these trends are still present and are the same when comparing regions to other with a similar intensity in terms of research and industrial activities.

To the question '*Are these trends statistically significant?*', the answer is also '*Yes*'. The evidence of these trends is also robust in both cases. As it has been mentioned before, for both scientific capacities and industrial activities we have analyzed the specialization trends in two ways: comparing all regions when only considering one field or sector and trying to see which are the leaders and the followers and also comparing all regions considering all fields or sectors at the same time, trying to allocate one field or sector to every region, according to their specialization indexes. As we have seen, those regions that are leaders in a field independently are also specialized in the same field when comparing it with others, which means that there is robustness in the results. To show and prove the existence of these specialization trends we could have used other proxies that have been developed in the literature, since there are many and all they look to find these tendencies, but the Balassa index is a simple and clear proxy which is easy to analyze, as well as the most used one.

To the question '*Are these trends enough to justify top-down policies regarding the smart specialization strategy?*', the answer is '*No*'. First, it must be taken into account that the smart specialization strategy also looks for a bottom-up point of view, following the principle of the entrepreneurial process of discovery. On the other hand though, regarding the top-down dimension, we need to focus in the identification of the sectors that can achieve the best results, fostering synergies among the regions, while stressing the connectivity. When we consider these concepts, the identified trends can be a good and proper start for regions aiming to identify which is the critical mass in their regions in order to establish a starting framework. After the identification of these main trends, it is necessary to evaluate the achievements for the field / sector in which a region appears to be specialized, in order to see whether the critical mass is related to the performance of the activity or not.

To the question '*Is the existing data good enough or data bases should be improved?',* we can answer that '*Data bases should definitely be improved'*. Data used for the analysis on the scientific capacities of the different region was all new, created from the Thomas and Reuters data base, following the criteria that was described in section 2.1. As we have mentioned, this data base presents some gaps, since not the totality of the institutions performing research are included, but the share of those included is large, covering an important percentage of the whole, making the data base a good tool to be used in the analysis. Concerning the industrial activities, as we mentioned in section 2.2, data coming from the Eurostat presents some biases that were also mentioned. Differences in the procedures for obtaining data coming from all the European regions make difficult to establish a general methodology that can be used for the analysis. It is necessary that the statistics agency of the European Union put some efforts in improving this data base as soon as possible.

To the question '*Are there significant connections between the research and the industrial activities?'*, the answer is '*Not enough'*. Even if some positive correlations were found between scientific and industrial production (for those fields and sectors that should be related), these correlations seem to be too weak to state that there are important connections between them. Table 2.3.1 in section 2.3 allows seeing these correlations between scientific capacities (in terms of scientific articles) and industrial activities (in terms of employees in the different sectors) and the analyses for each sector, also in those sections, show how these connections are not clear enough.

To the question '*Is concentration the key of specialization, the other way around, or are they independent?'*, the answer is '*They are related*'. This relation, though, is not as obvious as it may seem. As we mentioned in section 2.4, the literature around the concentration topic is much larger than the one concerning specialization; some of the authors studying these processes have tried to analyze their interactions, proving that, even if there exist some connections between them, they are in fact very different concepts. As we have been mentioning, those regions with a larger degree of concentration present lower rates of specialization in a concrete research field or industrial sector. All them present a medium-high rate of concentration, also in relative terms, which can be understood as a positive fact, since it means that the specialization patterns are not that broad and those regions specialized in a field or sector are do not share it with many other.

Finally, to the question '*Is it possible to compare all regions at the same time?'*, the answer is '*Not easily*'. The different intensities in terms of scientific production and industrial presence make the analysis much more complex. Additionally, we must consider that almost all European regions are subject to different regional legislations for industry and innovation systems, which affectations should be also taken into account. Thus, even if general models appear to be necessary, concrete analysis must be considered to make sure all variables are evaluated and reflected in conclusions.

After these remarks, we can conclude that there are indeed specialization trends in the European Union's regions, and these trends must be analyzed when considering top-down approaches for the smart specialization strategy. However, comparisons among regions must be analyzed in detail, since generalist approaches might be not accurate enough given the existent difference among regions, even those in a same state. Legislators should consider these trends and compare it to the bottom-up initiatives to see whether they are consistent or not, while considering at the same time other important concepts like concentration, synergies and complementarities. Chapter 3 will offer a more detailed analysis in the European top regions (in terms of intensity in research and industrial activities), aiming to provide an exhaustive overview of comparable regions and their institutions to see whether specialization trends are visible and consistent to develop the smart specialization strategy.

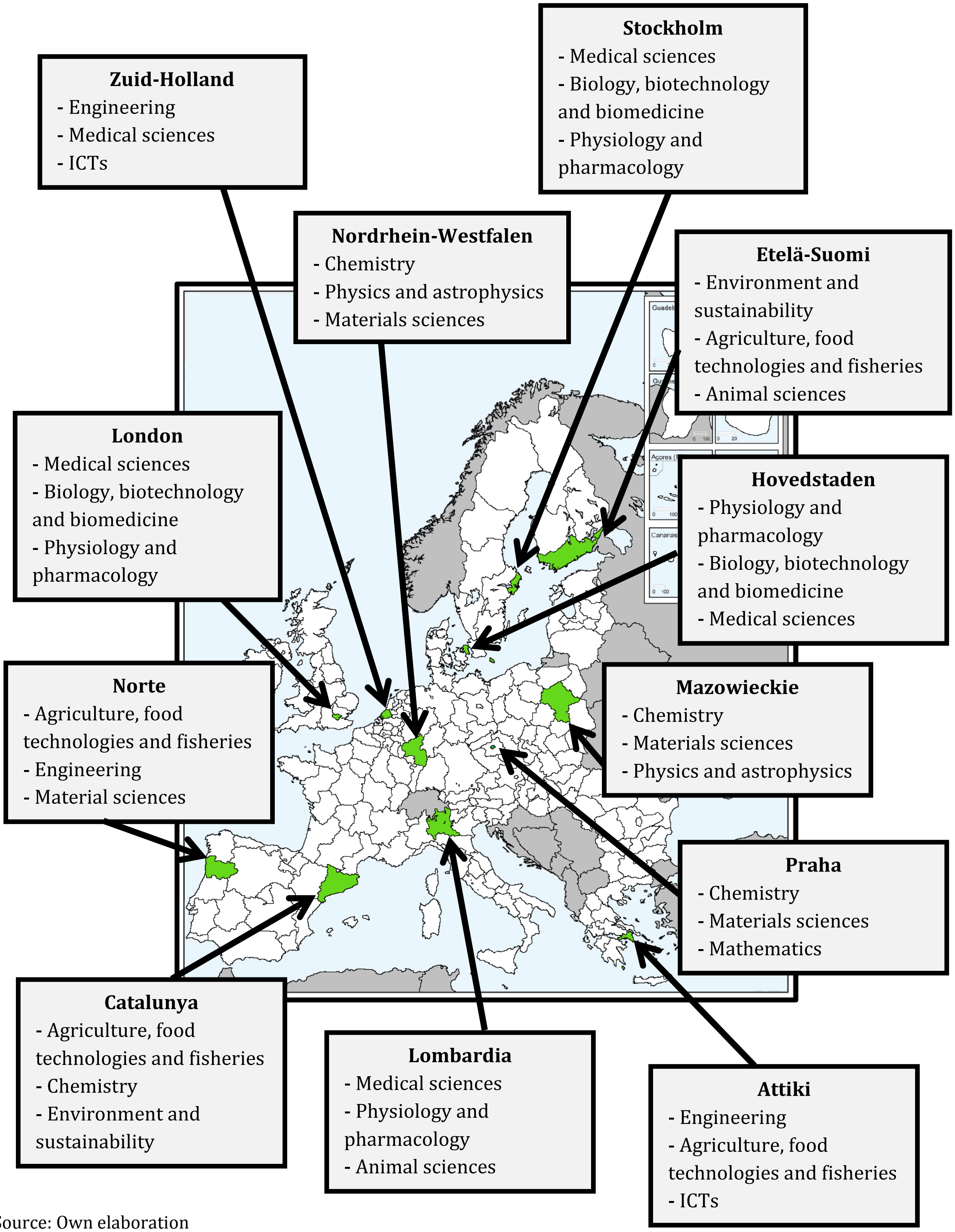
3. Overview of twelve European Union regions in the framework of the smart specialization strategy

In chapter 2, when we compared most of the European regions to identify their trends in terms of scientific capacities and industrial activities, we found that it is possible to identify some patterns that allow us to state that these regions could specialize in some fields and sectors, establishing leaders and followers for each one. However, one of the questions that rose from our analysis was whether it is possible or not to compare all regions at the same time. It is clear that, in absolute terms, differences are huge. For example, the number of universities, research institutions, or companies is usually related to the population: the larger the number of inhabitants, the larger the presence of such entities. It is clear that, therefore, the number of articles (the proxy we use to measure the intensity in science) and the number of employees (the proxy we use to measure the intensity in industry) will differ, in absolute terms, from region to region.

Given that in our work we aim to analyze the implications of the smart specialization strategy from a top-down approach, we need to be able to compare regions from a macro point of view. We now aim to see if a comparison among similar regions (in absolute terms) becomes easier and, at the same time, if it is possible to translate these patterns that we have identified to the reality of the region. To choose the 12 regions that we are going to analyze, we followed this methodology: first, we made 2 rankings, one for science and another for industry. In both cases, we ranked 1st the region with the largest number of scientific articles / employees, and last the region with the lowest absolute number. Afterwards, for each region we computed the average of the two values they obtained from each rank and we used this new value to generate a third raking. For example, if a region 'A' was 10th when considering the scientific articles and 14th when considering the number of employees, its value on the final ranking will be 12th. Once we got this new ranking, we choose the first region of the 12 first states (for which we previously did the same procedure), so we got the 12 regions, one per state, with the goal of comparing similar regions in absolute terms, but different enough to avoid other biases. Île-de-France is not considered because, even if France is for sure among the top 12 states in absolute terms, the missing data for industry in regional terms for the French regions does not allow us to take into account when doing our analysis.

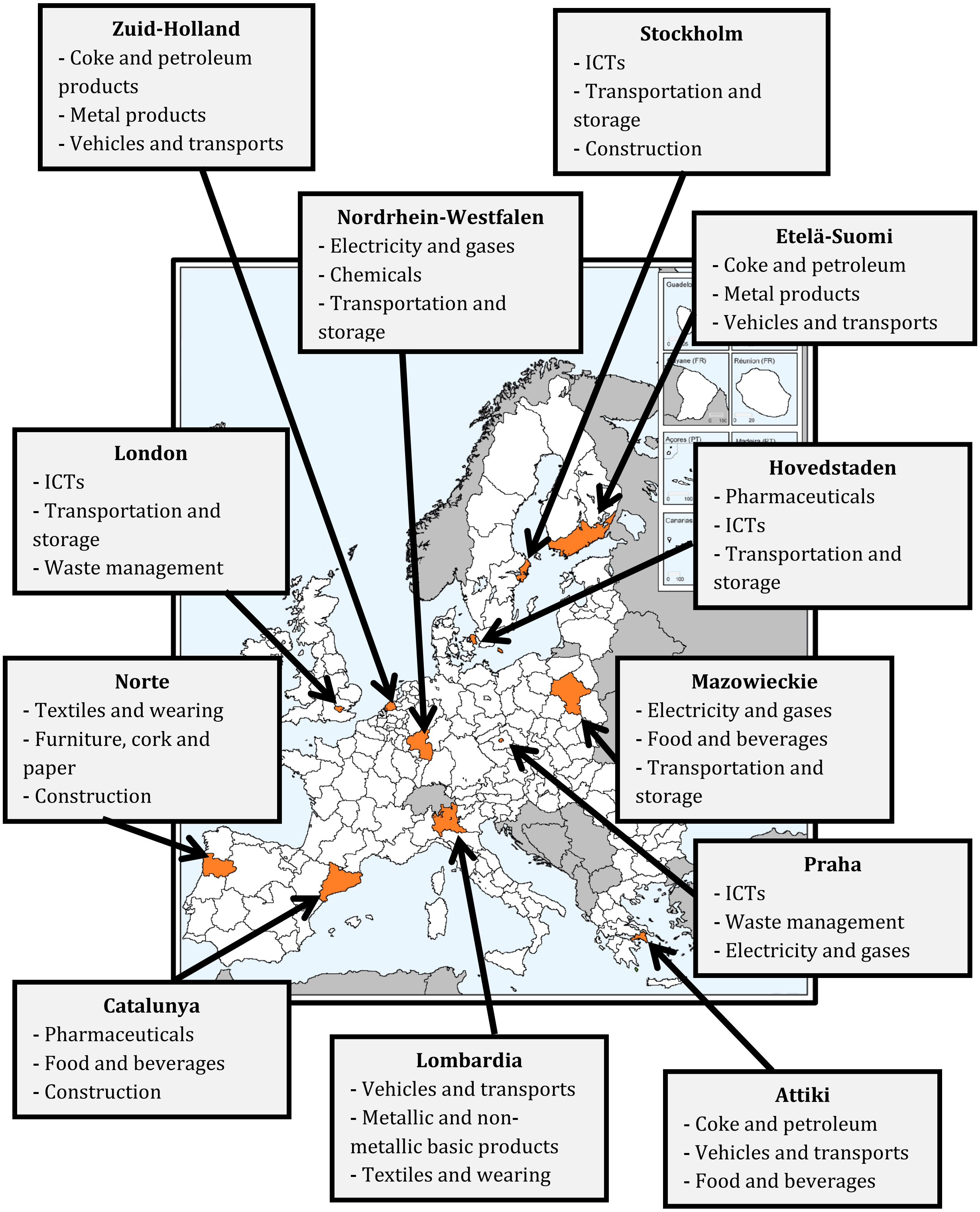
Next figures present the selected regions and their scientific fields and industrial sectors of specialization. The methodology used to determine them is exactly the same that we used in chapter 2, considering the Balassa index as the proxy. The difference is that now we have only compared the data for these 12 regions, omitting the rest, so these fields and sectors would be the chosen ones in an economy where only these regions play an active role.

Figure 3.0.1. Specialization trends for scientific activities in the 12 largest regions of the 12 largest states of the EU (in terms of number of articles)



Source: Own elaboration

Figure 3.0.2. Specialization trends for industrial activities in the 12 largest regions of the 12 largest states of the EU (in terms of number of employees)



Source: Own elaboration

Through regions' analyses, we aim to see how ready the different institutions of the region are to fit in a pre-established top-down proposal for the specialization strategies, assuming that the fields and sectors of specialization are those we have identified. With this purpose we analyze the main institutions related to science, technology, industry, and innovation in general terms for each region, taking into account the following criteria for each kind of them:

a) **Science and technology:** overview of the most representative (in terms of R&D production) universities and research centers in each region. In the case of the universities, we aim to see if their research lines are related to the detected specialization areas; same for the research centers when considering their field of activity. All the information has been obtained from the online information available in these institutions' websites.

b) **Industry:** we first list the largest sectors (in terms of employees) of the region, and also those sectors identified by the European Cluster Observatory (www.clusterobservatory.eu) as those in which the region is most specialized, in order to see whether it relates to our analysis. We also present some examples of the largest companies in the region, based on the number of employees, volume of profits, and/or relevance of their innovative activities. It is just an overview and it does not aim to be a detailed analysis or description, just a way to know a little more about the structure of the region, using some examples. We also include some examples of regional clusters, with the same purpose.

c) **Promotion of the innovation:** we take a look at the institutions aimed to promote innovation, science and industrial activities that are listed in the Regional Innovation Monitor of the European Commission[1]. We aim to see the influence these institution may have towards the definition and the implementation of the regional smart specialization strategies.

All this information must allow us to be able to identify whether the region is aligned to the specialization patterns defined in the analysis and, at the same time, we should see is the role of this institutions is significant when considering the regional strategy. With this objective, at the end of each region's analysis, we present some individual conclusions that will be aggregated at the end of the chapter in order to provide a totaled point of view.

As it will be mentioned in some sections of this chapter, even if we chose twelve of the largest European regions (always in absolute terms of scientific articles and number of employees), differences among them are still relevant. For example, it is still difficult to compare Nordrhein-Westfalen, with a population of almost 18 million inhabitants (2009), and Norte, with less than 1.7 million (2011). The population is always related to the number of universities, research centers, companies, and other institutions, and this is why the examples we can provide or the general overview may change from region to region. However, when considering specialization as the reference topic, we do not care that much about absolute numbers, but about comparative advantages. These differences only affect from a descriptive point of view, but they do not when taking into account the general identification of specialization trends. At the end of the chapter we shall be able to evaluate how important these differences are when comparing the regions with this goal.

[1] http://ec.europa.eu/enterprise/policies/innovation/policy/regional-innovation/monitor/

3.1. Attiki (Attica), Greece

Figure 3.1.1. Situation of Attiki. Source: Google Maps.

The region of Attki is located around the capital of Greece, Athens, in the Center and the South-East of the state. It comprises a population of 4.1 million people (2009) living in 4 districts, including Athens, also the capital of the region.

Table 3.1.1. Main indicators for economy, industry and R&D in Attiki

Indicator	Index	Year
Population	4099098	2009
GDP per capita (€ PPP)	28228	2008
Yearly growth of GDP per capita (PPP) (%)	5,3	2008
GDP per capita (€)	25400	2008
Yearly growth of GDP per capita (€)	7,23	2008
Disposable income per capita (€ PPP)	19256,2	2007
New foreign firms	0	2007
Employment rate (%)	60,2	2010
High and med. high-tech. manufacturing employment (% of total)	2,45	2009
Knowledge intensive services employment (% of total)	40,51	2009
Employment in industries with high energy purchases (%)	2,93	2005
Enterprises	N.D.	N.D.
Apparent labor productivity (€)	63882,04	2008

Indicator	Index	Year
Business R&D share of GDP (%)	0,3	2007
Business R&D personnel (% of total)	0,5	2007
Business investment (thousand €/employee)	7,31	2010
Public (government) R&D expenditure (%)	0,2	2007
Public (government) R&D personnel (%)	0,17	2007
Public (higher education) R&D expenditure (%)	0,3	2007
Public (higher education) R&D personnel (%)	0,48	2007
Total R&D expenditure (%)	0,79	2007
Total R&D personnel (%)	1,17	2007
Human resources in science and technology (%)	12,9	2009
Patents per million habitants	75,37	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	41,62	2007

Source: Eurostat and European Cluster Observatory

According to the comparative analysis on all regions developed in chapter 2, Attiki presents a comparative advantage in engineering and mechanics, when considering the scientific capacities, even if they present also some advantage in agriculture, food technologies and fisheries and, in less degree, ICTs and medical sciences. Regarding the industrial activities, the region presents specialization patterns in basic metals and metal products and motor vehicles and transport equipment.

If we only compare Attiki to the other 11 regions that we are considering in this chapter, we see that the region presents comparative advantage in engineering and agriculture, food technologies and fisheries when we consider the scientific capacities; regarding the industrial activities, Attiki would be specialized in the manufacture of coke and refined petroleum product and the production of motor vehicles and transport equipment.

3.1.1. High education institutions

a) **Agricultural University of Athens:** this university, located in Athens, centers its research in six main topics around agrofood sciences and technologies: crop science, animal science and aquaculture, agricultural biotechnology, agricultural economics and rural development, food science and technology, and natural resources management and agricultural engineering. It is important to have in mind that Attiki presents a specialization rate for agrofood higher than the average, so the research in this field is very relevant for the region.

b) **Harokopio University:** this small university is also located in Athens and it has around 1.150 students in its campus. Their main research topics, according to the university's departments are: dietetics and nutritional sciences, geography, ICTs, and home economics and ecology.

c) **National and Kapodiastran University of Athens:** this large and ancient public university of Athens has more than 50.000 students and its research is especially relevant in the fields of biomedicine and biotechnology, pharmacology, or computing sciences, among other, since they cover almost all research topics.

d) **National Technical University of Athens:** this is another old and public university, which has around 10.000 students, undergraduate and graduate. Their main research lines are around the topics of engineering and technology. They also have an important research center for renewable energies.

e) **University of Piraeus:** this university, located in the city of Piraeus, has around 10.000 students. They perform research around ICTs and informatics and maritime studies, besides having an important experience in business administration and economics.

The other two universities of the region, which are more focused in human and social sciences, are the Athens University of Economics and Business and the Panteion University of Social and Political Sciences. Summarizing, we can say that the main research topics of the region's universities are agrofood, engineering and ICTs, which is in the line of its specialization trends.

3.1.2. Research centers and facilities

a) **KETEP / IRIS (Athens Research and Innovation Center in Information, Communication and**

Knowledge Technologies): this research center, founded in 2003, employs around 230 people, including scientists, managers and administrative personnel. Their main research focus is, as its name indicates, ICTs.

b) **Alexander Fleming Biomedical Sciences Research Center:** more than 120 researchers performing their activity around these main topics: immunology, molecular biology & genetics, molecular oncology, and cellular and developmental biology.

c) **CRES (Center for Renewable Energy Sources):** also more than 120 people performing research in the following fields: wind energy, biomass, photovoltaic systems, active solar systems, small Hydroelectric plants, geothermal energy, RES and hydrogen technologies, and new RES technologies.

d) **NAGREF (National Agricultural Research Foundation):** more than 250 research personnel working in the following fields: technology in agricultural, forest, animal and fish production, the protection of crops, veterinary, management of marine resources, soil science, land improvement, processing and preservation of agricultural products, as well as agricultural economy and sociology.

e) **NCMR (Hellenic Centre for Marine Research):** Center devoted to the study and protection of the hydrosphere, its organisms, its interface with the atmosphere, the coast and the sea bottom, the physical, chemical, biological and geological conditions.

f) **HPI (Hellenic Pasteur Institute):** their main mission is the prevention and treatment of diseases through basic research, education and public health services. They have around 240 researchers performing their activity in these main fields: infectiology, immunology, and neurosciences and neuroimmunology.

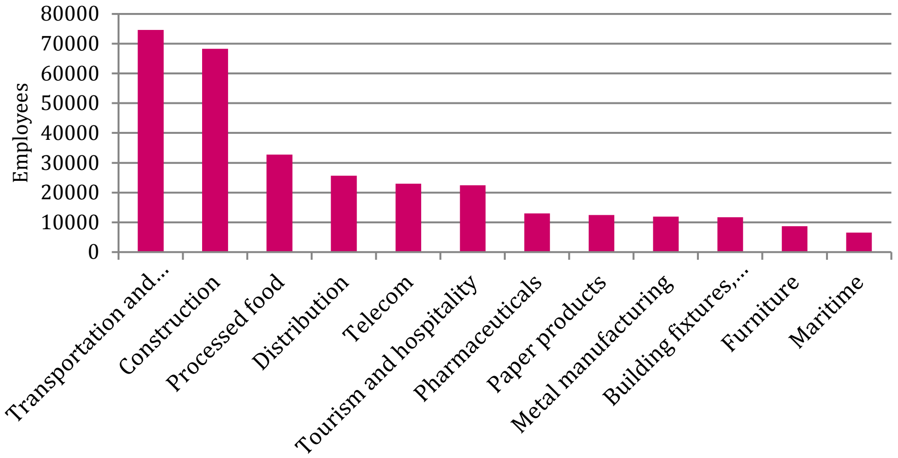
g) **National Observatory of Athens:** this observatory is divided in 4 institutes representing their main research areas: astronomy and astrophysics, geodynamics, environment and sustainable development, and space applications and remote sensing.

As we can see, most of these main research centers are national research centers located at the capital of the state, Athens. It does not mean that there is any bias in our present analysis, since we are comparing those regions with similar rates of critical mass, in absolute terms, and no other regions from the state are considered. Main research centers' fields of study are around ICTs, which appears to be one of the main interests of the region in terms of R&D, environment and sustainability, agriculture and food technologies, and biomedicine and biotechnologies. Some of these main areas correspond to those identified as the specialization fields of Attiki, so we can say that they are aligned.

3.1.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Attiki (data from 2006, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.1.2. Employment by sectors in Attika (2006), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

As we can see, in absolute terms, transportation and logistics, construction and processed food are the main industries in Attiki in absolute terms. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.1.2. Specialization trends in Attika (2006), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers.

Sector	Employees	Specialization
Jewellery and precious metals	3882	2,96
Pharmaceuticals	13032	1,92
Oil and gas	4078	1,85
Apparel	16425	1,61
Transportation and logistics	74639	1,57
Maritime	6582	1,52
Telecom	22987	1,41
Footwear	3817	1,32
Biotech	919	1,23
Distribution	25627	1,17
Furniture	8737	1,07
Construction	68272	1,05
Paper products	12482	0,98
Leather products	1012	0,9
Aerospace	3062	0,86
Medical devices	3772	0,8
Processed food	32743	0,79
Tourism and hospitality	22463	0,77
Chemical products	5357	0,71
Agricultural products	5727	0,66

Source: Adapted from the European Cluster Observatory

3.1.4. Examples of companies and cluster initiatives

We present an overview of some of the main companies in Attiki. The companies considered are among those with the highest weighed values in terms of employees and net profits. We identify some main sectors: food and beverages, ICTs, and metal products. It must be said that Attiki comprises the metropolitan area of the capital of the state, Athens, and we must underline the fact that most of the state's companies are located there.

Two of the most representative companies in **the food and beverages** sector are Vivartia and Ypsilon. The first one is a holding devoted to the production of nutritional milk and juice products and its distribution. This company was founded in Athens in 1968 and nowadays it has around 13.000 employees (2012). One the other side, Ypsilon is more oriented to the production of agrochemicals, seeds and fertilizers, but it made it to position itself as one of the most innovative companies of the region and the whole state, with just 22 employees (2013) in the main company, but it must be taken into account that they are main partners of more than 50 other companies located in Greece.

In the **ICTs** sector, we can mention examples like Anntena Group, Cosmote or the Hellenic Telecommunications Organization, which are the main companies in the sector. Anntena Group (ANT1) is the largest ICT and media company in the state of Greece, with different divisions including TV, radio, music, publishing, or general communications. Even if they may look just as a services company, they also work in improving the communications technologies. Cosmote is the largest mobile network in the whole state, and it is owned by the Hellenic Telecommunications Organization, the largest telecommunications provider in Greece, with more than 27.000 employees (2012), with many other subsidiaries and a large investment in infrastructures.

In the **metal products** sector we find large companies like Aluminum of Greece or Viohalco. The first one, with around 1.100 employees (2011), is the main aluminum producer in the state, while Viohalco is a large corporation in the Hellenic Copper and Aluminum Industry S.A., with almost 8.000 employees (2010) and working with products such copper, aluminum, and steel.

Besides these main sectors, we can mention some other relevant companies like Attica Holding, working in the transportation sector, Ellaktor, an international company working in the energy sector, as well as in real estate and infrastructures, or Lavipharm, an important firm in the pharmaceutical industry.

In order to put an example of the **clustering initiatives**, we can mention the Hellenic Biocluster, located in Athens, with more than 20 associated companies and 4 research institutions. They work on the following fields: biotechnology, diagnosis, medical devices, and pharmaceutics.

3.1.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Attiki are:

a) **Regional Development Fund of the Region of Attiki**, in charge of the management of the European Commission programs, as well as the provision of technical assistance to the region, executing these programs. They are the promoters of the Annual Regional Public Investment

Program, its development and its financial management. The smart specialization strategy could be included in this program, so the Regional Development Fund should have a role when defining or structuring this strategy.

b) **Intermediate Managing Authority (IMA) of Attiki**, which manages all the programs in Attiki coming from the Structural Funds, including the Regional Operational Program of Attiki 2007-2013. In 2008, they defined the Strategic Plan for Competitiveness, Innovation and Knowledge Society of the Region of Attiki, establishing concrete measures to promote innovation, so they can also be a key element in the definition of the region's smart specialization strategy.

c) **Region of Attiki**, the government of the region, in charge of all the administrative units and the public administration of the region. Regarding innovation policies, they also have some competences in this field, but it must be underlined that in Greece the research, development, technology and innovation activities (RDTI) are centralized, so there is less relevance for the region when defining policies that could support the smart specialization strategy.

3.1.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Attiki.

Table 3.1.3. Questions around the performance of the science and industry agents in Attiki regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Attiki universities related to the specialization patterns identified for the region?	✓		
Are the main research centers in Attiki performing research around those fields identified for the region?	✓		
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?		?	
Does the companies and clusters overview support the idea of specialization in the identified sectors?		?	
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?			✘

Source: Own elaboration. *Unclear

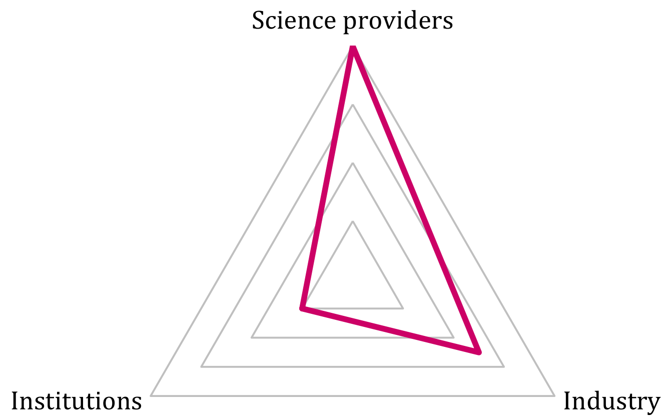
After the analysis around the main actors performing R&D&I activities in the main research institutions and the industry, we can say that, in average, Attiki follows the specialization trends that we defined in the previous chapters and sections. However, these trends seem to be clearer when we are considering the scientific activities. The main research fields of the universities in Attiki, as well as the research performed in the main research centers, show that they focus in agriculture and food technologies, as well as in ICTs, which appear to be two of the fields of specialization in the region. Environment and sustainability is also one of the main research subjects.

Regarding the industrial activities of the region, we can also see some trends showing that the identified industrial strengths of the region, such metal products or transportation, are those that are indeed those in which Attiki could specialize. However, it is more complicated to determine, also because the variables that should be evaluated regarding the industrial activities are many and we can just evaluate the number of employees per sector, but not the size of the companies, their revenues, their internationalization degree, etc.

Finally, regarding the regional organizations devoted to promote innovation around scientific and industrial activities, we find that these organizations in Attiki have not enough competences to establish specialization policies alone, and they would need the national support, since their model is still pretty centralized. However, they appear to be the most indicated to establish which are the specializations patterns that must be taken into account. When performing this analysis they must take into account the entrepreneurial discovery process and try to identify which are the main sectors that are to be promoted following this criteria.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Attiki.

Figure 3.1.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Attiki.



Source: Own elaboration.

According to the analysis for Attiki, we could say that the region seems to be half way in their path to adopt and internalize the smart specialization region around the R&D, industrial and innovation frameworks of the region. We have seen that their high education institutions and their research centers seems to be performing their activity aligned to the specialization trends that we have identified, while the industries in the region seem to be more diverse, not much specialized in a concrete sector. However, for both analyses, as we have already mentioned, more data would be needed in order to have a more accurate perspective.

Following the data that we showed at the beginning of this section (table 3.1.1) we see that Attiki still have some way to run when referring to the scientific and technological activities. We have also mentioned that the state of Greece is still pretty centralized regarding the innovation and industrial policies, which makes the implementation of a smart specialization strategy a little more difficult if we consider it from a regional point of view. Through this strategy, Attiki could probably improve their scientific and industrial capacities, assuming the presence of a higher rate of efficiency coming from the specialization; however, other variables should be considered and a deeper analysis should be made before, assuring the viability of this strategy for the region.

3.2. Catalunya (Catalonia), Spain

Figures 3.2.1. Situation of Catalunya. Source: Google Maps

The region of Catalunya is located in the North-East of the state of Spain, bordering the state of France and Andorra. It comprises a population of 7.6 million people (2012) living in 4 provinces, including the province of Barcelona, the capital of the region.

Table 3.2.1. Main indicators for economy, industry and R&D in Catalunya

Indicator	Index	Year
Population	7565603	2012
GDP per capita (€ PPP)	30283,8	2008
Yearly growth of GDP per capita (PPP) (%)	3,7	2008
GDP per capita (€)	27900	2008
Yearly growth of GDP per capita (€)	4	2008
Disposable income per capita (€ PPP)	16596	2007
New foreign firms	0	2007
Employment rate (%)	63,1	2010
High and med. high-tech. manufacturing employment (% of total)	6,68	2009
Knowledge intensive services employment (% of total)	31,74	2009
Employment in industries with high energy purchases (%)	4,1	2005
Enterprises	662406	2011
Apparent labor productivity (€)	59769,33	2008

Indicator	Index	Year
Business R&D share of GDP (%)	0,9	2007
Business R&D personnel (% of total)	0,65	2007
Business investment (thousand €/employee)	16,05	2010
Public (government) R&D expenditure (%)	0,3	2007
Public (government) R&D personnel (%)	0,18	2007
Public (higher education) R&D expenditure (%)	0,34	2007
Public (higher education) R&D personnel (%)	0,39	2007
Total R&D expenditure (%)	1,62	2007
Total R&D personnel (%)	1,33	2007
Human resources in science and technology (%)	11,3	2009
Patents per million habitants	482,1	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	58,83	2007

Source: Eurostat and European Cluster Observatory

The analysis that we developed in chapter 2, when we considered all the EU regions at the same time, showed that, when considering the scientific research, Catalunya presents a comparative advantage in agriculture, food technologies and fisheries, followed by chemistry, and environment and sustainability. Regarding the industrial activities, Catalunya presents specialization trends for the manufacture of pharmaceutical products and preparations and, with a lower index, the manufacture of chemicals and the food and beverages industry.

The results are similar when we compare Catalunya to the other regions with a larger critical mass in the 12 largest EU states regarding their scientific and industrial activities. Catalunya presents specialization trends in agriculture, food technologies and fisheries when we consider the scientific capacities, followed by chemistry, and environment and sustainability, while regarding the industrial capacities Catalunya appears again to be specialized in the manufacture of pharmaceutical products and preparations, but also in the food and beverages sector.

3.2.1. High education institutions

The largest universities in Catalunya are:

a) **Autonomous University of Barcelona:** this university, located in the Vallès area, near the city of Barcelona, has around 40.000 students, mostly concentrated in a main campus. They perform research in almost all fields, buy they are specialized in biotechnology and biomedicine, nanotechnology, ICTs and food technologies.

b) **University of Barcelona:** this large university, with around 80.000 students, is located in Barcelona downtown, with different campuses along the city. They have an important scientific production, with more than 4.000 articles published in 2011. Their main research fields are biomedicine, nanotechnology, pharmacology, and chemistry.

c) **Polytechnic University of Catalonia:** the third largest university in Catalunya, with around 30.000 students, mostly located in Barcelona downtown, but also in other campuses in the region. They main research fields are engineering, architecture, ICTs, environment and sustainability, and chemistry.

d) **University of Girona:** this university has around 15.000 students and it is located in the capital of another Catalan province, Girona. Their main research fields are bio sciences and ICTs, but also social sciences and humanities.

e) **Ramon Llull University:** this university is located in Barcelona and it has around 18.000 students. They perform their research activities around social sciences and humanities, biotechnology and ICTs.

f) **Pompeu Fabra University:** this 11.000-students university is located in Barcelona and they are mainly specialized in social sciences and humanities, but they also perform research in biomedicine.

Additionally, Catalunya hosts other smaller universities: the University of Lleida, the Rovira i Virgili University, the International University of Catalunya, the Open University of Catalunya, the University of Vic, and the Abat Oliba University, with less scientific production than the other above, but performing research in different fields.

3.2.2. Research centers and facilities

Catalunya has a very organized system of R&D centers. The main ones in the region are denominated CERCA (Centres de Recerca de Catalunya, Catalunya's Research Centers in Catala)n. We provide an overview of these research centers according to the field where they belong.

a) **Agriculture and food technologies:** some examples are Institute for Research in Agrofood Technologies (IRTA), with more than 600 employees (more than 200 researchers), which is the main example in this field. Other examples are the Center for Research in Agrotechnology (Agrotecnio), working in vegetal and animal production and the implications for the environment or the Center for Research in Agricultural Genomics (CRAG), performing research in the genetics field.

b) **Medical sciences:** Catalunya has some large hospitals performing research with an important scientific production, like the Hospital Clínic, the Hospital Vall d'Hebrón, or the Hospital de Sant Pau i la Santa Creu. Additionally, this region has an important number of research centers in the field of the medical sciences; some examples are the Center for Regenerative Medicine of Barcelona, the Barcelona Center for International Health Research, or the Catalan Institute for Cardiovascular Sciences, among many other.

c) **ICTs:** in the field of ICTs, Catalunya presents a good performance in R&D, with relevant university departments and large research centers such as the Catalan Telecommunications Technology Center, the Computer Vision Center, or the Internet and Digital Innovation in Catalonia, among other.

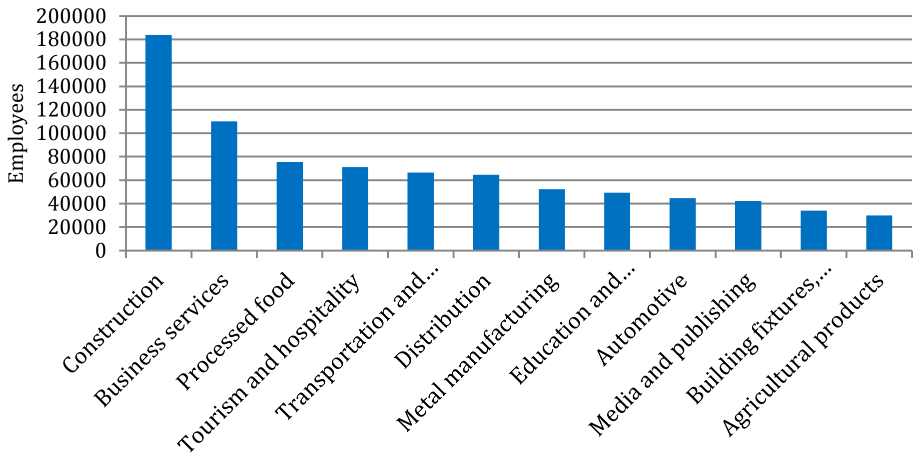
d) **Environment and sustainability:** research in this field is also very representative of the region; some of the main research centers are the Center for Ecological Research and Forestry Applications, the Center for Research in Environmental Epidemiology, the Catalan Climate Sciences Institute, or the Catalan Institute for Water Research.

Besides these main research centers in these fields, we can also mention some other example like the Catalan Institute for Photonic Sciences, the Catalan Institute of Nanotechnology, the Institute of Chemical Research of Catalonia, the Institute of Space Studies of Catalonia, or the Institute for Research in Biomedicine. Many other examples could be provided, since the Catalan research system covers, in more or less degree, all the research fields. Additionally, we can say that, even if we chose the four mentioned main fields, if we analyze the research centers located in Catalunya, we see that they have some specialization in the areas related to the human and animal health, the biomedicine and the biotechnology, even if the scientific publications make this field not to rank first or not to appear as the one on which the region should specialize. Besides the CERCA centers, the Spanish High Council for Scientific Research (CSIC) has also 21research centers where they participate located in Catalunya, for example the Centre de Recerca en Nanotecnologia, the Institut de Ciència dels Materials de Barcelona, the Insitut de Recerca en Intel·ligència Artificial, or the Institut de Biologia Molecular de Barcelona.

3.2.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Catalunya (data from 2008, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.2.2. Employment by sectors in Catalunya (2008), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are construction, processed food, and transportation and logistics. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.2.2. Specialization trends in Catalunya (2008), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Pharmaceuticals	26560	1,89
Agricultural products	29896	1,67
Distribution	64524	1,41
Construction	183910	1,36
Plastics	23181	1,34
Textiles	20760	1,26
Chemical products	19024	1,21
Farming and animal husbandry	22949	1,17
Tourism and hospitality	71064	1,17
Tobacco	2797	1,16
Media and publishing	42207	1,1
Sporting, recreational and children's goods	4497	1,08
Apparel	22706	1,07
Paper products	27407	1,03
Entertainment	22749	0,97
Maritime	8554	0,95
Automotive	44530	0,93
Lighting and electrical equipment	6856	0,9
Processed food	75417	0,88
Building fixtures, equipment and services	33974	0,86

Source: Adapted from the European Cluster Observatory

3.2.4. Examples of companies and cluster initiatives

We present an overview of some of the main companies in the Attiki region. The companies considered are among those with the highest weighed values in terms of employees and net profits. The largest Catalan companies operate in the Barcelona's metropolitan area, and we identify two main sectors: pharmacology and food and beverages, both identified as sectors in which the region is specialized.

In the **pharmacology sector** we identify large companies with large profits like Almirall, founded in Barcelona in 1943 and with more than 3.000 employees, Laboratoris Esteve, with also around 3.000 employees working since 1929, or Ferrer, founded in 1959, which is also another large Catalan pharmaceutical company. Additionally, very large pharmaceuticals like Novartis or Pfizer have their own divisions in Catalunya.

Catalunya has a large number of companies in the **food and beverages sector**. The region hosts large companies like Nutrexpa, founded in 1940 and which has over than 1.800 employees in Spain, Gallina Blanca, located in l'Hospitalet de Llobregat, founded in 1950 and with more than 2.000 employees, or Grup Alimentari Guissona, operating in the whole region, with more than 3.000 employees. Many other examples could be provided; large companies like Damm, Panrico, Borges, or Casa Tarradellas define the sector in which Catalunya has a large tradition.

Additionally, many other companies could be mentioned. Just to put some examples on large Catalan companies we can cite SEAT, the large automobiles company, with more than 11.000 employees, Grífols, one of the largest companies in Spain operating in the biotechnology sector all around the world, Gas Natural SDG, working in the energy sector, or Abertis, with more than 12.000 employees operating in the sectors of construction, infrastructures and logistics.

Regarding the **clustering initiatives**, Catalunya has done a great job promoting them and establishing very good clusters, and they have the support of the Catalan public administration. The most representative examples are:

- **Biocat:** more than 1.000 associates in the fields of the biotechnology, the biomedicine, and the pharmacology, clustering large companies like Roche, Pfizer or Novartis and Important research centers, as well as hospitals and universities.
- **Packaging cluster:** around 45 companies and 15 research institutions developing their activities related to the packaging. Some examples of companies are Nestlé, Henkel, Nutrexpa or Danone.
- **AINS:** cluster of the Association for Innovation in Nutrition and Health (AINS form its acronym in Catalan), operating in the village of Reus, with food companies like Borges of Ato.
- **CEEC:** Cluster of Energetic Efficiency of Catalunya, with 15 associated research institutions and more than 100 associated companies like Endesa, Siemens or Iberdrola.

Beside these cluster initiatives, other relevant examples are, for example, Solartys, clustering companies and research institutions working in the field of solar energy, SECPHO, working on photonics, Railgroup, in the sector of railways, Cluster 6m, working on the field of mobility, or ACTM, clustering companies operating in the sector of textiles.

3.2.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Catalunya are:

a) **Catalan Ministry of Economy and Knowledge**, in charge of the design of the main policies around the scientific strategies of Catalunya. Associated to this Ministry we find the Agency for the Management of University and Research Grants (AGAUR) and the Catalan Foundation for Research and Innovation (FCRI). The Ministry has established some strategic plans supporting and fostering collaboration among universities and research centers in Catalunya, but also outside, promoting the existence of synergies, which can help the smart specialization strategy.

b) **Catalan Ministry of Enterprise and Labor**, which supports the cooperation among companies and research institutions, while boosting innovation activities for the companies located in Catalunya, but also in cooperation with other located outside.

c) **ACC1Ó (Competitiveness for Catalonia)** is the main agency in Catalunya working to promote innovation. They have established different programs to support innovative initiatives for companies and other organization. They also promote the internationalization of the Catalan companies, the attraction of new investments, the improvement of the Catalan competitiveness and productivity, and the development of new ventures. This agency is also in charge of the definition of the smart specialization strategy for Catalunya.

d) **Southern Catalonian Knowledge Hub Association**, which is in charge of the organization of conferences, the production of new studies and reports about scientific initiatives, the provision of assistance to the research institutions in different fields, the international representation, etc.

e) **Catalan Foundation Institute for Research Support**, implementing and disseminating scientific activities in Catalunya. They are in charge of promoting private funding for R&D activities. They are also evaluators of the Catalan research system from a national and international point of view.

3.2.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Catalunya.

Table 3.2.3. Questions around the performance of the science and industry agents in Catalunya regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Catalunya universities related to the specialization patterns identified for the region?		?	
Are the main research centers in Catalunya performing research around those fields identified for the region?		?	
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	✓		
Does the companies and clusters overview support the idea of specialization in the identified sectors?	✓		
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?	✓		

Source: Own elaboration. *Unclear

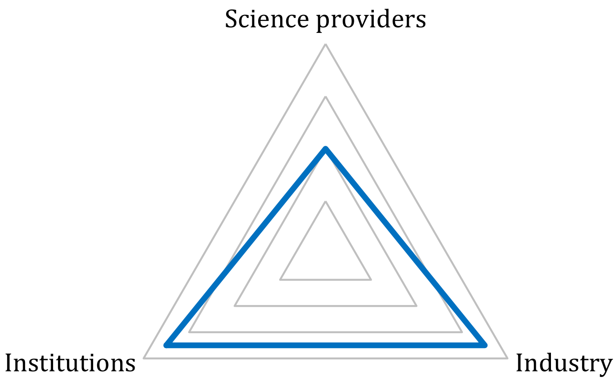
If we first take a look at the institutions performing R&D activities, universities and research centers, we find that they do research in the sectors identified at the beginning of this chapter: agriculture, food technologies and fisheries, followed by chemistry, and environment and sustainability. However, we must say that besides these fields, Catalunya performs high-quality scientific activities around many other fields, which makes complicated to determine if these are those in which the region should specialize or if others should be also included.

Regarding the industrial activities in Catalunya, it is possible to find a large range of sectors in the region, since it comprises one of the most important concentrations of companies in the southern EU states. According to our evaluation and the examples that we provide as support, we can say that there are indeed some trends of specialization for the sectors that we have identified: manufacture of pharmaceutical products and preparations and food and beverages. There are relevant examples in other sectors though, especially related to biotechnology and biomedicine, automotive industry or manufacture of metal and non-metal products, in which the region has also some advantage in both absolute and relative terms compared to the other regions.

The public agencies in charge of the promotion of science, technology, and innovation appear to be key elements in Catalunya for the definition and the implementation of the regional smart specialization strategy, since they include the main policy makers and agencies related to these activities. However, it is important to underline the fact that they must involve representatives from high education institutions, research centers, and business associations, among other, since they establish the bases for the whole strategy.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Catalunya.

Figure 3.2.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Catalunya.



Source: Own elaboration.

As a conclusion, we can say that, form a top-down approach, the policy makers in charge of the regional smart specialization strategy in Catalunya are able to identify specialization trends, especially when we consider the industrial sectors, but also for the scientific activities. However, the fact that the region concentrates a large number of R&D institutions and companies makes it more difficult to analyze, since we can find scientific and industrial activities in a large range of fields and sectors.

3.3. Etelä-Suomi (Southern Finland), Finland

Figures 3.3.1. Situation of Etelä-Suomi. Source: Google Maps

The province of Etelä-Suomi is located in the southern region of Finland, as its name indicates. It has a population of around 2.2 million inhabitants (2009) and it is divided in 6 regions: South Karelia, Päijänne Tavastia, Tavastia Proper, Uusimaa, Eastern Uusimaa, and Kymenlaakso.

Table 3.3.1. Main indicators for economy, industry and R&D in Etelä-Suomi

Indicator	Index	Year
Population	2209677	2009
GDP per capita (€ PPP)	33630,1	2008
Yearly growth of GDP per capita (PPP) (%)	4,5	2008
GDP per capita (€)	39600	2008
Yearly growth of GDP per capita (€)	4,8	2008
Disposable income per capita (€ PPP)	14297,7	2007
New foreign firms	0	2007
Employment rate (%)	70,7	2010
High and med. high-tech. manufacturing employment (% of total)	5,51	2009
Knowledge intensive services employment (% of total)	46,25	2009
Employment in industries with high energy purchases (%)	5,11	2005
Enterprises	176690	2010
Apparent labor productivity (€)	66155,39	2008

Indicator	Index	Year
Business R&D share of GDP (%)	2,4	2007
Business R&D personnel (% of total)	1,36	2007
Business investment (thousand €/employee)	17,03	2010
Public (government) R&D expenditure (%)	0,4	2007
Public (government) R&D personnel (%)	0,43	2007
Public (higher education) R&D expenditure (%)	0,72	2007
Public (higher education) R&D personnel (%)	0,7	2007
Total R&D expenditure (%)	3,66	2008
Total R&D personnel (%)	2,45	2008
Human resources in science and technology (%)	17,5	2009
Patents per million habitants	1018,33	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	69,12	2007

Source: Eurostat and European Cluster Observatory

In chapter 2, when we analyzed the specialization trends for most of the EU regions in terms of scientific capacities, we found that the region of Etelä-Suomi presents a comparative advantage for the research in environmental sciences and sustainability, followed by agriculture, food technologies and fisheries, and biotechnology and biomedicine. If we consider the industrial activities, the region appears to be specialized in the manufacture of coke and refined petroleum products, followed by the sector of metals, and the sector of motor vehicles and transport equipment.

Now, if we compare Etelä-Suomi only to the other regions that we are considering in this analysis, i.e. the 12 largest regions of the 12 largest states (considering the scientific and industrial critical mass), we find that Etelä-Suomi has, when considering the scientific capacities, competitive advantage for the research in environment and sustainability, followed by agriculture, food technologies, and animal sciences. Regarding the industrial activities, Etelä-Suomi presents specialization trends for the manufacture of coke and refined petroleum products, followed by the sector of metal products and the sector of motor vehicles and transport equipment, same than when considering all the EU regions.

3.3.1. High education institutions

The largest universities performing R&D in science and technology in Etelä-Suomi are:

a) **University of Helsinki:** this public large university, located in the capital of the region and the state, was founded in 1640 and it has more than 35.000 students, both undergraduate and graduate. Their publication rate is very high, with more around 10.000 articles per year. Their main research fields are materials sciences, nanotechnology, and energy.

b) **University of Vaasa:** this university has around 5.000 students and it is more specialized in social sciences, including finances and management. In the field of science and technology, their main strength is the research in energy.

c) **Aalto University:** this young university (established in 2010) is located in two main campuses, in the cities of Helsinki and Espoo, and it has almost 20.000 students. They perform research in different fields, but their main research areas are computation and modeling, materials sciences, and ICTs and media.

d) **Helsinki Metropolitan University of Applied Sciences:** another young university which was established in 2007 and which has around 16.000 students. They are mainly focused in technologies around the transportation sector.

e) **Haaga-Elia University of Applied Sciences:** university of more than 10.000 students mainly oriented to the business management and the polytechnic activities. Their main research lines are around information technologies.

3.3.2. Research centers and facilities

Etelä-Suomi has a large tradition around research and development, and they have large and important research centers performing disruptive research in two main areas: environment and sustainability and information and communication technologies. Some examples of these research centers are provided in our description.

a) **Environment and sustainability:** we can mention here, for example, the Finish Meteorological Institute (FMI), with more than 600 researchers and a budget of more than €42 million; they study the meteorology, the air quality, and the climate change, and they have some teams working on the observation of the earth, the sea, and the Artic. Another center is the Finish Geodetic Institute, performing their activity on measurements, data acquisition, and processing and exploitation of geospatial information. Another example is the Finish Institute for Marine Research (FIMR), which operates around the research in the changing states of the Baltic-Sea, the impacts of the environmental changes, and the conservation and utilization of natural resources. We can also mention the Center for Meteorology and Accreditation (MIKES), performing research in meteorology and measuring applications.

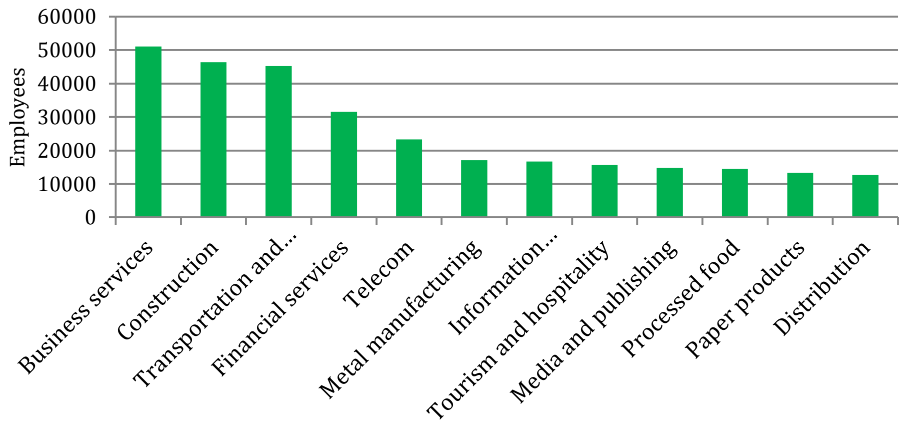
b) **Information and communication technologies:** some good examples are the Helsinki Institute for Information Technology (HIT), performing basic and applied research on information technologies, ranging from fundamental methods and technologies to novel applications; they focus on computational modeling and data analysis. Another example is the Smart Radios and Wireless Research Institute (SMARAD), studying around radio engineering, communications and signal processing.

Besides these main two topics, and as we already mentioned, Etelä-Suomi has an important number of other large research centers like the Helsinki Institute of Physics (HIP) or the Technical Research Center of Finland (VTT), among other.

3.3.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Etelä-Suomi (data from 2010, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.3.2. Employment by sectors in Etelä-Suomi (2010), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are construction, transportation and logistics, and telecommunications. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.3.2. Specialization trends in Etelä-Suomi (2010), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Telecom	23316	3
Power generation and transmission	3376	2,81
Information technologies	16719	2,21
Paper products	13358	2,19
Tobacco	1192	2,15
Transportation and logistics	45255	1,99
Farming and animal husbandry	8685	1,93
Media and publishing	14814	1,67
Business services	51088	1,54
Construction	46400	1,5
Chemical products	5031	1,39
Oil and gas	1380	1,31
Medical devices	2806	1,24
Distribution	12656	1,21
Production technology	8267	1,15
Tourism and hospitality	15668	1,12
Metal manufacturing	17101	1,08
Jewellery and precious metals	670	1,07
Heavy Machinery	4068	1,03
Pharmaceuticals	3245	1

Source: Adapted from the European Cluster Observatory

3.2.4. Examples of companies and cluster initiatives

The following examples aim to offer an overview of the main companies and clusters in Etelä-Suomi, according to their number of employees and profits. We find that most of these companies belong to some specific sectors: energy, ICTs, oil, transportation and metal products.

In the **energy sector** we identify large companies like Fingrid Oyj, located in Helsinki and operating in the field of the high-voltage grid and the transmission of electricity from electricity generating companies to distributors. They perform R&D activities to improve this transmission nets. Another example is Fortum Oyj, with more than 10.000 employees and located in Espoo, a company devoted to energy generation, divided in 3 main divisions: hydro power, nuclear power and energy efficiency. Another company producing energy is Pohjolan Voima Oy, which operates from Helsinki in the generation of electricity and heat through hydro power.

In the **information and communication technologies** field Etelä-Suomi also has a large experience. The most representative company is the Nokia Corporation, with around 100.000 employees and which market share is spread all over the world. However other examples are relevant. One of them is DNA Oy, with profits above €11 million in 2011 and operating in the field of communications, information retrievals, data communication services, etc. Elisa Oyj is another company in the sector, located in Helsinki and with about 4.000 employees; they work on digital television services and home security systems. We must also mention Tieto Oyj, with more than 16.000 employees operating in the field of information technologies services, including cloud services, big data systems and mobility.

Other relevant sectors must be also taken into account, since they prove the specialization of the region in the detected fields. In the case of the sector on the **oil industries** we can mention Neste Oil, with 5.000 employees, located in Helsinki and working on the fields of petroleum and renewable products on the chain to the end-user. In the sector of **transportation** the main examples are Cargotec, with more than 10.000 employees worldwide working shipping and cargo delivering, and VR Group, with more than 12.000 employees operating in the field of transport, logistics, and infrastructure engineering. In the **metal products** sector we can put as the main example Outokumpu, a company of more than 16.000 employees located in Espoo and devoted to the production of stainless steel and high performance allows.

Regarding the **clustering initiatives**, we summarize here some representative examples. The Airport Cluster of Finland, which has its headquarters in Vantaa, clusters around 30 companies in order to promote the growth and development of Finish companies in the airport industries. The Finish Cleantech Cluster, which has its headquarters in Lahti, has more than 400 associated companies working on environmental technologies. The Digitalbusiness cluster, based in Espoo, has more than 8.000 associated companies and it promotes their internationalization, and the competitiveness of the companies. Another example is the Nanotechnology Cluster, also based in Espoo, with around 45 companies (including Nokia) and 20 research institutions (including the Aalto University) associated.

3.3.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Etelä-Suomi are:

a) **Center for Economic Development, Transport and the Environment of Varsinais-Suomi and Center for Economic Development, Transport and the Environment of Uusimaa:** 2 of the 15 centers in Finland, spread at a regional level. These centers are devoted to foster the regional development by implementing and developing government activities in regions, including the Finish national innovation strategies through the activities and measures of the centers, such the provision of technology experts helping companies and research organizations to launch national and international R&D projects, or the development of European networks, among other services.

b) **Forum Virium Helsinki:** they work on the development of internationally competitive digital services for customers, in cooperation with companies, the public sector and citizens. They conduct projects in five main areas: well-being, media, learning, smart cities, and innovation communities.

c) **Uusimaa Regional Council:** regional developer which is a strategic planner, a land use planner, and a coordinator for some activities, like the promotion of the Baltic Sea Region as a leading knowledge region in the EU and as neighbor to Russia. They create a Regional Strategic Plan to promote long-term initiatives to strengthen the region and its activities.

d) **Culminatum Innovation Oy Ltd:** this company was created and its owned by the Uusimaa Regional Council, the city authorities of Helsinki, Espoo and Vanta, and the universities, polytechnics, research institutes, and business community of the region, and it seeks to improve the international competitiveness of the Helsinki region and to encourage the business utilization of the region's educational, scientific and research resources.

As we see, none of these organizations identified by the Regional Innovation Monitor has legislative or highly active instruments to promote scientific and industrial activities. They are more based on the execution and development of initiatives established by the government of the state of Finland.

3.3.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Etelä-Suomi.

Table 3.3.3. Questions around the performance of the science and industry agents in Etelä-Suomi regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Etelä-Suomi universities related to the specialization patterns identified for the region?		?	
Are the main research centers in Etelä-Suomi performing research around those fields identified for the region?	✓		
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?		?	
Does the companies and clusters overview support the idea of specialization in the identified sectors?	✓		
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?			✗

Source: Own elaboration. *Unclear

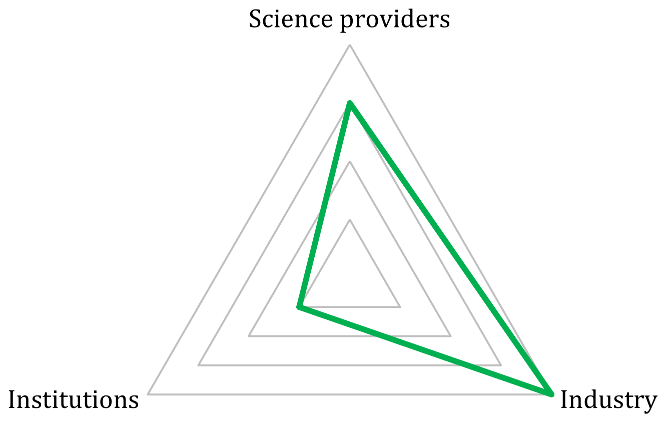
After the analysis on the main actors that are related to the design and implementation of the R&D&I activities in the Finish region of Etelä-Suomi, we can state that, for the case of the scientific capacities of the region, in general, it validates the fields identified as the strengths of the region. In chapter 2, when we compared all the European Union's regions, and at the beginning of this chapter, we compared only the 12 regions that we are taking into account, we found out that Etelä-Suomi presents some specialization trends in environmental sciences and sustainability, followed by agriculture, food technologies and fisheries, and biotechnology and biomedicine. The analysis on the main universities of the region does not confirm that these fields are those in which it should specialize, however it shows that there is some critical mass in those fields, especially when we consider environmental sciences and sustainability. On the other hand, the main research centers in the region prove that there is indeed some specialization, especially for environmental sciences and sustainability.

If we now take in consideration the industrial activities of Etelä-Suomi and its specialization trends, we see that data provided by the European Cluster Observatory (ECO), and its specialization indexes, go in the same way than the trends that we identified in chapter 2 and at the beginning of chapter 3, but this parallelism is not that clear, and it presents some differences; for example, the ECO shows higher specialization indexes for information and communication technologies. We have found that there is an important critical mass for ICTs in the region, but it does not necessarily mean that it must be a strength in terms of specialization. However, the analysis on the main companies of the regions show that Etelä-Suomi has very large companies in this sector and that it is very relevant for the region. Additionally, we have showed that the industrial sectors in which the region seems to be specialized (manufacture of coke and refined petroleum products, followed by the sector of metal products and the sector of motor vehicles and transport equipment) are, jointly with the energy and the ICTs sectors, those in which Etelä-Suomi has the largest companies of the region, so it confirms that there are specialization trends for these sectors.

Finally, if we consider the public organizations in charge of the promotion and development of initiatives around innovation, science and technology in Etelä-Suomi, we find that the initiatives they implement come mostly from the Finish national programs and its directives. Given this, even if the organizations that we mentioned have a very important role to promote these activities, their influence to promote specialization initiatives is rather limited, since the main programs are subject to the framework which is, in general, developed by the Finish government.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Etelä-Suomi.

Figure 3.3.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Etelä-Suomi.

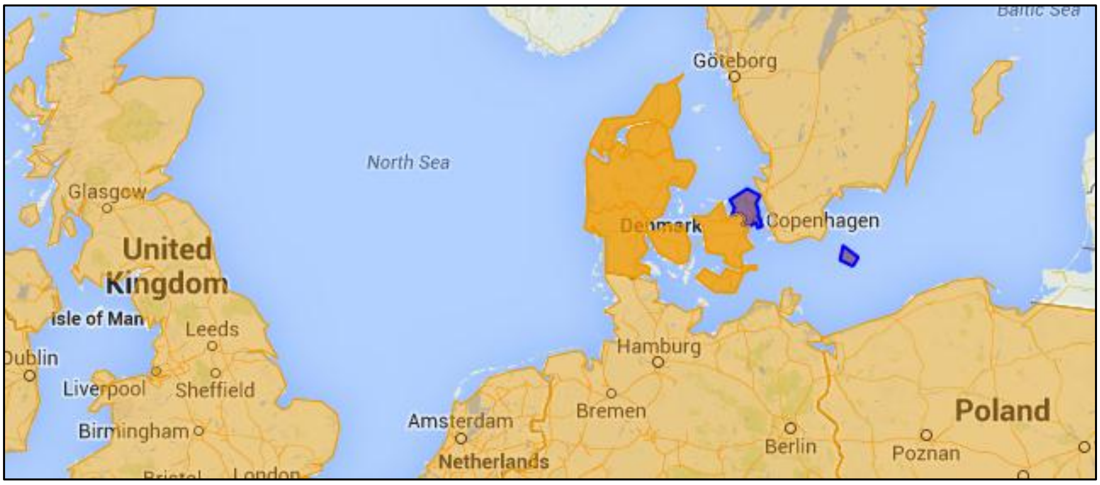


Source: Own elaboration.

According to the analysis for the region of Etelä-Suomi, we can state that it has done a great job to put itself in the top positions of the EU of regions developing innovation activities in science and industry, as the indicators provided at the beginning show. They have large and well-established high education institutions, as well as research centers, which perform excellence research and development activities that improve the competitiveness of the region.

Regarding the specialization trends, subject of our study, we can say that we have found some patterns that prove that there exists some kind specialization around some scientific fields and industrial sectors, especially those related to the environment and sustainability sectors, but also digital, metal industries, etc. Once again we face the fact that we would need more data to be able to determine up to which point these fields are those in which the region presents its competitive advantage and in which it should finally specialize.

3.4. Hovedstaden (Capital region), Denmark



Figures 3.4.1. Situation of Hovedstaden. Source: Google Maps

The region of Hovedstaden is located in an island, East to the continental part of Denmark. It comprises a population of 1.7 million people (2012) who live in the municipalities of Copenhagen, Frederiksberg, and their former countries, and the regional municipality of Bornholm.

Table 3.4.1. Main indicators for economy, industry and R&D in Hovedstaden

Indicator	Index	Year
Population	1729952	2012
GDP per capita (€ PPP)	37996,9	2008
Yearly growth of GDP per capita (PPP) (%)	2,4	2008
GDP per capita (€)	52400	2008
Yearly growth of GDP per capita (€)	2,61	2008
Disposable income per capita (€ PPP)	13050.5	2007
New foreign firms	0	2007
Employment rate (%)	75,2	2010
High and med. high-tech. manufacturing employment (% of total)	4,88	2009
Knowledge intensive services employment (% of total)	57,06	2009
Employment in industries with high energy purchases (%)	N.D.	N.D.
Enterprises	92430	2009
Apparent labor productivity (€)	62536,36	2008

Indicator	Index	Year
Business R&D share of GDP (%)	4	2007
Business R&D personnel (% of total)	2,6	2007
Business investment (thousand €/employee)	16,96	2010
Public (government) R&D expenditure (%)	0,2	2008
Public (government) R&D personnel (%)	0,14	2007
Public (higher education) R&D expenditure (%)	0,87	2007
Public (higher education) R&D personnel (%)	0,82	2007
Total R&D expenditure (%)	5,46	2008
Total R&D personnel (%)	4,37	2008
Human resources in science and technology (%)	21,5	2009
Patents per million habitants	688,6	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	71,55	2007

Source: Eurostat and European Cluster Observatory

In chapter 2 we analyzed the specialization trends of most of the EU regions, comparing them across scientific fields and industrial sectors. In the case of Hovedstaden, we found that the region presents competitive advantage, when considering the scientific fields, in environment and sustainability, but also, in less degree, in bio-related sciences and technologies, chemistry or agro-food technologies. Regarding the industrial sectors, Hovedstaden presents a large specialization in the manufacture of pharmaceutical products and preparations, followed by information and communication technologies and the transportation industries.

Considering now just the 12 regions that we are taking into account in chapter 3, we find that, regarding the scientific fields, Hovedstaden seems to be more specialized in physiology and pharmacology, followed by biosciences, health and agro-food technologies. If we take a look to the specialization trends for industrial sectors, we find that the region has competitive advantage in the same sectors that we found when comparing all regions: in the manufacture of pharmaceutical products and preparations, followed by information and communication technologies and the transportation industries.

3.4.1. High education institutions

The largest universities in Hovedstaden are:

a) **University of Copenhagen:** this large and ancient university was established in 1479 and it has around 35.000 students nowadays. They perform their research and development activities around these main fields: biology, pharmacology, health, and environment and sustainability.

b) **Aarhus University:** this also large university was established in 1928 and it is located in the city of Aarhus. It has more than 43.600 students. Their main research fields are ICTs, agriculture and food technologies, environment and sustainability, and health/medicine.

c) **University of Southern Denmark:** this university was officially established in 1998 and it is located in different campuses in Odense, Esbjerg, Kolding, Sønderborg, Slagelse, and Copenhagen. They perform their R&D activities focused in information and communication technologies and biotechnology.

d) **Aalborg University:** university located in Aalborg, but also with campuses in Esbjerg and Copenhagen. It has around 18.500 students and it was established in 1974. Their main research fields are engineering and medicine.

e) **Technical University of Denmark:** this technical university has around 9.000 students (undergraduate and graduate), it was established in 1829 and it is located in Copenhagen and the municipality of Lyngby-Taarbæk. They perform R&D activities around these main fields: nanotechnology, biotechnology, ICTs, energy and environment, food sciences, and space.

Additionally, other smaller universities that could be mentioned are the Information Technologies University of Copenhagen and the Copenhagen University College of Engineering, with around 2.000 students each. We can also refer to the Copenhagen Business School, with more than 17.000 students which, even if it does not perform research and development activities in science and technology, it has some departments working on business activities related to the technology-based companies.

3.4.2. Research centers and facilities

Hovedstaden has some relevant research centers performing high quality R&D activities, especially in the fields of biosciences – health – physiology and physics – astrophysics, among other fields.

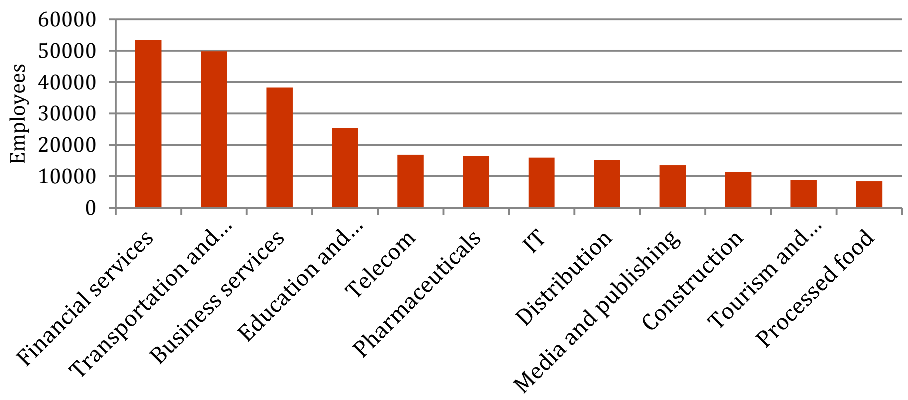
In the fields of **biosciences, health and physiology** we can mention some good examples like the August Krogh Institute, performing research in physiology and biochemistry, or the Center Startens Serum Institute, working to combat and prevent infectious diseases, congenital disorders, and threats from weapons of mass destruction. A more general example can be found in the Center for Geogenetics, performing research around biology, genetics or biofinformatics, but also in other fields like archaeology, paleontology, and geology.

Regarding the research in **environment, physics and astrophysics**, we find the Center for Planetary Research, or the Danish National Space Center, performing research around the universe and the solar system, the Earth's physics and geodesy, or the climate and the environment. Another example is the Niels Bohr Institute, which is specialized in astronomy, geophysics, particle physics, quantum physics, biophysics, and condensed matter physics. There is also the Denmark og Grønlands Geologiske Undersøgelse, working in hydrogeology, geophysics, geochemistry, marine geology, or mineralogy, among other.

3.4.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Hovedstaden (data from 2009, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.4.2. Employment by sectors in Hovedstaden (2009), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are transportation and logistics, telecommunications, and pharmaceuticals. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.4.2. Specialization trends in Hovedstaden (2009), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Pharmaceuticals	16500	4,43
Biotechnology	1671	4,07
Oil and gas	2683	2,21
Medical devices	4973	1,91
Transportation and logistics	49746	1,9
Telecommunications	16906	1,89
Information technologies	15938	1,83
Instruments	2814	1,56
Distribution	15113	1,25
Chemical products	5007	1,2
Plastics	4552	1
Jewellery and precious metals	571	0,79
Aerospace	1266	0,65
Lighting and electrical equipment	832	0,41
Production technology	3413	0,41
Processed food	8413	0,37
Construction	11322	0,32
Heavy Machinery	1292	0,29
Agricultural products	1262	0,27
Building fixtures, equipment and services	2742	0,26

Source: Adapted from the European Cluster Observatory

3.4.4. Examples of companies and cluster initiatives

The following examples aim to offer an overview of the main companies and clusters in Hovedstaden, according to their number of employees and profits. We find that these companies belong to some specific sectors: food and beverages, pharmaceutical and biotechnology, and energy, natural resources, and environment.

In the sector of **food and beverages** we find large companies like the Carlsberg Group, the well-known beer manufacturer, located in Copenhagen and with more than 40.000 employees. Another example is Danisco A/S, manufacturing products of bakery, beverages, frozen desserts, etc., located in Copenhagen, with 7.000 local employees and more than 70.000 worldwide. A third example is Chr. Hansen A/S, in the sectors of natural ingredients to the food, beverages, dietary supplements, and agriculture; it is based in Hørsholm and it has around 2.400 employees.

If we now take a look at the sectors related to **pharmacology and biotechnology**, we can refer to large companies like Novo Nordisk, a pharmaceutical company located in Bagsværd, with more than 30.000; they are focused in treatments for diabetes, hemophilia, or growth disorders, among others. Another large pharmaceutical company is H. Lundbeck A/S, located in Copenhagen, with more than 6.000 employees, and more focused in treatments for depression and anxiety, psychosis, bipolar disorders, and other psychic diseases. In the biotechnology sector we find, for example, Novozymes, located in Bagsværd and with more than 6.000 employees, specialized in enzymes and other proteins and microorganisms.

In the sectors of **energy, natural resources and environment** we find two main examples. The first one is the A.P. Moller – Maersk Group, a company located in Copenhagen, with more than 110.000 employees in the sector of shipping of oil and gas. The second example is FLSmidth & Co. A/S, based in Copenhagen and with more than 13.000 employees worldwide in the sector of supplying equipment and services to the global cement and mineral industries.

Regarding the region's **clustering initiatives**, we find, for example, the Cleantech Cluster, related to renewable energies, environmental solution and climate adaptation, the Biopeople Cluster, more focused in biology sciences and biotechnology, or the Danish Maritime Cluster, which puts together different institutions performing their activity around the maritime sector, including universities and research centers.

3.4.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Attiki are:

a) **Vaeksthus Greater Copenhagen:** they aim to promote, support and build growth-potential of start-ups, through guidance programs. They also act as mediators between entrepreneurs and other agents (banks, investors, lawyers, public organizations, etc.).

b) **Copenhagen Capacity:** they are in charge of the international promotion of the region, aiming to attract and maintain foreign companies and investment.

c) **The Bornholm Growth Forum:** they support and encourage the growth potential and development of start-ups and businesses in Bornholm.

3.4.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Hovedstaden.

Table 3.4.3. Questions around the performance of the science and industry agents in Hovedstaden regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Hovedstaden universities related to the specialization patterns identified for the region?	✓		
Are the main research centers in Hovedstaden performing research around those fields identified for the region?	✓		
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	✓		
Does the companies and clusters overview support the idea of specialization in the identified sectors?	✓		
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?			✗

Source: Own elaboration. *Unclear

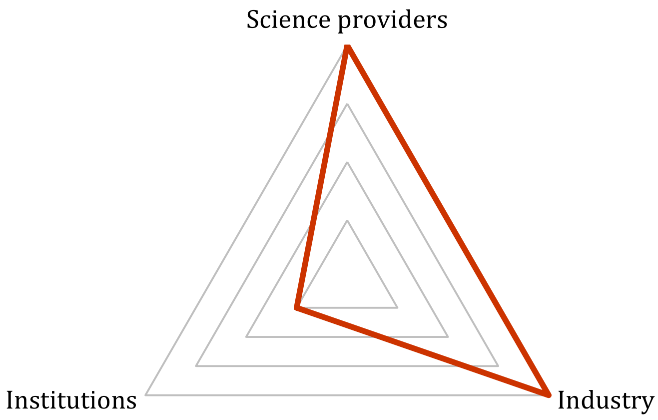
If we take a look at the universities and research centers of Hovedstaden we can see that they are aligned to the specialization trends that we found in chapter 2, when most of the European regions were taken into account, and the introduction of chapter 3, where we just considered the 12 regions with a largest critical mass from the 12 EU states whit also the largest critical mass, i.e. there is evidence of some specialization of the institutions performing R&D activities in the fields of environment and sustainability and bio-related sciences and technologies.

Something similar can be said regarding the industrial activities of Hovedstaden when we evaluate their specialization trends. We found, when analyzing the competitive advantages of the regions, that Hovedstaden is more specialized in the manufacture of pharmaceutical products and preparations, followed by information and communication technologies. The examples provided show that there is indeed an important critical mass for the first sector and, even if we did not enter that much in detail about ICTs, there is also an important number of companies in this sector.

When evaluating the public organizations promoting innovation-related initiatives, we face a situation similar to the one present in Etelä-Suomi, which means that most of the programs aimed at supporting these activities come from de Danish national framework. According to this, even the organizations described are a proper tool to promote the internationalization of the region and its start-up companies' growth, additional programs are required to establish a smart specialization regional strategy.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Hovedstaden.

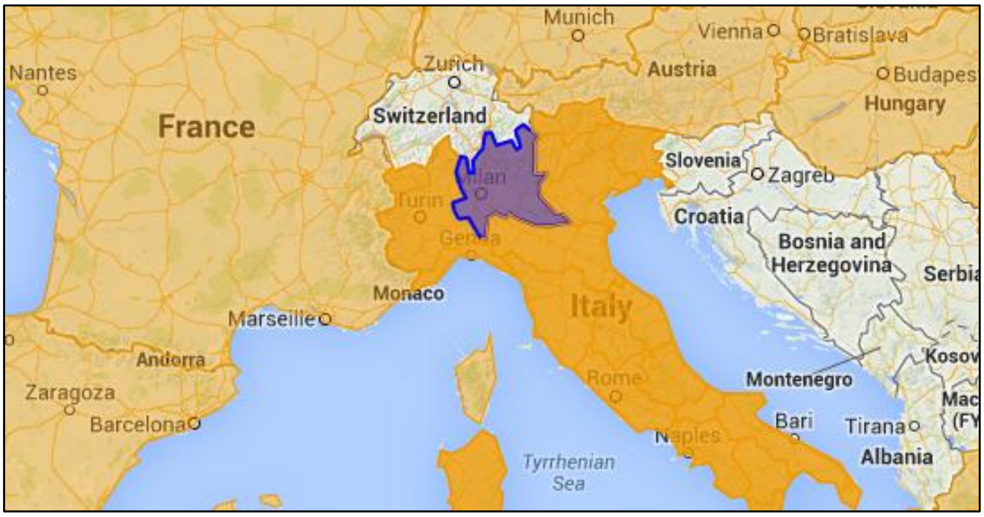
Figure 3.4.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Hovedstaden.



Source: Own elaboration.

After the analysis of these organizations we can conclude that Hovedstaden seems to be one of the regions where the specialization trends are more obvious, around the R&D activities in environment and sustainability, as well as in biology sciences and health, and the industrials sectors related to pharmaceutical products, the energy sector, and the ICTs. However, as we mentioned, in order to define a concrete smart specialization strategy, the region should go further when considering the regional programs or the structures to promote smart innovation policies and activities.

3.5. Lombardia (Lombardy), Italy



Figures 3.5.1. Situation of Lombardia. Source: Google Maps

The region of Lombardia is located in the north of Italy, bordering Switzerland. It comprises a population of about 10 million people (2012) and it is administratively divided in 12 provinces. Milan is the largest city and the capital of the region.

Table 3.5.1. Main indicators for economy, industry and R&D in Lombardia

Indicator	Index	Year
Population	9749593	2012
GDP per capita (€ PPP)	33549,6	2008
Yearly growth of GDP per capita (PPP) (%)	2,7	2008
GDP per capita (€)	33900	2008
Yearly growth of GDP per capita (€)	1,94	2008
Disposable income per capita (€ PPP)	19374,1	2007
New foreign firms	0	2007
Employment rate (%)	65,1	2010
High and med. high-tech. manufacturing employment (% of total)	8,97	2009
Knowledge intensive services employment (% of total)	31,88	2009
Employment in industries with high energy purchases (%)	12,37	2005
Enterprises	896383	2009
Apparent labor productivity (€)	689682,3	2008

Indicator	Index	Year
Business R&D share of GDP (%)	0,8	2007
Business R&D personnel (% of total)	0,57	2007
Business investment (thousand €/employee)	18,83	2010
Public (government) R&D expenditure (%)	0,1	2008
Public (government) R&D personnel (%)	0,06	2007
Public (higher education) R&D expenditure (%)	0,22	2007
Public (higher education) R&D personnel (%)	0,2	2007
Total R&D expenditure (%)	1,26	2008
Total R&D personnel (%)	1,04	2008
Human resources in science and technology (%)	7,6	2009
Patents per million habitants	897,49	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	57,44	2007

Source: Eurostat and European Cluster Observatory

In chapter 2, when we performed the analysis on the comparative advantages of most of the European regions, we saw that, when considering the scientific capacities, Lombardia presents specialization trends for medical sciences, followed by pharmacology and ICTs. Regarding the industrial activities, the region is more specialized in the sectors related to motor vehicles and transport equipment, as well as the manufacture of metallic and non-metallic basic products.

When we only consider the 12 regions that we are analyzing in this chapter, the results are more or less the same. If we take into account the scientific capacities, Lombardia presents comparative advantage in medical sciences, followed by pharmacology, animal health, and ICTs. If we consider the industrial sectors, the region presents specialization trends for motor vehicles and transport equipment, and the manufacture of metallic and non-metallic basic products, but also in textiles.

3.5.1. High education institutions

The largest universities performing R&D in science and technology in Lombardia are:

a) **University of Milan:** the largest university of the region, established in 1924, with around 65.000 students, and around 8.000 yearly articles published in the last years. Their main research fields are chemistry, computer sciences, food, environment, nutritional sciences, and pharmaceutical sciences.

b) **Politecnico di Milano:** established in 1863 and with about 35.000 students, this technology-oriented high education institution focuses their research and development activities around aeronautics and space, environmental sciences, biotechnology for health, chemistry, and materials and nanotechnologies.

c) **University of Milan-Bicocca:** this university, established in 1998, is located in Milan and it has around 30.000 students. They focus in R&D activities around mathematics, physics, medicine, and natural sciences.

d) **University of Pavia:** this ancient university, one of the oldest in Europe, was established in 1361 and it has around 20.000 students in the city of Pavia. Their main research fields are applied biology, earthquake engineering, and oncology.

e) **University of Brescia:** this university has around 14.000 students, it was established in 1982 and it is located in Brescia. They perform R&D activities in different fields, but they are especially focused on engineering, mathematics, and environmental sciences.

f) **University of Bergamo:** this university was established in Bergamo in 1968 and it also has around 14.000 students. Regarding their R&D activities, they focus on ICTs, engineering and mathematical methods.

3.5.2. Research centers and facilities

Lombardia has important internationally recognized research centers performing high quality R&D activities. If we take a look at the main ones located in the region, we realize that there are some specialization trends in health and medical sciences, as well as in environment and sustainability sciences.

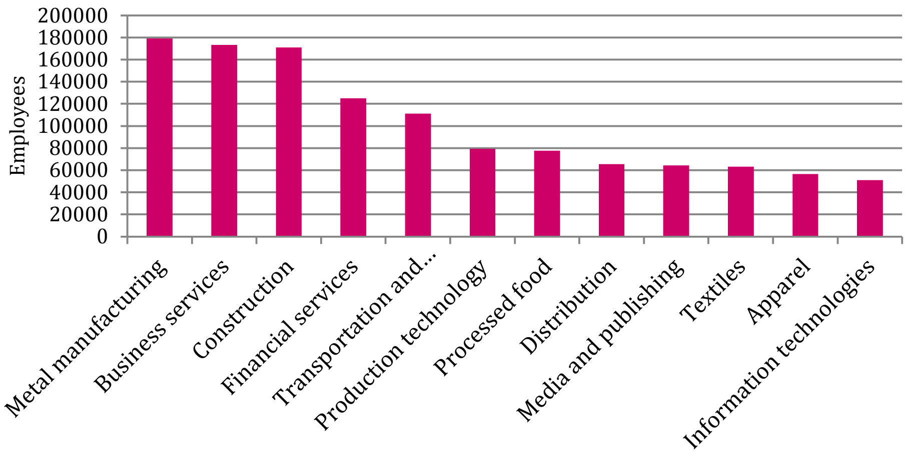
In the field of **health and medical sciences** we can provide some relevant examples. The first one is the Centro Cardiologico Monzino, located in Milan, with around 700 employees performing R&D activities around cardiovascular diseases. The Carlo Besta Neurological Institute (IRCCS) operates in the fields related to the oncological, degenerative and rare neurological diseases affecting children and adults, as well as in neurosurgery. In Milan we can also find the European Institute of Oncology (IEO), performing R&D in basic mechanisms regulating cell proliferation and differentiation, molecular mechanisms of tumor genesis, tumor biology and models, functional and structural genomics, and bioinformatics. Other related examples are the Institute for Health and Consumer Protection, which is focused in genetically modified organisms, nanotechnology, public health, food and consumers' products, and alternatives to animal testing, or the Carlo F. Dondena Center for Research on Social Dynamics, more oriented to the psychology and the sociology. Additionally, a related example can be mentioned: the Instituto Sperimentale Lazzaro Spallanzani, performing R&D activities around animal breeding and selection, and related fields like embryology, seminology, and molecular genetics.

Regarding the research centers in the field of **environmental sciences and sustainability**, we can mention, for example, the Institute for Environment and Sustainability (IES), which, besides their R&D activities, are in charge of the support for the development and implementation of European environmental policies. We can also talk about the Tethys Research Institute, also operating in other fields, with their main activities focused in the use of remote sensing en telemetry data, the use of laser range-finding binoculars and GPS to record the movement of whales, bioacoustics research, remote collection of biopsy data for genetic and toxicological data, etc.

3.5.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Lombardia (data from 2009, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.5.2. Employment by sectors in Lombardia (2009), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are metal manufacturing, construction, and transportation and logistics. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.5.2. Specialization trends in Lombardia (2009), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Textiles	63306	3,6
Apparel	56534	2,5
Metal manufacturing	179061	2,43
Production technology	79370	2,37
Pharmaceuticals	34061	2,26
Lighting and electrical equipment	17481	2,13
Plastics	38414	2,08
Leather products	4734	1,9
Jewellery and precious metals	5198	1,78
Furniture	31299	1,72
Chemical products	28127	1,67
Media and publishing	64270	1,56
Sporting, recreational and children's goods	6731	1,51
IT	50936	1,45
Medical devices	14945	1,42
Power generation and transmission	7830	1,4
Distribution	65522	1,34
Paper products	35563	1,25
Telecom	44836	1,24
Construction	171088	1,18

Source: Adapted from the European Cluster Observatory

3.5.4. Examples of companies and cluster initiatives

The following examples aim to offer an overview of the main companies and clusters in Lombardia, according to their number of employees and profits. This analysis shows us that there is an important presence of companies in the sectors of non-metallic materials and products, and energy.

If we take a look at the sector of the sectors related to the **non-metallic materials and products**, we can provide some examples of large companies in Lombardia. A well-known company is Pirelli & C. S.p.A., located in Milan and with more than 34.000 employees worldwide; they work in the production of tires and they have a large R&D team working in fields related to the new materials and processes, fuel cells, new-generation optical components, or nanotechnologies. The Luxottica Group S.p.A., also located in Milan, has about 65.000 employees and they are in the sector of the eyewear and lenses, developing also machinery used to produce prescription lenses. Other examples are Bruni Glass, located in Milan and producing glass containers for food, pharmaceutical products, and related accessories, and Abon Plastic SRL, located in Milan and performing their industrial activity around the thermoforming for plastic materials.

In the **energy sector** we find examples like Edison S.p.A., located in Milan and with more than 3.200 employees, working in the sectors of natural gas and electric power; their R&D activities are devoted to the environmental protection and the technological progress, aiming to reduce the greenhouse gas emissions, increasing the energy efficiency, and expanding the use of renewable sources. Other examples are the Compagnia Generale di Electtricità, S.p.A., or the ButanGas, both located in Milan and in charge of the distribution of the electricity and the butane gas.

Beside these sectors, other examples of large companies in Lombardia are worthy to be commented. In the transportation sector we can mention Azienda Trasporti Milanesi, with more than 9.500 employees in Milan, providing public transport; they perform innovation activities around the alternative fuels, the development of hybrid, electrical, and hydrogen engines, etc. Another example would be Cargolux Italia S.p.A., an all-cargo airline operating in Europe, Asia and South America. Regarding the telecommunications sector, Mediaset, with more than 6.200 employees, and Fastweb S.p.A., with around 3.500 employees, are two of the main examples for Lombardia, which has a large tradition in ICTs as well.

If we take a look at the **clustering initiatives** in Lombardia, we see that the region has been improving and consolidating its clusters. Regarding the specialization trends that they present, we find that there are associated clusters. One of the main examples is the Poli-Auto cluster, around the sector of transportation and automobiles, with around 90 associated companies (including Pirelli or Petroceramics) and 25 research institutions (including the Politecnico di Milano and the Università Cattolica del Sacro Cuore). Another example is the Distretto Aerospaziale Lombardo, operating in the sector of the aerospace, which represents around 185 companies and more than 18.000 employees. We can also mention the Lombardy Energy Cluster, with around 100 associated companies like Alstom or Praxair, and 15 research institutions, including the Politecnico di Milano, the LIUC University and the CNR.

3.5.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the two main organizations working to promote innovation-related activities in Lombardia are:

a) **CESTEC:** CESTEC is the acronym for Center for Technological Development, Energy and Competitiveness. CESTEC is a company owned by the Lombardia Region and develops its actions according to the regional innovation plans, supporting the SMEs through their services and projects. These services are divided in:

- Innovation: promotion of public-private partnerships with companies, universities and other institutions, promotion of the growth of business networks, improvement of the innovative potential of the companies, etc.
- Internationalization: technical assistance to the internationalization projects and regional calls to promote the internationalization.
- Development of communities: participation in European and international platforms, technical assistance in the participation in EU programs, regional planning regarding competitiveness, promotion of European and international partnerships, etc.

b) **Finlombarda Spa:** Finlombarda Spa is another company owned by the Lombardia Region. They support the regional policies looking for the economic and social development of the region, using financial and management tools. They finance initiatives coming from the SMEs and the carrying out of projects on infrastructures and public services. They also provide advisory services and technical assistance to the regional government in the definition of new polices and their implementation. Among their technical activities, we find the support to the region in the identification, development and implementation of programs funded by the EU, the participation of the region itself in some projects, as well as in the participation in international networks to strengthen the international role in innovation around companies and infrastructure.

Additionally, the Regional Innovation Monitor of the Commission mentions two other institutions that we do not include above since they are associated to universities and they perform activities related to them. We are talking about the Fondazione Politecnico, a foundation, established by the Polytechnic of Milan, jointly with other founder members, which has as a mission the contribution to the economic and cultural growth of the university and the region, favoring innovation and business as well as providing incentives for competitiveness at an international level, as well as creating new knowledge and transferring it to the society. Their main activities are the support for the creation of new high-technology companies, de implementation of cooperative European projects, and the setting-up of a science and technology park in their campus in Milan. The other institution is the Catholic University of Milan itself, for which the Monitor only mentions its academic capabilities.

3.5.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Lombardia.

Table 3.5.3. Questions around the performance of the science and industry agents in Lombardia regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Lombardia universities related to the specialization patterns identified for the region?	✓		
Are the main research centers in Lombardia performing research around those fields identified for the region?	✓		
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	✓		
Does the companies and clusters overview support the idea of specialization in the identified sectors?	✓		
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?		?	

Source: Own elaboration. *Unclear

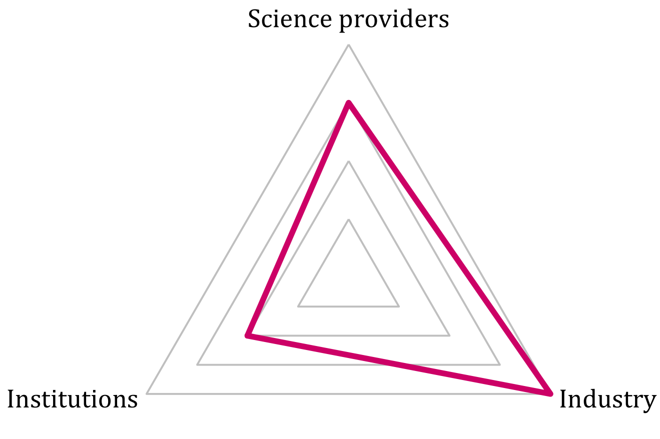
Analyzing the universities and research centers in Lombardia, and if we take a look at those scientific fields in which they appear to be specialized, according to the activity of the institution (in the case of the research centers) and the self-evaluation of the universities, we see that these trends seem to be the same that we identified in chapter 2, when we compared most of the European regions, and in chapter 3, when we compared just 12 of them. Medical sciences appears to be the field in which Lombardia could specialize the most, but also in other fields like physiology and pharmacology, animal sciences, or information and communication technologies, in which the region presents competitive advantages. Additionally, we have detected that Lombardia seems also to have an important critical mass in the fields related to the environment and the sustainability that must also be considered as strength of the region, even if the value of the Balassa index is not on the top when considering this field in Lombardia.

Regarding the industrial specialization in the region, and after taking a look in the data coming from the European Cluster Observatory and the information regarding some big companies and clusters that can be used as representative examples, we can say that Lombardia presents significant specialization trends. As we found in our study, the region has comparative advantage in the sectors of motor vehicles and transport equipment, followed by the manufacture of metallic and non-metallic basic products, and textiles. In our study, we have focused in providing examples of companies in the sector of non-metallic manufacturing. We must say that, in many cases, companies in this sector are directly related to the sector of motor vehicles, since they produce pieces and complements. The energy sector appears also to be very important in the region, with large and well-placed companies in the state and the whole European Union. We can find clustering initiatives in many different sectors, not only those in which me find more specialization.

Considering the institutions presented in the Regional Innovation Monitor, we see that both entities can play a key role in the definition and implementation of the smart specialization strategy, since they are completely related to the regional innovation strategies and the tools and programs that are defined around the different innovation policies. However, it is not that clear that, regarding the smart specialization strategy, these institutions have the role they could develop, and more information would be required to evaluate that.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Lombardia.

Figure 3.5.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Lombardia.



Source: Own elaboration.

Lombardia is one of the regions in which the specialization patterns are more evident, if we consider the 12 regions that we are considering in chapter 3. The evidences and examples that we have provided for both scientific capacities and industrial activities in the region prove the fact that, when defining the regional innovation smart specialization strategy, Lombardia can easily identify their priorities, which must be taking into account when defining the top-down approach. Considering representatives from the main institutions that we have mentioned, as well as the representatives from the business sector, will be the key to present a proper strategy that considers all the strengths and opportunities in Lombardia.

3.6. London, United Kingdom

Figures 3.6.1. Situation of London. Source: Google Maps

The region of London is located in the South-East of England and the state of the United Kingdom. It comprises a population of 8 million people (2009) living in the area of the state's capital, London.

Table 3.6.1. Main indicators for economy, industry and R&D in London

Indicator	Index	Year
Population	7725159	2009
GDP per capita (€ PPP)	49061,8	2008
Yearly growth of GDP per capita (PPP) (%)	3,2	2008
GDP per capita (€)	50610,75	2008
Yearly growth of GDP per capita (€)	0,73	2008
Disposable income per capita (€ PPP)	22435,13	2007
New foreign firms	0	2007
Employment rate (%)	67,4	2010
High and med. high-tech. manufacturing employment (% of total)	1,37	2009
Knowledge intensive services employment (% of total)	58,45	2009
Employment in industries with high energy purchases (%)	3,42	2005
Enterprises	N.D.	N.D.
Apparent labor productivity (€)	102619,9	2008

Indicator	Index	Year
Business R&D share of GDP (%)	0,4	2007
Business R&D personnel (% of total)	0,29	2007
Business investment (thousand €/employee)	14,71	2010
Public (government) R&D expenditure (%)	0,1	2008
Public (government) R&D personnel (%)	0,7	2007
Public (higher education) R&D expenditure (%)	0,55	2007
Public (higher education) R&D personnel (%)	0,83	2007
Total R&D expenditure (%)	1,01	2008
Total R&D personnel (%)	1,2	2008
Human resources in science and technology (%)	17,91	2009
Patents per million habitants	324,93	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	56,55	2007

Source: Eurostat and European Cluster Observatory

In the analysis that we developed in chapter 2, when we considered all the EU regions at the same time, we saw that that, when considering the scientific research, London presents a comparative advantage in medical sciences, followed by biotechnology and biomedicine, physiology and pharmacology, and ICTs. Regarding the industrial activities, London presents a large specialization index in information and communication technologies. Additionally, even if the rate is much lower, there are also some competitive advantages in transportation and storage or waste management.

The results are similar when we compare London to the other regions with a larger critical mass in the 12 largest EU states regarding their scientific and industrial activities. London also presents specialization trends in medical sciences, followed by biotechnology and biomedicine, physiology and pharmacology, and ICTs, while regarding the industrial capacities London has competitive advantage for information and communication technologies, followed by transportation and storage and waste management.

3.6.1. High education institutions

The largest universities in London (in those fields related to science and technology) are:

a) **Imperial College London:** founded in 1907, the college has more than 13.000 students in its urban campus. Among their main research topics, we find engineering, especially chemical, civil, mechanical, aeronautical, and manufacturing, as well as biomedicine, where they are especially focused in Parkinson's disease, multiple sclerosis, and epidemiology.

b) **University College London:** this public university was established in 1826 and nowadays it has around 25.000 students, undergraduate and graduate. Their main research fields are related to clinical medicine, immunology, neurosciences and behavior, pharmacology and toxicology, psychiatry and psychology, and social sciences.

c) **King's College London (University of London):** it is also a public university and it was established in 1829. It has around 25.000 students in its urban campus. Among their highlighted research fields we find biomedical sciences, including chemistry, pharmaceutics, and neurobiology, psychiatry and neurosciences, and medicine in the fields of, among other, asthma, allergies, cancer, genetics, infections and inflammatory diseases, or diabetes and nutritional immunology.

d) **City University London:** established in 1966, this university has around 17.500 students, where almost 45% of them are graduate. In the fields related to science and technology, their main research fields are engineering and mathematical sciences, health, and informatics.

e) **Queen Mary (University of London):** with almost 15.000 students nowadays, and located in the urban campus in London, it was established in 1885 (as a college). In those fields associated to science and technology, they are specially focused in cancer studies, dentistry, epidemiology, and other hospital based clinical subjects.

f) **Middlesex University:** first established as a polytechnic, in the seventies it was recognized as a university in 1992 and it has around 24.000 students. They perform research activities in health and biomedical sciences, as well as in engineering, product design, and computing and other information sciences.

g) **University of East London:** it was also a polytechnic and it was recognized as a public university in 1992. It has around 28.000 students. Their main research field is digital and information technologies. The other main fields are related to social sciences and humanities.

h) **Kingston University:** after being a technical institution, it gained the university status also in 1992. It has around 23.000 students. Besides social sciences and humanities, their main research fields are related to computing and information systems, and engineering (especially in aerospace and sustainable technologies).

3.6.2. Research centers and facilities

London has a large number of important and well positioned research and technology centers in many fields. However, they are especially focused in health and medical sciences.

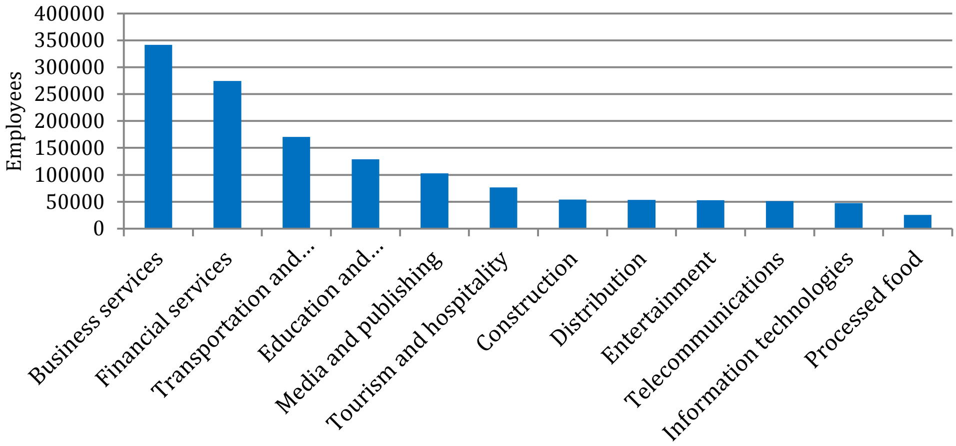
If we concentrate in the field of **health and medical sciences**, we can present some relevant examples. We must mention the Institute of Cancer Research, with different research teams in breast cancer, cancer biology, or cancer therapeutics, among other, and more than 1.000 employees. The Institute of Optometry develops its research promoting excellence in the field of optometry, as its name indicates. The Institute of Psychiatry, associated to the King's College London, perform R&D activities in the fields of neurosciences, molecular genetics and biology, etc. The National Institute for Medical Research is mostly focused in developmental biology, infections and immunity, neurosciences, and structural biology, with around 240 researchers developing high-level research. The Wolfson Center for Age-Related Diseases focuses in neurodegeneration and regeneration, neurogenesis, or genetics of deafness, among other. They also have a drug discovery unit and a team devoted to bioinformatics. The London Research Institute performs research around three main fields: biology of tumors and tissues, cellular regulatory mechanisms, and genomic integrity. Finally, we can also mention the William Harvey Research Institute, another center of excellence that performs R&D activities related to health, in the medical fields of inflammation, cardiovascular, and endocrinology.

As we see, London has a large and well-established tradition regarding the research and development activities around the medical sciences, their main strength in terms of specialization, as we have mentioned before, being a leader region in the field worldwide. However, London has also many relevant and high level research centers in different other fields. For example, we can mention the Center for Polar Observation and Modeling, which works towards the development of improved understanding and theoretical representation of physical processes that play a pivotal role in the balances of heat, mass, and momentum in the polar seas. Another good example is the London Center of Nanotechnology, one of the most relevant centers in this field in the EU. They work with nanotechnologies applied to different fields: biosciences, carbon structures, device engineering, magnetism and spintronics, nuclear materials, quantum informatics, etc. Finally we can also put the example of the National Physics Laboratory, working in cross-disciplinary fields related to physics.

3.6.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in London (data from 2005, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.6.2. Employment by sectors in London (2005), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are transportation and storage, construction, and ICTs. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.6.2. Specialization trends in London (2005), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Biotechnology	2729	1,49
Transportation and logistics	170339	1,46
Telecommunications	50770	1,27
Information technologies	47572	1,23
Tourism and hospitality	76643	1,07
Distribution	53456	0,99
Jewelry and precious metals	2064	0,64
Construction	54163	0,34
Instruments	2585	0,32
Leather products	858	0,31
Apparel	7142	0,29
Lighting and electrical equipment	2632	0,29
Pharmaceuticals	4284	0,26
Processed food	25154	0,25
Maritime	2328	0,22
Sporting, recreational and children's goods	1017	0,21
Plastics	3896	0,19
Heavy Machinery	3396	0,17
Furniture	3177	0,16
Aerospace	1287	0,15

Source: Adapted from the European Cluster Observatory

3.6.4. Examples of companies and cluster initiatives

London presents a large variety of industries and it is difficult to define some specific sectors to be defined as those in which we can find the most relevant examples. We present some large companies that are representative from different sectors, but it is just a small overview of the whole industrial environment present in the region.

In the sector of the **telecommunications**, we can mention the BT Group, the multinational provider of ITCs, with almost 90.000 employees and profits over £2.000 billion, or the Vodafone Group, a well-known provider of technologies related to the mobile phones and related devices, with more than 85.000 employees and almost £7.000 billion in revenues. In the sectors related to the **natural resources**, we can put the example of three large companies: British Petroleum, with more than 8.000 employees, BHP Billiton, with more than 46.000 and working in the sector of metals and mining, or ENRC, in the same sector, with around 72.000 employees and almost £2.000 billion of revenues. In the sector of **aerospace and defense** we find, for example, the Rolls-Royce Group, working in gas turbines, enabling technologies, or nuclear technologies, among other, with around 40.000 employees, and turnovers around £850 million. BAE Systems operates in the field of security, but more from an IT perspective, with more than 100.000 employees and £1.250 billion in revenues. Besides these sectors, many other examples could be provided. We can mention Unilever, the large multinational operating in the field of consumable goods, with more than 170.000 employees and almost £4.500 billion in revenues. Finally, to put an example of a large pharmaceutical, we can mention AstraZeneca, also working in biologics, with more than 7.000 employees and almost £10.000 billion of profits.

Additionally, we must say that London is a well-known region for their banks and other financial institutions, and services companies. We do not mention examples in these sectors since we want to focus just in the industrial activities.

Regarding the **clustering initiatives**, London has done a great job promoting their clusters and its number and excellence must be highlighted. In order to put some representative examples, we can mention the East London Tech City, which clusters around 200 national and international companies in the sector of ICTs, including Cisco, Google, Vodafone, or Amazon. One Nucleous is related to the sectors of biosciences and biotechnology, and it clusters almost 400 companies and around 60 research institutions. Other examples are the London Cleantech Cluster, including Synergy Energy, Planet Positive, and Nomura Code, or the North West London Health Innovation and Education Cluster (NWL HIEC), promoting health and medical-related activities.

3.6.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in London are:

a) **London Higher:** this is an organization that represents over 40 higher education institutions in London, including public universities. Their activities support high-level research and education, being an advisory group, promoting networking, meetings, workshops, research reports, and other actions aimed to stimulate academic and research activities.

b) **UK Department for Business Innovation and Skills Regional Office London and East:** there are six teams associated to the UK Department for Innovation and Skills (BIS). Among their main objectives, we find: establish networks with local enterprises and local governments, assist in the coordination of the economic development delivery, provide intelligence to ensure the effective coordination of government responses to economic shocks, on maintaining strong links with selected large business and key sectors.

c) **London Enterprise Panel:** they aim to maximize London's economic growth through the support to the companies in the region, i.e. ensuring a business-les and devolved agenda for development in London. They define some actions focused to promote regional companies with this purpose.

d) **Greater London Authority (GLA) (and the Mayor of London):** GLA has three main responsibilities, which are the economic development and wealth creation, the social development, and the environmental improvement. Related to these priorities, they work jointly with the London Mayor, helping his office to develop strategies, some of them related to innovation activities.

Besides these four institutions, the Regional Innovation Monitor also mentions two other organizations that we do not describe since their activities are not that directly related to promote innovation, research, or industry: the British Library and Welcome Trust, a global charity institution.

3.6.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in London.

Table 3.6.3. Questions around the performance of the science and industry agents in London regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the London universities related to the specialization patterns identified for the region?	✓		
Are the main research centers in London performing research around those fields identified for the region?	✓		
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	✓		
Does the companies and clusters overview support the idea of specialization in the identified sectors?			✗
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?		?	

Source: Own elaboration. *Unclear

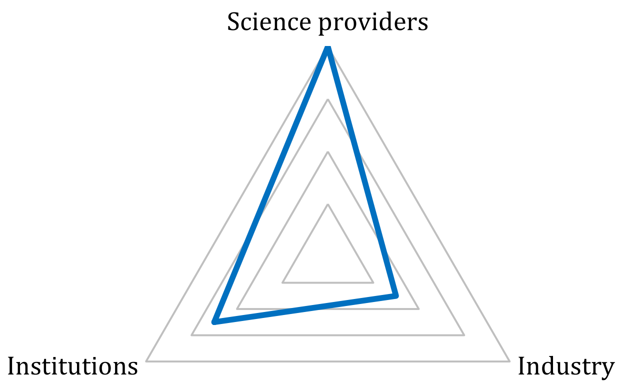
First at all, if we examine the main universities and research centers in London, we can say that this is one of the regions where the specialization trends are clearer. The regional specialization in health and medical sciences is evident and London is a leader around the world in this field. The large and well-positioned research centers in the field are a proof of the capacities that the region has an important critical mass to develop high level research, and many universities have also research teams performing their R&D activities in this field. Additionally, London also presents specialization patterns in other fields. Our analysis shows that our pre-identified fields of specialization appear to be those in which the region has actually competitive advantage: biotechnology and biomedicine, pharmacology, or ICTs.

When we consider the industry and we try to identify specialization trends according to the different companies in London, we see that, if we want to have a wider point of view than just the number of employees (number of companies, revenues and profits, sells, etc.), it becomes much more difficult to talk about specialization. London concentrates a large number of companies, most of them in the services sector, but also industry. If we focus in the last, we can find examples of almost all sectors, and many of them are international and very large companies. This diversity makes more complex to identify specialization trends if we want to take into account more than one variable at a time. We must also say that London is one of the biggest agglomerations of industrial companies in the EU and, as we mentioned before, the larger the presence of industry, the more difficult to identify specialization patterns.

Regarding the institutions and organizations related to the innovation that we have described according to the information provided by the European Regional Innovation Monitor, we see that they have possibilities to support the way towards the implementation of the smart specialization strategy, but it is not clear up to what point. The UK Department for Business Innovation and Skills Regional Office London and East and the Greater London Authority (GLA) (and the Mayor of London) appear to be the two institutions with a larger decision power in London when considering the innovation and business related activities. However the information available is not concrete enough to be able to determine whether these institutions can play a central role in the definition of the strategy, or if they will only implement it.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of London.

Figure 3.6.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for London.



Source: Own elaboration.

To summarize the whole analysis of the region of London we can say that, as we mentioned, it is very easy to identify specialization trends when we consider the scientific capacities, especially around the fields related to health and medical sciences, where London appears to have a large competitive advantage and a large critical mass. However, regarding the industrial activities, even if we are able to identify some patters according to data, it is difficult to determine how significant they are if we want to consider other variables besides the number of employees. In any case, London presents a large variety when we consider the industry, being able to compete in different sectors.

3.7. Mazowieckie (Province of Mazovia), Poland

Figures 3.7.1. Situation of Mazowieckie. Source: Google Maps

The region (province) of Mazowieckie is located in the Center-East of Poland. It comprises a population of 5.2 million people (2009). It includes the capital and the largest city of the state, Warsaw.

Table 3.7.1. Main indicators for economy, industry and R&D in Mazowieckie

Indicator	Index	Year
Population	5213331	2009
GDP per capita (€ PPP)	22220,4	2008
Yearly growth of GDP per capita (PPP) (%)	6,7	2008
GDP per capita (€)	15000	2008
Yearly growth of GDP per capita (€)	14,09	2008
Disposable income per capita (€ PPP)	10281	2007
New foreign firms	0	2007
Employment rate (%)	64,4	2010
High and med. high-tech. manufacturing employment (% of total)	3,84	2009
Knowledge intensive services employment (% of total)	38,15	2009
Employment in industries with high energy purchases (%)	2,19	2005
Enterprises	620401	2010
Apparent labor productivity (€)	46503,42	2008

Indicator	Index	Year
Business R&D share of GDP (%)	0,3	2007
Business R&D personnel (% of total)	0,22	2007
Business investment (thousand €/employee)	8,32	2010
Public (government) R&D expenditure (%)	0,6	2008
Public (government) R&D personnel (%)	0,48	2007
Public (higher education) R&D expenditure (%)	0,2	2007
Public (higher education) R&D personnel (%)	0,37	2007
Total R&D expenditure (%)	1,21	2008
Total R&D personnel (%)	0,98	2008
Human resources in science and technology (%)	14,7	2009
Patents per million habitants	37,63	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	74,75	2007

Source: Eurostat and European Cluster Observatory

In chapter 2, when we analyzed the specialization trends for most of the EU regions in terms of scientific capacities, we found that the region of Mazowieckie presents a comparative advantage for research in chemistry and material sciences, followed by physics. If we consider the industrial activities, the region appears to be specialized in the sector of transportation and storage, followed by activities related to electricity, gas, steam and air conditioning supplies, and the manufacture of basic pharmaceutical products and preparations; in less degree there are also specialization patterns for ICTs and food and beverages.

Now, if we compare Mazowieckie only to the other regions that we're considering in this analysis, i.e. the 12 largest regions of the 12 largest stats (considering the scientific and industrial critical mass), we find that the region still has, when considering the scientific capacities, competitive advantage for research in chemistry and material sciences, followed by physics. Regarding the industrial activities, Mazowieckie presents specialization trends for electricity, gas, steam, and air conditioning supplies and, in less degree, food and beverages, and transportation and storage activities.

3.7.1. High education institutions

The largest universities in London (in those fields related to science and technology) are:

a) **University of Warsaw:** established in 1816, this public university has more than 55.000 students in its urban campus. They perform R&D activities in a wide range of fields. Among the most representative we find chemistry, biotechnology, biomedicine, or ICTs.

b) **Warsaw University of Technology:** it was established in Warsaw in 1826 and it has nowadays more than 30.000 students. They also develop research in many fields, including advanced materials, chemistry, physics and energy, or mathematics, among other.

c) **Warsaw University of Life Sciences:** established in 1816, this university has around 25.000 students. They are focused in R&D activities in the fields of agriculture and biology, environment and sustainability, animal sciences, and food sciences.

3.7.2. Research centers and facilities

Mazowieckie has research and technology centers in many different fields, most of them located in Warsaw, the regional and national capital. Here there is a list with the most representative examples.

In the field of health, medical sciences, and pharmacology we find:

- **Maria Sklodowska Curie Institute of Oncology:** as its name indicates, this research center located in Warsaw develops high-level research in the field of cancer biology.

- **Pharmaceutical Research Institute:** research and development in the field of pharmaceutical sciences, including manufacturing of selected active pharmaceutical ingredients in laboratory and production scale.

- **Center of Preclinical Research and Technology:** they develop R&D activities related common diseases, especially neurological and vascular, as well as those related to ageing.

- **Interdisciplinary Center for Behavior Genetic Research:** they perform research in the fields of behavior genetics, psychopathologies, and psychotherapy effectiveness.

In the field of advanced materials, engineering and new technology we can put as example:

- **Institute of Electronic Materials Technology:** the work in the development of materials and innovative devices and components based on different materials for uses related to electronics and micromechanics.

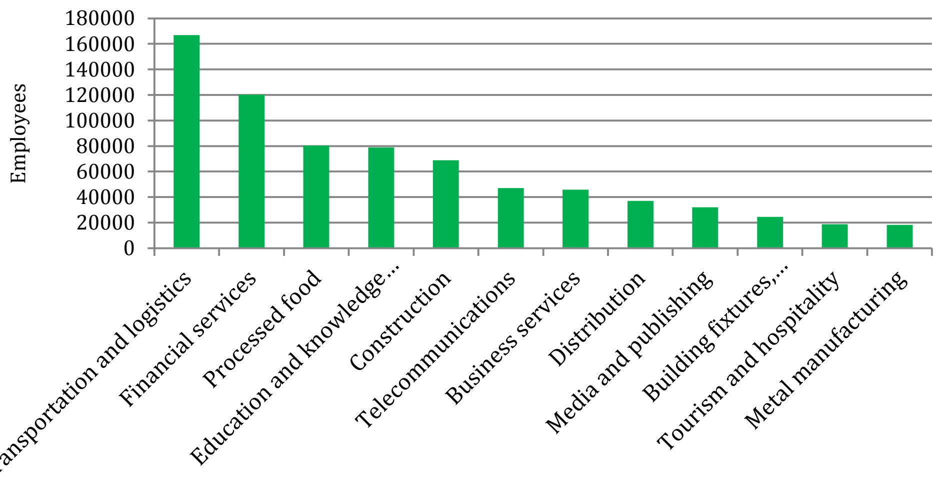
- **Center of New Technologies:** they develop their R&D activity focused in the development of new technologies in the fields of ICTs or new materials, but also biotechnology and biomedicine.

Additionally, we can also mention the University Center for Environmental Studies, located in Warsaw and developing research and development activities in the field of environmental protection. In the field of biotechnology we can put as a relevant example the Biological and Chemical Research Center of the University of Warsaw, performing R&D in the fields related to biomedicine and biotechnology, but also those related to the environment.

3.7.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Mazowieckie (data from 2010, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.7.2. Employment by sectors in Mazowieckie (2010), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are transportation and logistics, food processing and construction. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.7.2. Specialization trends in Mazowieckie (2010), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Transportation and logistics	167001	3,08
Telecommunications	47105	2,54
Oil and gas	6260	2,49
Tobacco	2840	2,14
Pharmaceuticals	16250	2,11
Processed food	80371	1,71
Distribution	36964	1,48
Paper products	17462	1,2
Building fixtures, equipment and services	24418	1,12
Construction	68798	0,93
Chemical products	8003	0,92
Plastics	8619	0,91
Apparel	9918	0,85
Instruments	3058	0,82
Power generation and transmission	2309	0,81
Information technologies	13480	0,75
Jewelry and precious metals	1118	0,75
Leather products	903	0,71
Lighting and electrical equipment	2936	0,7
Heavy machinery	5477	0,58

Source: Adapted from the European Cluster Observatory

3.7.4. Examples of companies and cluster initiatives

The following examples look to offer an overview of the main companies and clusters Mazowieckie, according to their number of employees and profits. We will put a few examples in two of the main sectors: energy and transportation.

In the sector of **energy**, we can put as example of the Polish Energy Group, with more than 46.000 employees and about 5.000 zlotys of profits, developing different industrial activities in different fields related to energy. PGNiG, a large company located in Warsaw, works in the exploration and production of natural gas and oil, including the import, storage, trade, and distribution of gas and liquid fuels. The Polish Oil Concern Orlen, located in Plock and with around 24.000 employees, operates in the sectors of oil refiner and petrol retailer.

Om the sector of **transportation**, we can mention LOT Polish Airlines, and well as the two main companies related to railways: the Polish State Railways, with around 3.000 employees, and the PJKP Przewozy Regionale, with more than 13.000 employees.

Regarding the **clustering initiatives**, Mazowieckie has many different clusters in very different fields. Some examples are the BioTechMed Cluster of Mazovia, with 110 associated companies and research institutions in the fields related to biotechnology and biomedicine, the Euro-centrum Cluster of Energy Saving Technologies, with more than 50 associated companies, the ICT Mazowiecki Cluster, with around 70 associated companies and research institutions, the Polish Automotive Cluster, the Creative Communication Cluster, or the Alice-Med cluster (in the field of biomedicine), among other in a large range of sectors.

3.7.5. Public agencies promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Mazowieckie are:

a) **Center for Technology Transfer and Entrepreneurship Development:** it is associated to the Warsaw University of Technology, and their main goal is the technology and knowledge transfer from the research units to the society. They develop different initiatives with this purpose, including the development of technology transfer methods in environment protection in Mazowieckie, being a technology transfer center, and the Warsaw technology incubator.

b) **Mazovia Develop Agency Plc:** the agency's main activity is related to serving investors and assisting the region's companies through the promotion of the regional economy and the regional brands and products, the support to the innovative projects, especially those related to the technology transfer from science to business, the support to the public-private partnerships to develop innovative projects, or the organization of workshops with the local authorities, among other.

c) **Marshal Office of Mazowieckie:** if we consider their activities based on innovation, their main office is the Department of Strategy and Regional Development, in charge of the preparation of the regional development strategy and the implementation of their operational programs. They also have an innovation unit, elaborating the regional innovation strategy and developing the networking among all related actors in the region, providing also consultancy services on innovation activities.

3.7.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Mazowieckie.

Table 3.7.3. Questions around the performance of the science and industry agents in Mazowieckie regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Mazowieckie universities related to the specialization patterns identified for the region?		?	
Are the main research centers in Mazowieckie performing research around those fields identified for the region?		?	
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	✓		
Does the companies and clusters overview support the idea of specialization in the identified sectors?		?	
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?	✓		

Source: Own elaboration. *Unclear

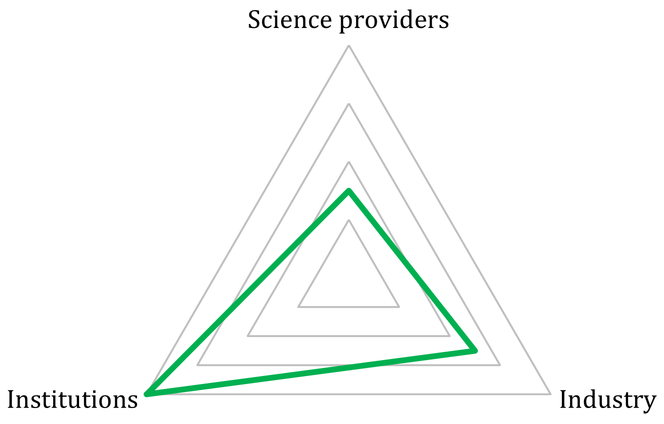
If we aim to analyze the specialization trends of Mazowieckie when considering their scientific capacities, we find that it is not that easy. Their universities do not present any defined pattern that allows us to say that there is a clear trend, and we reach a similar conclusion if we take into account the region’s research centers. As we have seen, the fields in which the different institutions work include a large number of topics and, according to the limited view that we have, we cannot say that there is a few number of fields in which the region could specialize.

We face a similar situation when, instead of the scientific capacities, we consider the industrial activities of Mazowieckie. The region is largely industrialized and it host companies in many different sectors. Our analyses, in chapter 2 and at the beginning of chapter 3, show that the region present specialization trends in transportation and storage, followed by activities related to electricity, gas, steam and air conditioning supplies, and the manufacture of basic pharmaceutical products and preparations. We can find examples for all these sectors, but there are also many other industries with large and well-established companies. Therefore, our examples are not enough to prove the existence of these patterns. In the case of the clustering initiatives, it is important to underline the large number of clusters in Mazowieckie, which cover many different sectors, making also difficult to signal specialization trends.

Finally, regarding the institutions related to the innovative activities that we have described, we can say that all them, but especially the Mazovia Develop Agency and the Marshal Office of Mazowieckie, are in charge of developing programs around innovation, technology transfer and related activities, and the future implementation. It means that they are in a privileged position to work towards the smart specialization strategy.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Mazowieckie.

Figure 3.7.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Mazowieckie.



Source: Own elaboration.

In conclusion, Mazowieckie has an important critical mass when considering both scientific capacities and industrial activities. However, the variety of research fields and industrial sectors make difficult to establish concrete specialization patters, even if some trends can be identified. More data would be needed in order to define them from a more solid point of view.

3.8. Nordrhein-Westfalen (North Rhine-Westphalia), Germany

Figures 3.8.1. Situation of Nordrhein-Westfalen. Source: Google Maps

The region of Nordrhein-Westfalen is located in central-east Germany. It comprises a population of 1.8 million people (2009) in 24 districts and 12 urban districts. The regional capital is Mainz.

Table 3.8.1. Main indicators for economy, industry and R&D in Nordrhein-Westfalen

Indicator	Index	Year
Population	17902914	2009
GDP per capita (€ PPP)	29086,8	2008
Yearly growth of GDP per capita (PPP) (%)	3,7	2008
GDP per capita (€)	30309,87	2008
Yearly growth of GDP per capita (€)	3,89	2008
Disposable income per capita (€ PPP)	18946,38	2007
New foreign firms	0	2007
Employment rate (%)	67,7	2010
High and med. high-tech. manufacturing employment (% of total)	9,23	2009
Knowledge intensive services employment (% of total)	39,24	2009
Employment in industries with high energy purchases (%)	4,56	2005
Enterprises	420116	N.D.
Apparent labor productivity (€)	60134,53	2008

Indicator	Index	Year
Business R&D share of GDP (%)	1,1	2007
Business R&D personnel (% of total)	0,58	2007
Business investment (thousand €/employee)	11,35	2010
Public (government) R&D expenditure (%)	0,3	2008
Public (government) R&D personnel (%)	0,17	2007
Public (higher education) R&D expenditure (%)	0,39	2007
Public (higher education) R&D personnel (%)	0,25	2007
Total R&D expenditure (%)	1,88	2008
Total R&D personnel (%)	1,02	2008
Human resources in science and technology (%)	10,21	2009
Patents per million habitants	721,61	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	70,75	2007

Source: Eurostat and European Cluster Observatory

If we consider most of the European regions, as we did in chapter 2, and we analyze their specialization trends, we find that Nordrhein-Westfalen, when we analyzed the scientific capacities, presents competitive advantage in physics and astrophysics, followed by health and medical sciences, and chemistry. Regarding the industrial activities of the region, we find that it presents some specialization patterns for the manufacture of chemicals, chemical products, coke, and refined petroleum products, followed by the sector of motor vehicles and transport equipment, and the sector of basic metals and metal products.

If we now only consider the 12 regions that we are taking into account in chapter 3, we find that, regarding the scientific fields, Nordrhein-Westfalen seems to be more specialized in chemistry, followed by physics and astrophysics, materials, and mathematics. If we consider the industrial sectors, their competitive advantage appears to be in electricity, gas, steam and air condition supply, followed by the manufacture of chemicals and chemical products, transportation and storage, and computer and electronic products.

3.8.1. High education institutions

The largest universities performing scientific and technological R&D in Nordrhein-Westfalen are:

a) **University of Münster:** established in 1780, this public university is located in an urban campus in Münster and it has around 40.000 students. The scientific fields in which they are more focused are mathematics, natural sciences, life sciences, and social sciences and humanities.

b) **University of Cologne:** it was established in 1388, but it was closed from the 1798 (due to the French invasion) to the 1919, when it was reopened. They have around 38.000 students in the campus in Cologne. Their main specialization fields are mathematics, natural sciences, medicine, and economics and social sciences.

c) **Ruhr University Bochum:** it was established in 1962 and it is located in an urban campus in Bochum, with around 37.000 students. Their main R&D fields are chemistry, plasma sciences and technologies, materials, and neurosciences.

d) **RWTH Aachen University:** it was established in 1870 and it is located in an urban campus in Aachen. It has around 35.000 students. They perform research activities around many different fields, but they are especially focused in computational science and engineering, energy, chemical and process engineering, ICTs, material sciences, medical sciences, molecular sciences, mobility and transport, and production engineering.

e) **University of Bonn:** with around 31.000 students, this university was established in 1818 and it is located in an urban campus in Bonn. Regarding their scientific activities, they are more focused in mathematics, physics, chemistry, pharmacology, genetic medicine, and neuromedicine.

f) **University of Düsseldorf:** established in 1965, this university, located in Düsseldorf, has nowadays around 20.000 students. They are specialized in research activities in the fields of life sciences, natural sciences, and social sciences and humanities.

g) **Dortmund University of Technology:** with almost 30.000 students and located in Dortmund, they are focused in production and logistics, chemical biology and biotechnology, and modeling.

h) **Bielefeld University:** it was established in Bielefeld in 1969, and it has about 18.000 students. Regarding their scientific activities, they are more focused in interactive intelligent systems, molecular and nano sciences, and theoretical sciences.

i) **University of Paderborn:** established in 1614, this public university located in Paderborn has around 18.000 students. Its most relevant research fields are intelligent technical systems and light constructions.

3.8.2. Research centers and facilities

Nordrhein-Westfalen concentrates some of the most important research institutions in the whole EU, performing **R&D activities in many different fields**:

- The *German Fraunhofer Institutes* (11 in Nordrhein-Westfalen) develop their research activities in health, nutrition and environment, safety and security, ICTs, transportation and mobility, energy and living, and production and environment.
- The *Max-Planck Institutes*, with 12 centers in the region and a budget of 1.3 billion Euros/year, are more focused in astronomy and astrophysics, biology and medicine, materials technologies, and environment and climate.
- The *Leibniz Association*, with 11 institutes in the region, is focused in communications and microelectronics, materials and nanotechnology, ophthalmology technology, environment and climate, and humanities.
- The *Jülich Research Center*, with around 5.000 employees, performs R&D activities around health, energy and environment, and ICTs.
- The *Center of Advanced European Studies and Research* is more focused in neurosciences, cell biology, and biophysics.
- The *Forschungszentrum Jülich GmbH*, performing research in simulation sciences, electron microscopy, hadrons, neutrons, and structural biology.

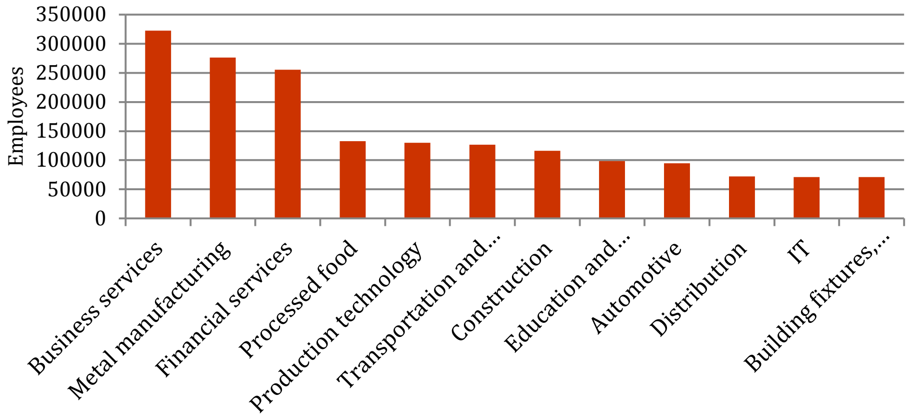
Now we can put some examples of relevant research centers performing their activities around **specific fields**:

- The *German Aerospace Center*, located in Cologne, with more than 6.000 employees and 29 associated institutes, perform R&D activities in aeronautics, space, energy, transport, and defense and security.
- The *German Center for Neurodegenerative Diseases*, with 8 institutes and headquarters in Bonn, is focused in the causes, mechanisms, diagnosis and therapy of the neurodegenerative disorders.
- The *Institute for Mobile and Satellite Communication Technology* works on radio communications, radar systems, microsystems and nanoelectronics.
- Interdisciplinary Center for Advanced Materials Simulation centers its activity on a new generation of simulation tools, materials modeling, and cost reduction for new materials.
- The *Ernst Ruska-Center for Microscopy and Spectroscopy with Electrons*, performs basic and applied research on high-resolution transmission electron microscopies.

3.8.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Nordrhein-Westfalen (data from 2011, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.8.2. Employment by sectors in Nordrhein-Westfalen (2011), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are the metal manufacturing, processed food, and production technology. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.8.2. Specialization trends in Nordrhein-Westfalen (2011), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Production technology	130014	2,40
Metal manufacturing	276177	2,31
Chemical products	56403	2,06
Lighting and electrical equipment	26497	2,00
Plastics	56570	1,89
Oil and gas	14781	1,86
Medical devices	24734	1,46
Instruments	15557	1,32
Information technologies	71303	1,25
Automotive	94966	1,14
Power generation and transmission	9769	1,08
Paper products	47832	1,04
Agricultural products	31892	1,03
Building fixtures, equipment and services	70992	1,03
Heavy machinery	29555	1,00
Biotechnology	2596	0,97
Jewellery and precious metals	4425	0,94
Telecommunications	53788	0,92
Distribution	71985	0,91
Textiles	25503	0,90

Source: Adapted from the European Cluster Observatory

3.8.4. Examples of companies and cluster initiatives

The following examples aim to offer an overview of the main companies and clusters in Hovedstaden, according to their number of employees and profits. Nordrhein-Westfalen concentrates some of the largest European companies, in a large range of sectors (from chemicals to transportation, from energy to ICT, etc.). Because of this, providing a complete overview might presents some difficulties, but the following examples are some of the most relevant.

Related to the **chemicals sector**, we can find Henkel, the multinational that has its headquarters in Düsseldorf and has more than 50.000 employees and profits over 1.2 billion Euros (2011). They are related to laundry and home care, beauty care and adhesive technologies. Altana, based in Wesel, has more than 5.000 employees and 1.6 billion Euros in profits (2011). They work on chemicals for coating manufactures, paint and plastic processors, and the electrical industry. Regarding pharmaceuticals, we can mention the well-known Bayer Group, with more than 110.000 employees and almost 2.5 billion Euros on profits (2011), operating in many fields related to physiology and pharmacology.

If we take a look at the **energy and engineering industry**, we can talk about E.ON AG, based in Düsseldorf and operating in the electrical sector, with almost 80.000 employees and 2.6 billion Euros in profits (2012), or GEA Group AG, also based in Düsseldorf, working in the fields related to systems for food and energy processes, and with profits over 300 million Euros (2012).

Related to **transportation and logistics**, we can mention Lufthansa, the main German airlines, based in Köln and with almost 40.000 employees and almost 1 billion Euros of profits (2012). Deutz AG is a company also located in Köln, operating in the field of engine systems and with more than 4.000 employees and 75 million Euros (2011). ThyssenKrupp works on steel manufacturing, components and systems for the automotive industry, elevators, escalators, material trading, and industrial services; their headquarters are in Duisburg and Essen, and they have more than 150.000 employees. In 2011 they have a loss over 3 million Euros.

Regarding the **clustering initiatives**, Nordrhein-Westfalen presents a large number of clusters in many different fields. Some examples could be:

- *Autocluster.NRW:* 650 companies (including Opel and Ford) and 55 research institutions related to the automotive technology, which comprises more than 800.000 employees.
- *BIO.NRW:* 360 companies (including Bayer and Henkel) and 105 research institutions in the fields of biotechnology, biomedicine, physiology, and pharmacology.
- *Chemie.NRW:* around 1.000 companies in the sector of chemical products and technologies.
- *Engieregion.NRW:* around 3.300 companies and 280 research institutions in fields related to engineering, especially photovoltaic industry, power plant engineering, fuel cells and hydrogen, biomass, solar construction, or wind power, among other.
- *IKT.NRW:* it clusters companies like Deutsche Telekom, T-Mobile, or Vodafone D2, all them operating in the sector of information and communication technologies.
- *Kunststoff.NRW:* more than 900 companies (representing more than 100.000 employees) and 20 research institutions in industrial activities related to plastics.
- *Logistik.NRW:* 220 companies in activities related to logistics.

Additionally, we could put some other examples, all under the regional cluster's denomination '.NRW': Emährung.NRW (food), CGW.NRW (health and medicine technologies), Medien.NRW (media), or NMW.NRW (nanotechnology, microsystems, and raw materials), among other.

3.8.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Nordrhein-Westfalen are:

a) **Nordrhein-Westfalen State Chancellery:** they are the central office for all the state's government action and their policies, and they are in charge of define priorities and the main frameworks, also for innovation, science and technology.

b) **Ministries of Nordrhein-Westfalen:** the Regional Innovation Monitor mentions the Ministry for Health, Emancipation, Care, and Senior, the Ministry for Economic Affairs, Construction, Habilitation, and Transport, the Ministry for Climate Protection, Environment, Agriculture, Nature, and Consumer Protection, and the Ministry of Innovation, Science, and Research. The first three ministries have some programs related to their action fields to support innovation activities through different programs and measures they are implementing. The last one is in charge of the promotion of innovation, science and technology, strengthening related activities in universities, research centers, and other institutions.

c) **ZENIT GmbH – Center for Innovation and Technology in Nordrhein-Westfalen:** ZENIT provides services on behalf of different European, national and regional institutions, to promote companies, especially SMEs, but also universities and research institutions, through different projects. They are characterized as an advisory and innovation promotion agency and they are part of the Enterprise Europe Network supporting technology-oriented SMEs as well as research institutions working on technology transfer.

d) **NRW.Bank:** it is a development bank, which operates around four main areas of competence: business start-up and mid-market development, social housing promotion, infrastructure holding and municipal finance, and individual promotion. Related to innovation and technology, they support companies and innovative start-ups with venture capital and other financing products.

3.8.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Nordrhein-Westfalen.

Table 3.8.3. Questions around the performance of the science and industry agents in Nordrhein-Westfalen regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Nordrhein-Westfalen universities related to the specialization patterns identified for the region?		?	
Are the main research centers in Nordrhein-Westfalen performing research around those fields identified for the region?		?	
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	✓		
Does the companies and clusters overview support the idea of specialization in the identified sectors?	✓		
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?	✓		

Source: Own elaboration. *Unclear

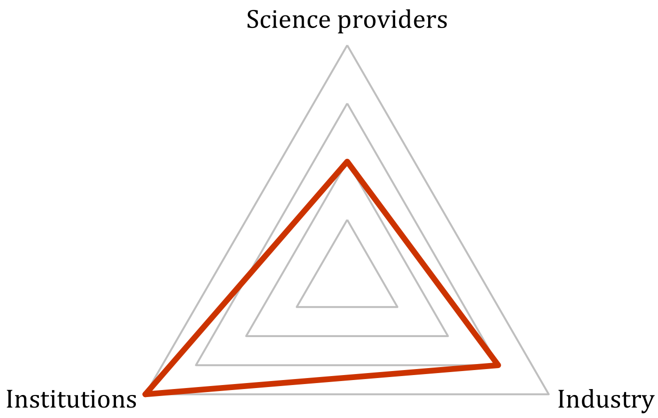
If we take a look at the universities and research centers in the region we find that they do perform R&D around the fields identified as those in which Nordrhein-Westfalen seems to have comparative advantage, but there are also relevant activities in many other fields, which makes difficult to determine whether there are some specialization trends or not.

Something similar happens when we take a look at the industrial activities in the region. However, for all the sectors identified (manufacture of chemicals, chemical products, coke, and refined petroleum products, followed by the sector of motor vehicles and transport equipment, and the sector of basic metals and metal products) we can find examples of large companies and clustering initiatives, and these examples are significant, which proves that, at least, the region does actually perform large industrial activities in these sectors. Nevertheless, more information would be required to be able to determine whether these are indeed the sectors in which the region is most specialized, since maybe other sectors should be included as well.

Regarding the institutions that we can find at the Regional Innovation Monitor and which are in charge of promoting scientific, industrial, and innovative activities in Nordrhein-Westfalen, we can say that they have the right role and competences to influence the definition and the implementation of the regional smart specialization strategy, given that these institutions include the regional government and its ministries (in charge of the science, technology, and innovation programs) and also other institutions aiming to promote these activities.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Nordrhein-Westfalen.

Figure 3.8.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Nordrhein-Westfalen.



Source: Own elaboration.

Nordrhein-Westfalen is the largest European region (in absolute terms) performing scientific and industrial activities, with the largest concentration of scientific articles and industry (in terms of employees). Given this, there is room for many different scientific fields and industrial sectors in the region, which makes a little more complicated the search for specialization trends. What is clear is that this German region is one of the main European hubs (if not the most important) in terms of science, technology and industry, for a large range of fields and sector.

3.9. Norte (North), Portugal

Figures 3.9.1. Situation of Norte. Source: Google Maps

The region of Norte is located in the north of Portugal (as its name indicates) bordering Spain, the rest of Portugal, and the Atlantic Ocean. It comprises a population of about 3.7 million people (2011). Porto is the largest city and the capital of the region.

Table 3.9.1. Main indicators for economy, industry and R&D in Norte

Indicator	Index	Year
Population	1689173	2011
GDP per capita (€ PPP)	15552,1	2008
Yearly growth of GDP per capita (PPP) (%)	3,4	2008
GDP per capita (€)	12900	2008
Yearly growth of GDP per capita (€)	3,9	2008
Disposable income per capita (€ PPP)	10009,9	2007
New foreign firms	0	2007
Employment rate (%)	63,2	2010
High and med. high-tech. manufacturing employment (% of total)	3,76	2009
Knowledge intensive services employment (% of total)	22,97	2009
Employment in industries with high energy purchases (%)	5,7	2005
Enterprises	342044	2009
Apparent labor productivity (€)	33886,79	2008

Indicator	Index	Year
Business R&D share of GDP (%)	0,5	2007
Business R&D personnel (% of total)	0,19	2007
Business investment (thousand €/employee)	6,97	2010
Public (government) R&D expenditure (%)	0	2008
Public (government) R&D personnel (%)	0,02	2007
Public (higher education) R&D expenditure (%)	0,37	2007
Public (higher education) R&D personnel (%)	0,3	2007
Total R&D expenditure (%)	1,22	2008
Total R&D personnel (%)	0,68	2008
Human resources in science and technology (%)	6,3	2009
Patents per million habitants	42,02	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	76,2	2007

Source: Eurostat and European Cluster Observatory

In chapter 2, when we performed the analysis on the comparative advantages of most of the European regions, we found that, when considering the scientific capacities, Norte presents some specialization trends for agriculture, food technologies and fisheries, followed by engineering and materials sciences. Regarding the industrial activities, the region is highly specialized in textiles, leather and wearing, but it also presents some comparative advantage for the sector of wood and furniture, cork and paper, and construction.

When we only consider the 12 regions that we are taking into account in this chapter, the results are similar. If we take into account the scientific capacities, Norte presents comparative advantage in agriculture, food technologies and fisheries, followed by engineering and materials sciences. If we consider the industrial sectors, the region presents specialization trends for textiles, leather and wearing, but it also presents some comparative advantage for the sector of wood and furniture, cork and paper, and construction, especially for the first sector.

3.9.1. High education institutions

The largest universities performing scientific and technological R&D in Norte are:

a) **University of Porto:** this public university was established in 1911 and its urban campus comprises around 31.000 students (undergraduate and graduate). They perform R&D in many different fields, but they are more focused in molecular biology, biodiversity and genetic resources, and physics and astrophysics.

b) **University of Minho:** located in the Minho area, this public university which headquarters are in Braga, was established in 1973 and it currently has around 16.000 students. Regarding their scientific and technological activities, they are more focused in psychology, regenerative medicine, and molecular and environmental biology.

c) **University of Aveiro:** public university located in Aveiro, in an urban campus, which was established in 1973 and which currently has around 12.000 students. Regarding their performance on R&D, they are more focused in telematics engineering and electronics, communication sciences and technologies, and geotechnologies.

d) **University of Trás-os-Montes and Alto Douro:** also a public university, established in 1986. It is located in Villa Real and Chaves, and it has around 7.000 students. It is especially focused in biotechnology, agriculture engineering, and animal sciences.

3.9.2. Research centers and facilities

Norte is a relevant region in terms of scientific and technological activities in Portugal and in the EU. They perform R&D in many different fields, but we can find some good examples especially in the area of health and medical sciences, but also in computing sciences.

The most relevant examples in the field of **health and medical sciences** are:

- **Abel Salazar Biomedical Sciences Institute:** with around 600 employees, this research center is focused in fundamental biology and areas of health, environment, food processing, and quality control.

- Institute of Molecular Pathology and Immunology of the University of Porto: its name already indicates its main research fields, and they are especially focused in cancer.

- Institute of Molecular and Cell Biology: around 430 employees performing research related to life sciences, and especially, as its names indicates, molecular and cell biology.

Three additional examples of regional research centers in the field of **computing sciences** which are interesting to be mentioned:

- Research Center in Real-Time Computing Systems: research center of the School of Engineering of the Polytechnic Institute of Porto, performing R&D in computing systems. Currently they have around 75 employees.

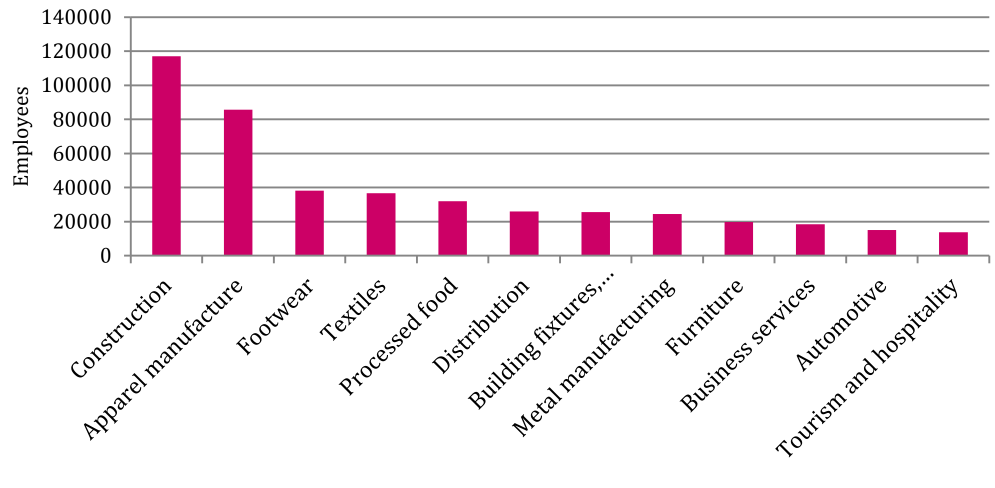
- Institute for Systems and Computer Engineering of Porto: around 650 employees developing high-level research in the fields its name indicates.

- Porto Interactive Center: they are focused in two main areas: computer graphics and human computer interaction, including 3D synthetic characters and how they behave in virtual and real environments.

3.9.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Norte (data from 2009, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.9.2. Employment by sectors in Norte (2009), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are construction, apparel manufacture, footwear and textiles, and processed food. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.9.2. Specialization trends in Norte (2009), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialisation
Footwear	38108	17,86
Apparel	85693	11,38
Textiles	36695	6,27
Stone quarries	2924	5,06
Furniture	19788	3,27
Jewelry and precious metals	3004	3,1
Maritime	8788	2,74
Construction	117090	2,44
Construction materials	6068	2,22
Building fixtures, equipment and services	25665	1,82
Distribution	26008	1,6
Power generation and transmission	2324	1,25
Leather products	992	1,2
Paper products	11316	1,2
Processed food	31911	1,04
Metal manufacturing	24537	1
Plastics	6126	1
Agricultural products	6209	0,97
Automotive	15095	0,88
Heavy machinery	3887	0,64

Source: Adapted from the European Cluster Observatory

3.9.4. Examples of companies and cluster initiatives

The following examples look to offer an overview of the main companies and clusters in Lombardia, according to their number of employees and profits. This analysis shows us that there is an important presence of companies in the sectors of food and beverages, and construction and engineering.

In the sector of **food and beverages** we can mention as example Unicer Bebidas de Portugal, located in Leá do Balio, with around 1.600 employees and 30.5 million Euros in profits (2011), produces soft drinks and wines, but it also has some activities in the tourism sector. Lactogal, located in Porto, produces dairy products, milk, fruit juice, and mineral water. Altri, also located in Porto and with 690 and 17.5 million Euros in profits in 2011, is a well-known pulp producer selling their products around the world.

In the sector of **construction and engineering** we can provide as example Soares da Costa, with 52 million Euros in losses in 2011, but still with more than 1.600 employees. Martifer, in the fields of engineering, energy production, and construction has more than 4.200 employees in Oliveira de Frades. Additionally examples would be EFACEC or Mota-Engil, also related to the energy sector.

Regarding the **clustering initiatives** in the region, we can mention CEIIA, related to the automotive and aeronautics sectors, Productech, in the field of competitive solutions for the manufacturing industry, or the Health Cluster Portugal, clustering 110 companies (including Roche or Pzier) and 30 research centers (including those of the University of Porto) working in the sectors of well-being and aging, prevention and treatment of diseases, and e-health.

3.9.5. Public agencies promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Norte are:

a) **University of Porto:** even if it should not be listed as an agency, they include this university given that it is responsible of 20% of the Portuguese scientific articles and, through its 69 research units, provides greater economic value thanks to its scientific production and their partnerships with industry leaders in the state.

b) **Porto Science and Technology Park – PortusPark:** network of six science and technology parks and incubators in the region, promoting their development and the establishment of new companies in its framework. Besides the real estate activities, they provide other services like support to research projects, promotion of technology transfer activities, interface with the industry, promotion of the entrepreneurship, training activities for entrepreneurs and innovators, or attraction of companies willing to cooperate with their associated institutions, among other.

c) **Norte Regional Coordination and Development Commission (CCDR-N):** regional body with administrative and financial autonomy that aims to coordinate and promote the governmental policies in Norte around the regional planning and development. Among their competences, we fine the definition of regional development policies, the participation in strategic planning processes of the territorial base, the encouragement of partnership, or the promotion of inter-regional and trans-regional cooperation, among other.

3.9.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Norte.

Table 3.9.3. Questions around the performance of the science and industry agents in Norte regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Norte universities related to the specialization patterns identified for the region?		?	
Are the main research centers in Norte performing research around those fields identified for the region?			✗
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	✓		
Does the companies and clusters overview support the idea of specialization in the identified sectors?		?	
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?		?	

Source: Own elaboration. *Unclear

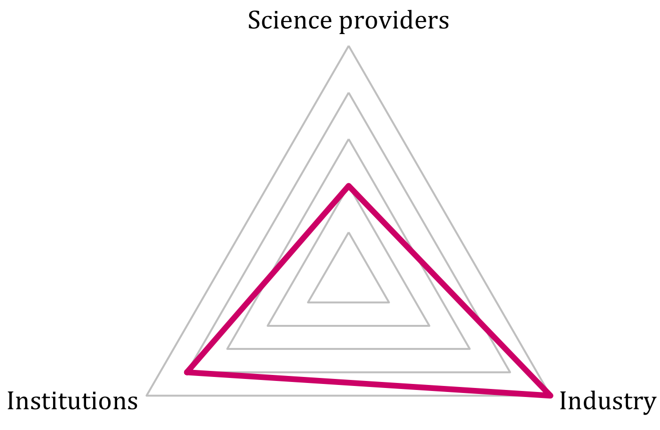
First of all, if we analyze the scientific capacities of Norte, taking into account its universities and research centers, we find that we cannot find robust evidence that there is indeed a specialization pattern for the fields of agriculture, food technologies and fisheries, and material sciences. Universities present some intensity in these fields, but also in others, so it is not clear enough. Regarding the research centers, the main ones, as we saw, are more related to health and medical sciences, and computing sciences, which are not the fields that we identified as those in which the region appears to have more comparative advantage, so for this region, these patterns are not clear enough.

If we now consider the industrial activities in Norte, we find that they are a little more related to the identified specialization sectors: textiles, leather and wearing, but it also presents some comparative advantage for the sector of wood and furniture, cork and paper, and construction. However, it is difficult to find representative examples for the first sectors, probably due to the fact that these are composed by a large number of smaller companies.

Finally, if we evaluate the institutions in charge of the promotion of the innovative activities in Norte, we find that their influence is significant, but probably not enough for the implementation of a proper smart specialization strategy. From the three described institutions, only the Norte Regional Coordination and Development Commission (CCDR-N) plays a concrete role in this process, and they are actually well-positioned to identify which should be the regional priorities and the main measures that should be implemented towards the RIS3.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Norte.

Figure 3.9.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Norte.



Source: Own elaboration.

In conclusion, we can say that Norte does present some specialization trends in the sectors that we have identified, but these patterns are not clear enough when we take a look at the examples (from both scientific capacities and industrial activities), and a more exhaustive analysis would be required to determine if these fields and sectors are those in which the region should be specialized or if other should be also taken into account.

3.10. Praha (Prague), Czech Republic

Figures 3.10.1. Situation of Prague. Source: Google Maps

Praha is the area of the capital and largest city of the Czech Republic, which has the same name. It has a population of around 1,25 million people (2009). It has the largest concentration of people in the state.

Table 3.10.1. Main indicators for economy, industry and R&D in Praha

Indicator	Index	Year
Population	1241118	2009
GDP per capita (€ PPP)	43247,7	2007
Yearly growth of GDP per capita (PPP) (%)	6,7	2008
GDP per capita (€)	30400	2008
Yearly growth of GDP per capita (€)	14,04	2008
Disposable income per capita (€ PPP)	13209,2	2007
New foreign firms	0	2007
Employment rate (%)	71,5	2010
High and med. high-tech. manufacturing employment (% of total)	2,82	2009
Knowledge intensive services employment (% of total)	47,3	2009
Employment in industries with high energy purchases (%)	4,44	2005
Enterprises	331243	N.D.
Apparent labor productivity (€)	58485,79	2008

Indicator	Index	Year
Business R&D share of GDP (%)	1,1	2007
Business R&D personnel (% of total)	1,21	2007
Business investment (thousand €/employee)	24,27	2010
Public (government) R&D expenditure (%)	0,9	2008
Public (government) R&D personnel (%)	1,24	2007
Public (higher education) R&D expenditure (%)	0,47	2007
Public (higher education) R&D personnel (%)	0,88	2007
Total R&D expenditure (%)	2,42	2008
Total R&D personnel (%)	3,24	2008
Human resources in science and technology (%)	16,9	2009
Patents per million habitants	67,4	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	64,13	2007

Source: Eurostat and European Cluster Observatory

After the analysis in chapter 2, when considering all the European regions, we found that, when we were taking into account the scientific fields, we found that Praha presents comparative advantage in chemistry, followed by materials sciences, mathematics, and physics. Regarding the industrial activities, this region presents specialization trends for non-metallic materials and products, followed by motor vehicles and transport equipment, water supply and waste management, and wood, furniture, cork, and paper products.

Now, when we compare only the largest regions of the 12 largest states (regarding their scientific and industrial activities in absolute terms), we find that results are similar for the scientific capacities, and the region seems to be specialized in chemistry, followed by materials sciences and mathematics. However, there are some differences regarding the industrial activities and, in this analysis, the region appears to be specialized in information and communication technologies, followed by water supply, sewerage and waste management, and electricity, gas, steam, and air conditioning. We must have in mind that data from some sectors was not available for Praha.

3.10.1. High education institutions

The largest universities performing scientific and technological R&D in Praha are:

a) **Charles University:** this public university, located in Prague, was established in 1348 and nowadays it has around 50.000 students in its urban campus. Among their main research fields, we find health sciences and medicine, pharmacy, and life sciences.

b) **Czech Technical University:** with around 23.000 students, this public university established in 1707 and located in Prague, is focused in mechanical and electrical engineering, nuclear sciences and physical engineering, and information technologies.

c) **Czech University of Life Sciences:** this public university, re-established in 1952, has its campus in Prague and it has around 19.000 students. Among their research fields, they have a special focus in food technologies, life sciences, and environment.

3.10.2. Research centers and facilities

Praha, being the region of the capital of the state, concentrates the largest number of research centers in the Czech Republic. Among the main research and development institutions, we find some good examples in two main fields: biology, biotechnology and medical sciences, and chemicals, food technology, and agriculture.

If we take a look at some examples in the field of **biology, biotechnology, biomedicine, and medical sciences**, we find representative centers like:

- **Institute of Microbiology:** R&D activities in the fields of biogenesis and biotechnology of natural compounds, cell and molecular microbiology, autotrophic microorganisms, ecology, and immunology and gnotobiology.
- **Institute of physiology:** they work in cardiovascular research, neuropsychiatric studies, applied genomics, molecular biology and physiology, and neurosciences, among other.
- **Biotechnology Institute of the Academy of Sciences:** they develop biotechnological methods and tools for human, and veterinary medicine.

- **Institute of Molecular Genetics of the ASCR:** more than 400 employees working in molecular and cellular immunology, applied genomics, targeted therapeutics, chemical genetics, molecular economy, cell functional organization, and cell invasiveness in embryonic development.
- **Institute of Experimental Medicine:** biomedical research, especially in cell biology and pathology, neurobiology, neurophysiology, toxicology, molecular epidemiology, molecular pharmacology, cancer research, stem cells, and nervous tissue regeneration, among other.

Regarding those fields related to **chemicals, food technology and agriculture**, we find these most relevant examples:

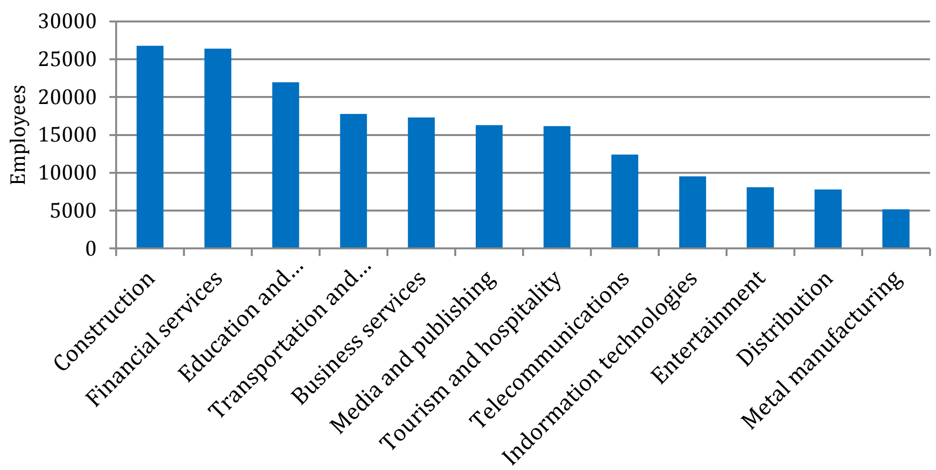
- **Institute of Chemical Process Fundamentals:** they are focused in chemical engineering, physical chemistry, chemical thermodynamics, catalysis and reaction engineering, multiphase chemical reactors and bioreactors, or applied organometallic chemistry, among other.
- **Food Research Institute Prague:** they work in developments in food chemistry, biochemistry, and engineering.
- **Crop Research Institute:** they develop new technologies for integrated crop production and production of hygienically-safe foodstuffs.

Additionally, we can mention other relevant examples in other fields, like the Astronomical Institute, performing R&D around solar physics, stellar physics, interplanetary matter, and galaxies and planetary systems. The Veterinary Research Institute is the first institution in the state working in animal health and veterinary medicine, as well as related fields, including structural biology. Finally, the Institute of Experimental Botany of the Academy of Sciences is focused in plant genetics, its physiology, and biotechnology,

3.10.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Praha (data from 2005, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.10.2. Employment by sectors in Praha (2005), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are construction, transportation and logistics, and telecommunications. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.10.2. Specialization trends in Praha (2005), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Biotech	1368	4,94
Telecommunications	12402	2,06
Information technologies	9534	1,63
Construction	26789	1,11
Pharmaceuticals	2757	1,1
Transportation and logistics	17759	1,01
Distribution	7802	0,96
Lighting and electrical equipment	809	0,59
Instruments	723	0,59
Medical devices	1005	0,57
Production technology	3132	0,56
Aerospace	703	0,54
Building fixtures, equipment and services	3749	0,53
Agricultural products	1457	0,46
Heavy Machinery	1325	0,43
Metal manufacturing	5187	0,42
Chemical products	1170	0,42
Maritime	680	0,42
Plastics	1184	0,39
Textiles	1063	0,36

Source: Adapted from the European Cluster Observatory

3.10.4. Examples of companies and cluster initiatives

Praha clusters a large number of companies in different sectors. It is difficult to identify which companies are the most representative, since it is not easy to find data on the Czech companies. The follow examples aim to provide a general overview of some of the most representative sectors in Praha.

In the sector of **transportation**, we find two main examples in two sectors: railways and airlines. České dráhy, in the sector of railways, has more than 35.000 employees and it works in the assessment, testing activities and also consulting for railway systems and rail transport. Cezch Airlines, operating since 1923, is the national airline of the Czech Republic and the one that operates most flights in the state. Related to the airlines we can mention Aero Vodochody, an aerospace manufacturer, with more than 1.300 employees, which works on the design and development of parts for jet engines, steam and gas turbines.

Regarding the sector on **energy and related industries**, we find RWE Transgas, with around 8.000 employees, in the sector of natural gas and oil trading, developing new energy applications and renewable energies, as their main R&D lines. ČEZ is a company in the sectors of electricity generation, trade, and distribution, heat, and coal mining, with over 31.000 employees and established in Prague; they develop research around nuclear safety, waste management, technical engineering, or reactor services, among other.

Regarding the **clustering initiatives**, we will just mention the Automotive Industry Association of the Czech Republic, which clusters more than 300 companies, including Škoda Auto, one of the most representative automotive companies in the EU, with more than 20.000 employees.

3.10.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Praha are:

a) **Technological Innovation Center CKD Prague:** first technology business incubator in Prague, which supports entrepreneurial activities in order to enable new, innovatively oriented companies and support them in their early stages, including the provision of specialized business services.

b) **Developing Projects Prague:** company owned by the City of Prague, and it is responsible for the management and implementation of some activities in the field of innovation, delegated by the local authority. They are the contact center for companies, providing consultancy for SMEs, and they aim to strength their innovation potential.

c) **Inovacenter of the Czech Technical University:** this consultancy institution supports the implementation and acceleration of the technology transfer, transforming the results from R&D activities into commercial products through innovative entrepreneurship, fostering the third mission of the university.

d) **Technology Center of the Academy of Sciences of the Czech Republic:** consortium of legal entities, the institutes of the Academy of Sciences of the Czech Republic. The main activities of the center are: being the national information center for European research, developing activities related to innovation and technology transfer, working in strategic studies and projects aimed to define and implement the strategies at a national and regional level, and being the Czech Liaison Office for Research and Development (CZELO).

e) **Prague City Hall:** they have some competences in the field of innovation, which is a responsibility of the Department of Regional Development, and they are in charge of the preparation and implementation of regional development strategies, including the regional innovation strategy. Among their main activities we find: issue the regional regulations, coordinate the territorial development, decide on the interregional and international cooperation, or offer grants for activities related to innovation and competitiveness in specific fields and sectors.

3.10.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Praha.

Table 3.10.3. Questions around the performance of the science and industry agents in Praha regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Praha universities related to the specialization patterns identified for the region?		?	
Are the main research centers in Praha performing research around those fields identified for the region?		?	
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	✓		
Does the companies and clusters overview support the idea of specialization in the identified sectors?			✗
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?	✓		

Source: Own elaboration. *Unclear

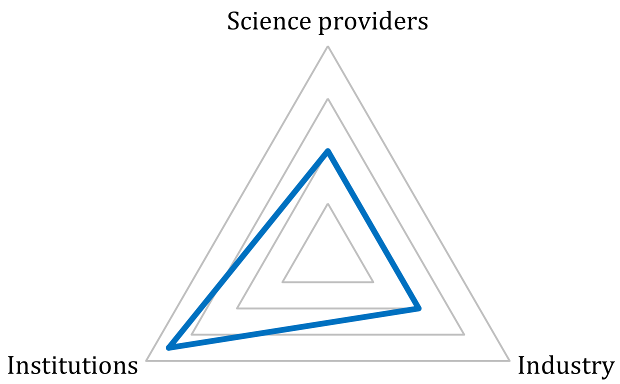
If we first take a look at the specialization patterns in terms of Praha's scientific capacities, we find that some of the universities and research centers perform their R&D activities in the fields identified: chemistry, followed by materials sciences and mathematics. However, this is not clear since they also work in many other fields and their individual relative productivity is not evident.

Regarding the industrial activities in the region, we cannot be sure if the sectors identified as those in which the region has comparative advantage (information and communication technologies, followed by water supply, sewerage and waste management, and electricity, gas, steam, and air conditioning) are those in which the evidence shows the region should actually specialize. The number of examples and the available data are not enough to get conclusions.

Finally, we can say that the institutions supporting innovation in the regions seem to be in a good position in order to establish themselves as leaders in the regional innovation smart specialization strategy, especially trough the Prague City Hall.

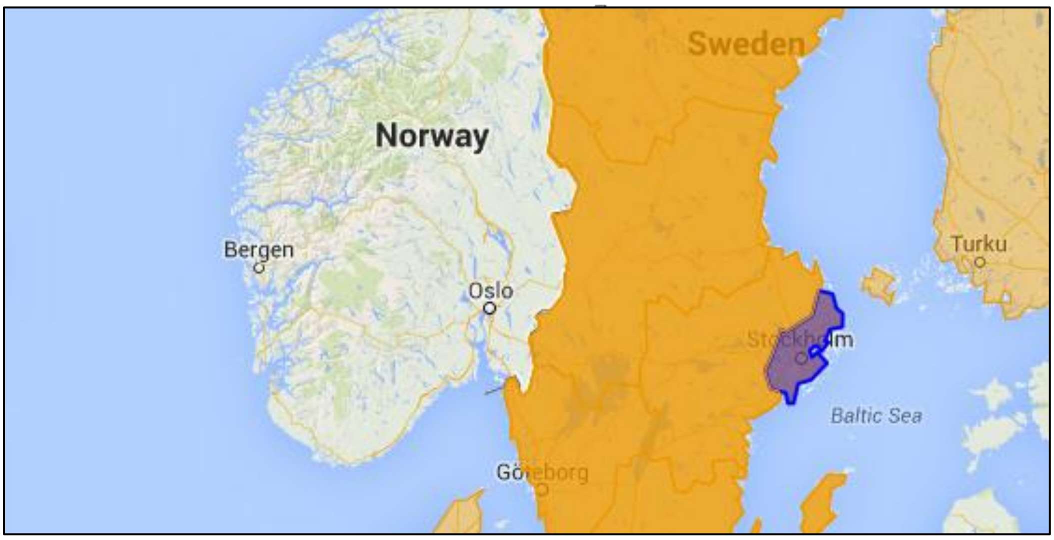
Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Praha.

Figure 3.10.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Praha.



Source: Own elaboration.

3.11. Stockholm, Sweden



Figures 3.11.1. Situation of Stockholm. Source: Google Maps

The Stockholm County is the region that comprises the capital of the state, which has the same name. More than 2 million people live in the county (2009) and, besides Stockholm, it comprises 25 other municipalities.

Table 3.7.1. Main indicators for economy, industry and R&D in Stockholm

Indicator	Index	Year	Indicator	Index	Year
Population	2000222	2009	Business R&D share of GDP (%)	3,0	2007
GDP per capita (€ PPP)	42061,9	2008	Business R&D personnel (% of total)	1,85	2007
Yearly growth of GDP per capita (PPP) (%)	3,4	2008	Business investment (thousand €/employee)	15,56	2010
GDP per capita (€)	49200	2008	Public (government) R&D expenditure (%)	0,2	2008
Yearly growth of GDP per capita (€)	2,34	2008	Public (government) R&D personnel (%)	0,16	2007
Disposable income per capita (€ PPP)	17242,2	2007	Public (higher education) R&D expenditure (%)	0,78	2007
New foreign firms	0	N.D.	Public (higher education) R&D personnel (%)	0,48	2007
Employment rate (%)	75,9	2010	Total R&D expenditure (%)	4,35	2008
High and med. high-tech. manufacturing employment (% of total)	2,66	2009	Total R&D personnel (%)	2,52	2008
Knowledge intensive services employment (% of total)	59,01	2009	Human resources in science and technology (%)	22,2	2009
Employment in industries with high energy purchases (%)	2,18	2005	Patents per million habitants	1099,94	2007
Enterprises	248157	2010	Patent collaborations (%)	N.D.	N.D.
Apparent labor productivity (€)	75227,96	2008	Patents with foreign collaboration (%)	64,61	2007

Source: Eurostat and European Cluster Observatory

In chapter 2, when we analyzed the specialization trends for all the EU regions in terms of scientific capacities, we found that the region of Stockholm presents a comparative advantage in health and medical sciences, followed by biotechnology and biomedicine, and physiology and pharmacology. If we consider the industrial activities, the region appears to be specialized in the sector of information and communication technologies, followed by transportation and storage, and construction.

Now, if we compare Stockholm only to the other regions that we are considering in the present analysis (the 12 largest regions of the 12 largest stats when considering the scientific and industrial critical mass), we find that the region still has, when considering the scientific capacities, competitive advantage in health and medical sciences, followed by biomedicine and biotechnology, and physiology and pharmacology. Regarding the industrial activities, Stockholm presents specialization trends for information and communication technologies, followed by transportation and storage, and construction, like when we were comparing all the regions.

3.7.1. High education institutions

The largest universities in Stockholm (in those fields related to science and technology) are:

a) **Stockholm University:** established in 1878, this public university has around 65.000 students. Its main research fields in science and technology are: biology sciences, physics and astrophysics, climate and environment, genome function and stability, and organic and materials chemistry.

b) **Royal Institute of Technology:** public university established in 1827 with more than 14.000 students nowadays. Its main research fields are energy, information and communication technologies, materials sciences, life sciences technologies, and transports.

c) **Karolinska Institutet:** medical university with a urban campus in Stockholm, established in 1810, with around 5.500 students nowadays. It is mostly focused in health and medical sciences, especially in the fields of cancer, circulation and respiration, endocrinology and metabolism infection, inflammation and immunology, neurosciences, reproduction, growth and development, and tissue and motion.

3.11.2. Research centers and facilities

Stockholm has a great performance regarding their scientific and technological centers. Many research activities are undertaken in the universities mentioned before, that is why some research centers are not listed here, since they are part of those universities. Besides social sciences and humanities, in which the region has a large expertise, we can put some examples in different scientific fields.

- In the field of **chemistry, nanotechnology, and materials sciences**, we can mention the Institute for Surface Chemistry, which develops its research on formulation technologies, interfacial and surface modification technologies, nanotechnology and structured materials, controlled delivery and release technologies, and cleantech energy and environment.

- Regarding the fields related to **environment and sustainability**, we can put two examples. The Stockholm Environment Institute, with around 200 employees, centers its research in managing environmental systems, reducing climate risk, and transforming the governance systems and the development. The Stockholm International Water Institute is more related to climate change and its implications to water, the transboundary water management, or the links between water, energy and food, among other. In Stockholm we also find the Swedish Environmental Research Institute.

- Related to **information and communication technologies** we find the Mobile Life Center, devoted to mobile phone technologies, with more than 60 employees working in this sector and related technologies.

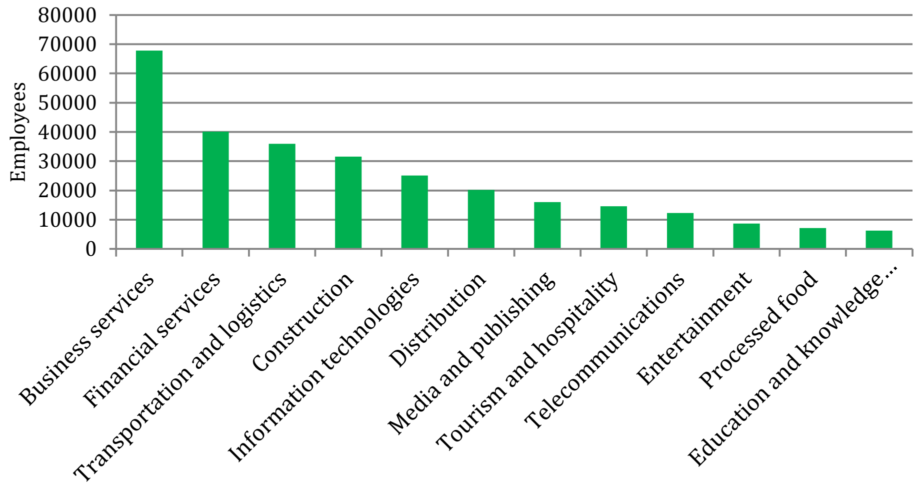
- Regarding basic sciences like **physics and astrophysics**, but also **mathematics**, we find the Nordic Institute for Theoretical Physics, which works in astrophysics and astrobiology, subatomic physics, condensed matter, and statistical and biological physics. On the other hand, the Mittag-Leffler Institute is oriented to mathematics.

Even if we are not analyzing the scientific activities in the fields related to social sciences and humanities, Stockholm has very good examples, like the Institute for International Economic Studies, the Institute for Security and Development Policy, the Research Institute of Industrial Economics, or the Stockholm International Peace Research Institute.

3.11.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Stockholm (data from 2010, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.11.2. Employment by sectors in Stockholm (2010), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, the main industrial sectors (if we exclude services, which are also included in the figure) are transportation and logistics, food processing and construction. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.11.2. Specialization trends in Stockholm (2010), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Information technologies	25160	3,73
Distribution	20198	2,16
Instruments	2955	2,11
Transportation and logistics	35991	1,78
Telecommunications	12282	1,77
Construction	31615	1,14
Medical devices	1513	0,75
Biotechnology	178	0,56
Agricultural products	1943	0,53
Heavy machinery	1728	0,49
Paper products	2472	0,45
Lighting and electrical equipment	675	0,43
Processed food	7187	0,41
Building fixtures, equipment and services	2841	0,35
Metal manufacturing	4652	0,33
Production technology	2120	0,33
Plastics	1066	0,30
Chemical products	901	0,28
Maritime	459	0,25
Construction materials	296	0,19

Source: Adapted from the European Cluster Observatory

3.11.4. Examples of companies and cluster initiatives

The following examples look to offer an overview of the main companies and clusters Stockholm, according to their number of employees and profits. We will put a few examples in three of the main sectors: information and communication technologies, automotive, defense and transportation, and construction.

In the sector of the **information and communication technologies,** in which the region seems to be specialized the most, we find, for example, Ericsson, the large multinational with more than 75.000 employees and over SEK 10.5 billion in 2012; they are providers of telecommunications equipment and services to mobile and fixed network operators, currently devoting their R&D activities to wireless access networks, radio access technologies, and packet technologies, among other. We can also mention TeliaSonera, operating in the sectors related to telecommunications in a broad sense, with almost 30.000 employees.

In the **automotive, defense and transportation** sectors we can mention Scania, with about 35.000 employees in the automotive industry, being manufacturers of commercial vehicles, including trucks and buses. Autoliv, with more than 12.000 employees, is more focused in automotive safety systems. A third example would be Saab, another multinational that operates in the sectors of aerospace and defense, developing new technologies related to radar, control, or air defense systems; they have over 12.000 employees.

In the sector of **construction**, in which the region also presents some specialization trends, we can talk about Atlas Copco, with more than 30.000 employees, working in the sectors of compressors, construction, mining equipment, power tools, and assembly systems.

Besides these sectors, Stockholm has large companies that are relevant enough to be mentioned. Skanska, located in Solna, operates in the sector of life sciences and renewable energies, especially related to project development and construction. Electrolux is a large multinational with more than 50.000 employees producing household appliances, with more than SEK 2.500 million in profits (2012). Finally we can talk about Hexagon, company with more than 12.000 employees in the sectors of integrated design, measurement, and visualization technologies.

Regarding the **cluster initiatives**, we find that Stockholm has many interesting clusters. We present some of the most relevant, most focused in life sciences and health:

- **LifeScience:** more than 800 affiliated companies (including Novartis or Johnson & Johnson) and 45 research institutions (from Stockholm and all Sweden). All this entities are more focused in medical sciences and health, especially neurosciences, cardiovascular diseases, cancer, or infectious diseases, among other.

- **Kista Science City:** operating in the field of life sciences, clustering companies that represent 25.000 employees and research institutions like the Royal Institute of Technology or the University of Stockholm.

- **Stockholm Life:** especially related to some fields like animals and environment, biology, chemistry, mathematics and medicine. Among its participants we find the three main universities in Stockholm.

3.11.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Stockholm are:

a) **OpenLab:** space where researcher and students from the universities in Stockholm work together with clients from the Stockholm County Council, the Stockholm County Administrative Boars, and the City of Stockholm in order to promote new ideas that can be turned into solutions and the definition of partnerships clustering different fields and professions.

b) **SLL Innovation (Stockholm County Council Innovation):** it fosters the transformation of ideas coming from the Stockholm County Council in collaboration with three hospitals in order to create new, innovative products or services which must aim to facilitate daily working and/or to improve the quality of patients in the health care sector.

c) **Stockholm Innovation and Growth:** business incubator entity which aims to assist entrepreneurs and innovators from the academia, research institutes and industry. Among their services we find the support on the setting-up of new companies, business coaching, business acceleration services, or support to the international expansion.

d) **Stockholm New Business Center:** advisory services (about 9.500 every year) aiming to create new companies (with a result of about 2.000 new companies every year). They have more than 60 advisors and around 30 collaborative partners.

e) **Stockholm Academic Forum:** it clusters 19 colleges and universities in Stockholm aiming to establish the region as an international center for students and other actors, including the business sector. The main objective is to establish Stockholm as a reference knowledge region.

f) **County Administrative Board of Stockholm:** government body responsible of many different areas with the goal of ensuring a sustainable society based on economic development linked to the environment and the social welfare, always looking to generate growth in the region. They are involved in the design of the regional development programs, as well as in stimulating entrepreneurship and business development through different support programs, funding, and evaluation.

g) **Office of Regional Planning (Stockholm County Council):** it manages the regional planning and the regional development within the County of Stockholm. It is responsible for realizing the vision and focus of the regional development plans for the County. These plans define the region's vision, objectives and future strategies.

h) **Stockholm Business Region Development:** they assist investors regarding the different business opportunities in the Stockholm region. They provide advice and guidance at no cost to firms that are being created or growing new business opportunities. They promote entrepreneurship and innovation through different programs and activities.

3.11.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Stockholm.

Table 3.11.3. Questions around the performance of the science and industry agents in Stockholm regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Stockholm universities related to the specialization patterns identified for the region?	✓		
Are the main research centers in Stockholm performing research around those fields identified for the region?		?	
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	✓		
Does the companies and clusters overview support the idea of specialization in the identified sectors?	✓		
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?	✓		

Source: Own elaboration. *Unclear

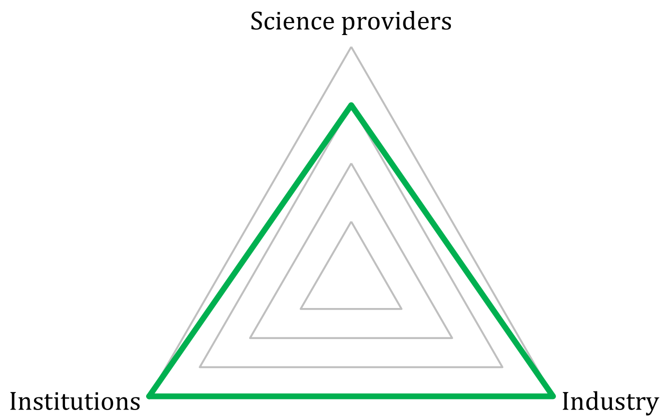
As we can see in the table above, Stockholm seems to be aligned with the regional smart specialization strategy in terms of its agents and their activities. It shows that they could become a referent when evaluating if a region has the right context to start evaluating the specialization patterns and the potential activities towards the strategy.

If we first take a look at the scientific capacities in Stockholm, represented by its universities and research centers, we see that, in general, the fields in which they develop their research and development activities are aligned to the specialization trends that we found for this region: the fields of health and medical sciences, followed by biomedicine and biotechnology, and physiology and pharmacology. To be a little more concrete, Stockholm's universities seem to focus in health and medicine, for example, among other fields. In the case of the research centers, even if some of them are devoted to these fields, there are many other large research centers. We would need more data from all these centers for further conclusions.

Regarding the region's industrial activities, we can say that for the sectors in which we found that Stockholm has comparative advantage, information and communication technologies, transportation and storage, and construction, we can find examples relevant enough to say that, at least, the region can compete in these sectors. However, we must also say that Stockholm hosts many large companies in other sectors. In the case of the clusters, we presented three relevant ones in fields related to life sciences, but other smaller initiatives can be found around other sectors.

Finally, if we analyze the institutions promoting innovation-related activities in Stockholm, we find that they are very well positioned for being the ones that must lead the regional smart specialization strategy and the programs coming from its definition. Additionally, we see that these regions represent, in a way or another, all the actors of the quadruple helix model. These eight institutions, but especially the Office of Regional Planning (Stockholm County Council), must be key elements in the implementation of the strategy and they must contribute to the proper structuration of different programs on its framework.

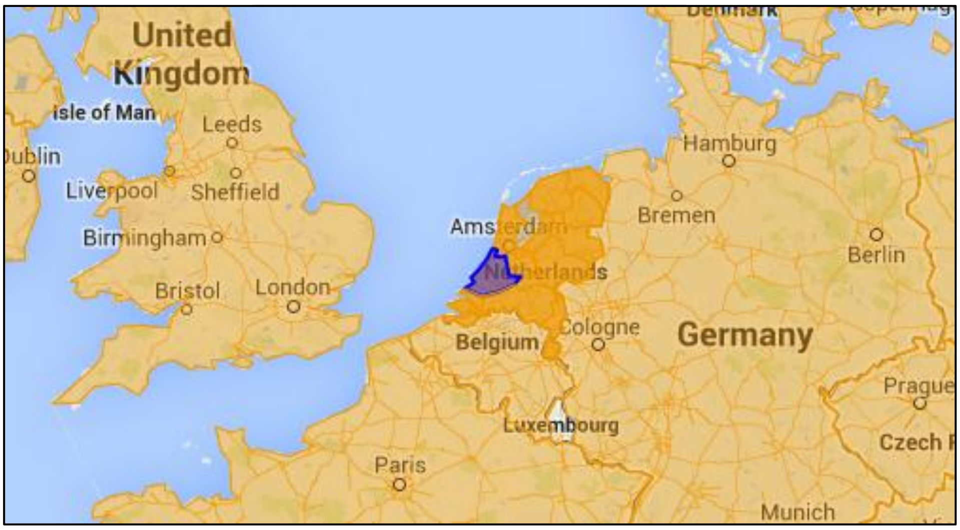
Figure 3.11.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Stockholm.



Source: Own elaboration.

After our analysis, we can conclude that Stockholm could be a leader in the process of definition and implementation of the first smart specialization strategies. In one hand, as we said, it has identified specialization trends in some scientific fields and industrial sectors, which should probably be the regional priorities, and, on the other hand, Stockholm has the appropriate institutions to support the whole process towards the execution of the elected strategy. All actors involved in these institutions must now have a role to participate in the first actions that are to be implemented in the following years. It would be also interesting that Stockholm, as well as other leading regions, could define some methods to monitor the implementation of the strategy and its results.

3.12. Zuid-Holland (South Holland), Netherlands



Figures 3.12.1. Situation of Zuid-Holland. Source: Google Maps

The region of Nordrhein-Westfalen is located in south-west Netherlands. It comprises a population of about 3.5 million people (2009) living in 67 municipalities. The regional capital The Hague and the largest city is Rotterdam.

Table 3.12.1. Main indicators for economy, industry and R&D in Zuid-Holland

Indicator	Index	Year
Population	3493584	2009
GDP per capita (€ PPP)	34413,7	2008
Yearly growth of GDP per capita (PPP) (%)	4,2	2008
GDP per capita (€)	37300	2008
Yearly growth of GDP per capita (€)	4,59	2008
Disposable income per capita (€ PPP)	15851,2	2007
New foreign firms	0	2007
Employment rate (%)	73,5	2010
High and med. high-tech. manufacturing employment (% of total)	2,07	2009
Knowledge intensive services employment (% of total)	47,34	2009
Employment in industries with high energy purchases (%)	3	2005
Enterprises	231975	N.D.
Apparent labor productivity (€)	83246,46	2008

Indicator	Index	Year
Business R&D share of GDP (%)	0,7	2007
Business R&D personnel (% of total)	0,4	2007
Business investment (thousand €/employee)	15,74	2010
Public (government) R&D expenditure (%)	0,3	2008
Public (government) R&D personnel (%)	0,2	2007
Public (higher education) R&D expenditure (%)	0,75	2007
Public (higher education) R&D personnel (%)	0,46	2007
Total R&D expenditure (%)	1,68	2008
Total R&D personnel (%)	1,01	2008
Human resources in science and technology (%)	16,2	2009
Patents per million habitants	512,68	2007
Patent collaborations (%)	N.D.	N.D.
Patents with foreign collaboration (%)	66,55	2007

Source: Eurostat and European Cluster Observatory

If we consider most of the European regions, as we did in chapter 2, and we analyze their specialization trends, we find that Zuid-Holland, when we consider the scientific capacities, presents comparative advantage in health and medical sciences, followed by engineering, and information and communication technologies. Regarding the industrial activities, the region seems to be highly specialized in the manufacture of coke and refined petroleum products, followed by basic metals and metal products, and motor vehicles, and transport equipment.

If we now only consider the 12 regions that we are taking into account in chapter 3, we find that, regarding the scientific fields, Zuid-Holland has comparative advantage in engineering, followed by health and medical sciences, and information and communication technologies. If we take a look at the industrial activities, we see that the region presents the same specialization patterns as before, in the related to the manufacture of coke and refined petroleum products, followed by basic metals and metal products, and motor vehicles and transport equipment.

3.12.1. High education institutions

The largest universities performing scientific and technological R&D in Zuid-Holland are:

a) **Rotterdam University of Applied Sciences:** established in 1988 in Rotterdam, this university has around 30.000 students nowadays. When referring to their R&D performance, they are more focused in engineering, information and communication technologies, and chemistry.

b) **The Hague University of Applied Sciences:** this public university, established in 1987 in The Hague, has about 23.000 students in its campuses. They work on research related to many applied areas, including energy and environment. They have also large groups in social sciences and humanities.

c) **Delft University of Technology:** with almost 20.000 students, this public university was established in Delft in 1842. They are focused in new technologies, microelectronics, nanotechnology, aviation, engineering design, earth observation and space systems, wind energy, and simulation, motion and navigation technologies.

d) **Erasmus University Rotterdam:** established in Rotterdam in 1913, this public university has more than 20.000 students. Besides their research activities in the fields of social sciences and humanities, they are also specialized in health and medical sciences.

3.12.2. Research centers and facilities

Zuid-Holland has a few research centers in different fields. Here we provide the most representatives in order to have a general overview:

- Biomedical Primate Research Center: this is the largest primate research center in the EU and it is located in Rijswijk. They are focused in R&D to develop new treatments for AIDS, tuberculosis, malaria, arthritis, and parkinson, among other diseases.

- Kavli Institute of Nanoscience Delft: linked to the Delft University of Technology, this research center, established in 2004 in Delft, works on the fields related to nanotechnologies related to two main fields: quantum nanosciences and bionanosciences.

- Netherlands Environmental Assessment Agency: located in The Hague, this large research center operates in fields related to environmental sciences and sustainability, especially in biodiversity, climate change, integral nitrogen, models and data, sustainable development, and transboundary air pollution.

- TNO: independent research organization working for the industry and the organizations in order to provide solutions to these entities needs. They work on health living, industrial innovation, defense, safety and security, energy, transport and mobility, construction, and information and communication society.

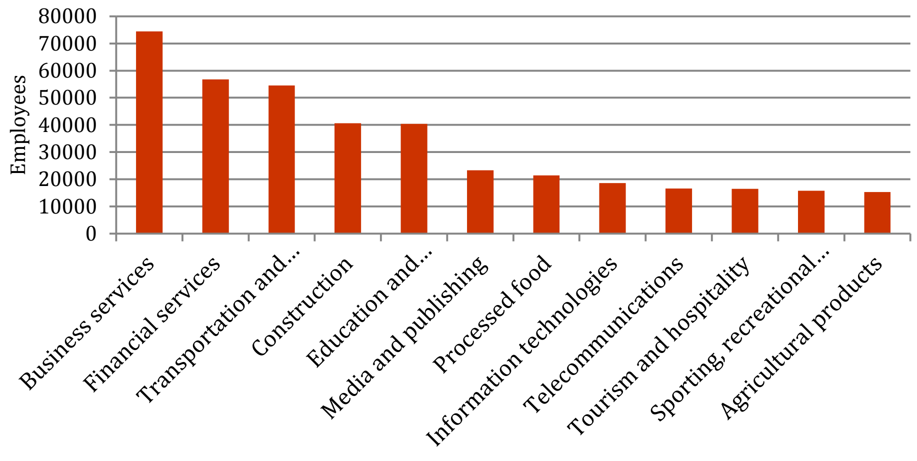
- Center for Human Drug Research: located in Leiden, they develop clinical trials for human drugs, and they are specialized in three main research areas: central nervous system, cardiovascular system and metabolism, and respiratory system and allergy.

- Dutch Ophthalmic Research Center: located in Zuiland, they develop research and new medical technologies in the field related to ophthalmic and optical devices, reusable instruments, and single use devices.

3.12.3. Industry overview

This subsection has been developed using data and information from the European Cluster Observatory (ECO) and it has been adapted to make it fit with the sectors described by Eurostat. The following figure present the productive structure in Zuid-Holland (data from 2005, last available) in terms of number of employees by industrial sectors, according to the ECO.

Figure 3.12.2. Employment by sectors in Zuid-Holland (2005), considering the sectors with a larger number of employees.



Source: Adapted from the European Cluster Observatory

The figure shows that, in absolute terms, taking into account the number of employees as the proxy we use for measuring industrial activities, the main industrial sectors (if we exclude services, which are also included in the figure) are transportation and logistics, construction, and processed food. The ECO also defines a specialization index for the sectors. Next table shows the main industries in the region according to these indicators.

Table 3.12.2. Specialization trends in Zuid-Holland (2005), considering the 20 sectors with a larger index of specialization. Employees in absolute numbers

Sector	Employees	Specialization
Sporting, recreational and children's goods	15756	8,71
Oil and gas	12074	6,06
Tobacco	2424	2,31
Biotechnology	1392	2,07
Agricultural products	15295	1,97
Jewellery and precious metals	1733	1,46
Information technologies	18628	1,3
Transportation and logistics	54565	1,27
Telecommunications	16569	1,13
Chemical products	7178	1,05
Construction	40591	0,69
Plastics	4844	0,65
Maritime	2443	0,63
Processed food	21396	0,57
Aerospace	1761	0,55
Power generation and transmission	1196	0,53
Building fixtures, equipment and services	7777	0,45
Distribution	8595	0,43
Pharmaceuticals	2314	0,38
Instruments	1068	0,36

Source: Adapted from the European Cluster Observatory

3.12.4. Examples of companies and cluster initiatives

Zuid-Holland presents a particularity that it is important to mention before we present some examples of companies and clusters in the region: even if it is the largest region of the Netherlands (in terms of scientific articles and number of employees in the industry) the fact that the region is relatively small (given that there are 12 regions in a small state, in terms of territory and population) makes that the number of large companies that can really be used to define an overview of the region is smaller. This is why it becomes more complicated to present many different examples.

In the sectors related to **logistics. Infrastructure and construction**, we can mention APM Terminals, located in The Hague and with around 25.000 employees worldwide and a $4 billion of profits in 2012, operating in port management and terminal operations. Royal Boskalis Westminster, located in Papendrecht, with more than 13.000 employees and about €250 million in profits in 2012, works in maritime services, and has a team devoted to improve these services and the technologies related to ports and the maritime infrastructures. Archirodon Group NV, located in Dordrecht and with around 10.000 employees, is devoted to engineering and construction, especially related to the maritime infrastructures. Finally, we could talk about Mittal Steel Company, established in Rotterdam, producing steel for international costumers.

In the sector of **energy and energy products**, we find Royal Dutch Shell, with more than 90.000 employees worldwide operating in the sector of the petrochemicals, with more than $1 billion dedicated to R&D (2011). Another example is Fugro, established in Leidschendam, with about 14.000 employees working in the oil and gas industry, as well as construction and mining.

Regarding the **clustering initiatives**, and in order to mention an example, we can talk about Maritime by Holland, which clusters a large range of companies in the sectors related to the construction of vessels, dredging, inland navigation, yacht building, fishery, work boats, and sea shipping.

3.12.5. Institutions promoting innovation

According to the Regional Innovation Monitor of the European Commission, the three main organizations working to promote innovation-related activities in Zuid-Holland are:

a) **Knowledge Alliance:** its main objective is to increase and strengthen the region's organizing capacity around the concepts of knowledge, innovation, and entrepreneurship. They have teams working in the creation of consortia for innovative projects, the setting-up of networks, the execution of benchmark studies, etc.

b) **TNO:** they are an independent research organization to promote the competitiveness of the industry and the institutions through innovative development projects, creating new products. Most of the costumes of TNO are SMEs and large companies, non-governmental institutions, and service providers.

c) **Province of South Holland:** regional authority in charge of promoting Zuid-Holland's development. It must support the regional economy through different programs and activities, but they do not have a concrete role on science and innovation, only the promotion of networking, support to start-ups, and other related activities.

3.12.6. Remarks and conclusions

The following table aims to offer an overview of the possibilities of the different analyzed agents to promote the smart specialization strategy in Zuid-Holland.

Table 3.12.3. Questions around the performance of the science and industry agents in Zuid-Holland regarding the smart specialization strategy for the region.

	Yes	U*	No
Are the main research fields of the Nordrhein-Westfalen universities related to the specialization patterns identified for the region?	✓		
Are the main research centers in Nordrhein-Westfalen performing research around those fields identified for the region?		?	
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?		?	
Does the companies and clusters overview support the idea of specialization in the identified sectors?		?	
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?			✗

Source: Own elaboration. *Unclear

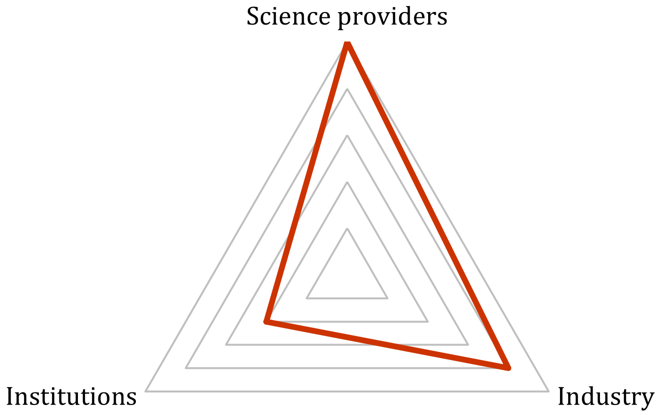
First of all, regarding the scientific capacities of the universities and the research centers in Zuid-Holland, we see that there is some relation between their R&D activities, especially in the case of the university, and the fields identified as those in which the region has comparative advantage (engineering, followed by health and medical sciences, and information and communication technologies). However, these trends are not that clear since these institutions also perform R&D in many other fields and more information would be needed to identify which are the patterns that can be defined as real priorities.

If we take a look at the industrial sectors in Zuid-Holland, we find that, even if we can actually identify some examples of large companies in the sectors identified as those in which the region could specialize (manufacture of coke and refined petroleum products, followed by basic metals and metal products, and motor vehicles and transport equipment), we cannot find enough evidence to state that these are the right sectors to be prioritized according to the information we have.

Finally, related to the institutions, agencies and administrations in charge of promoting innovation and scientific and industrial technologies, we find that those listed in the Regional Innovation Monitor do not have enough competences or active role to be those to lead the regional smarts specialization strategy, at least not alone. However, these institutions should be taken into account when defining the strategy and, especially, towards its implementation.

Next figure presents, as a final conclusion, a relation of how ready are the different actors that we have described and analyzed to support the patterns identified around the smart specialization strategy for the region of Zuid-Holland.

Figure 3.12.3. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for Zuid-Holland.



Source: Own elaboration.

In conclusion, after analyzing the scientific capacities, the industrial activities, and the institutions promoting innovation, we can say that it is complicated, compared to other regions, to determine whether it is possible to identify priorities from a top-down point of view. More information would be required to be able to significantly identify specialization patterns. Additionally, is important to underline the fact that, as we said before, Zuid-Holland is a small region (in absolute terms) compared to most of the regions that we are analyzing in this chapter, so finding examples and defining clearer conclusions becomes more difficult.

3.13. Final remarks and conclusions

3.13.1. Aggregated analysis

After analyzing the 12 regions that we are considering in chapter 3, one by one, we now want to take a look at the aggregated results that we obtain from a grouped analysis. We aim to see, from a top-down approach, what is the position of the regional actors related to science, innovation and industry towards the development of the regional smart specialization strategies. For every region in this chapter, we presented a table summarizing these results. Next one presents the aggregation of all the answers (in green the number of affirmative answers for each question, in amber those unclear and, finally, the negative ones in red).

Table 3.13.1. Questions around the performance of the science and industry agents in the 12 analyzed regions regarding the smart specialization strategy for the region. Aggregated number of answers.

	Yes	U*	No
Are the main research fields of the universities related to the specialization patterns identified for the region?	6	6	/
Are the main research centers performing research around those fields identified for the region?	5	6	1
Is the industry overview of the European Cluster Observatory related to the results coming from the analysis made following the Eurostat data?	9	3	/
Does the companies and clusters overview support the idea of specialization in the identified sectors?	6	4	2
Are the organizations promoting innovation activities ready to assume a main role and follow the specialization patterns of the region?	5	3	4

Source: Own elaboration. *Unclear

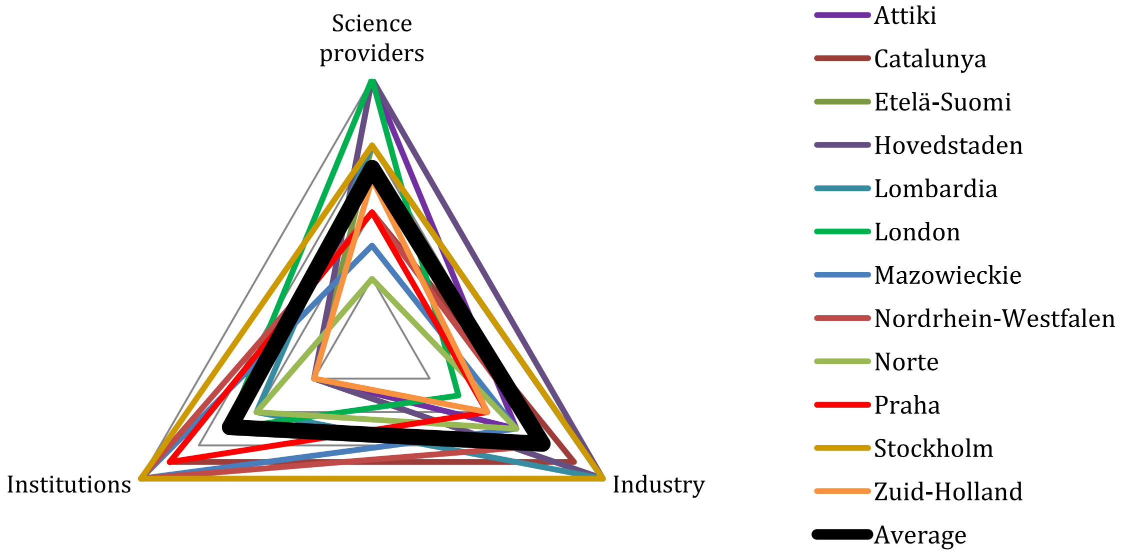
First, if we take a look on whether the main R&D fields of the universities fit the patterns identified or not, we see that in 50% of the cases they do, and for the rest it is not that clear. Research in large universities usually covers many different fields, which makes easy that at least some of the specialization patterns are related to the identified ones. However, in many cases this variety also makes it less easy to significantly prove that these are those in which the region has real comparative advantage. Something similar happens for research centers. In most cases, especially in the largest regions, we find some research centers performing R&D in the fields identified, but we can also find relevant examples for other fields, so we would need more information to obtain more concrete conclusions, especially through more quantitative and qualitative indicators related to the activities and the scientific production of these centers.

For each region, we also compared the specialization patterns in industrial sectors obtained when considering data from Eurostat and those that we obtained from the European Cluster Observatory. We see that in most cases it completely fits, and the indicators are related. In some cases it is a little more unclear, but in general terms we can conclude that both indicators lead to the same results. On the other hand, when we take a look at the different examples of large companies, the results are not that clear. We must underline the fact that most of the companies in Europe are SMEs and we are only putting our attention on large companies, but in terms of number of employees, those are really representative, even if these examples are not enough to have a complete overview, and they must be understood as a support to our analysis. If we had carried out a work on the productive structure of these regions we would probably have much more data related to companies and industrial sectors, but we only wanted to provide a more general point of view in order to see if the identified sectors could really fit in the strategy if they are elected as the priorities for the region. We face the same issue when we analyze the clustering activities, since in many cases we can find examples in the sectors in which we found specialization patterns, but also in many others, so a much deeper study should be undertaken to provide relevant conclusions from a cases analysis.

Finally, regarding the public and private institutions supporting and promoting innovation that are listed on the Regional Innovation Monitor of the European Commission, we found that there are many disparities among regions. These disparities depend on two main variables. The first one is the power that regions have when deciding the smart specialization strategies compared to the national point of view. In some cases, regions have the leadership but we can also find examples in which the state's role is the crucial one, and the decisions taken from a regional point of view have a smaller impact. The second variable is the typology of institutions. In some cases we see that the regional authorities are more committed to the innovation processes; these are the cases in which the institutions may play a larger role towards the definition and implementation of the smart specialization strategy. However, support agencies and other entities might be the key in this process, depending on their structure and the activities and programs they have. As we saw, in 5 of the 12 cases, these institutions seem to be ready to lead the process, while in the rest it seems more unclear or difficult.

Related to these conclusions, we have also aggregated the 12 figures (one per region) that aim to see how ready the institutions are, related to the activities that we are considering towards the smart specialization strategy. Next figure presents this aggregation.

Figure 3.13.1. Readiness of the different types of agents involved in the smart specialization strategy according to the analysis performed for the 12 analyzed regions.



Source: Own elaboration.

We see that, in average, evidence in specialization trends is easier to be found in the industrial activities. However we can state that, as we see in the figure, these evidences are pretty well distributed in average, but the change a lot from region to region, so we cannot say that this aggregated trend can be generalized, since deviations are individually large and only through a disaggregated study we can consider the particular context for each one, even if it is useful to see that, as a group, they present evidences on the specialization trends for all kind of actors.

3.13.2. Concluding questions

After the individual and the aggregated analysis around the entities/agents related to science, technology, industry, and innovation that are to play a role towards the implementation of the smart specialization strategy as a key element for the regional innovation strategies, we aim to see whether this separate analysis of these 12 regions lead us to more consistent conclusions than in the case when we were considering most of the European regions. The following questions summarize the most relevant deductions.

To the question '*There are relevant differences when evaluating only these 12 regions compared to the case where most of the regions where analyzed?*', the answer is '*Not really*'. If we compare the results when we were analyzing most of the European regions and those in chapter 3, we find that the specialization fields and sectors for these 12 regions are more or less the same in both analyses. This is actually good, since it proves that the patterns identified are consistent. We can state this considering the Balassa index, the proxy that we have used for our analysis; however, we should check other methodologies and indicators to make sure whether these trends stand the same in both analysis, for most of the regions, or only the 12 in chapter 3.

To the question '*In an imaginary economy composed by these 12 regions only, would it be possible to significantly identify leaders and followers for each scientific field and industrial sector?*', the answer is '*Yes, but not that significantly*'. In this imaginary economy, if we wanted to establish some kind of international trade model to allow us to define leaders for each scientific filed and industrial sector, in charge of working more intensively in these fields/sectors and then exchanging the outputs, it would be possible, but not at a higher degree than in the case when we considered most of the European regions. Additionally, it is important to underline here too that we found that larger regions (in absolute terms) present lower rates of specialization. Since we are now considering 12 of the largest European regions it becomes more difficult to find higher indexes that allow us to robustly identify leaders and followers for every field/sector.

To the question '*Are the largest regions of the largest countries (in absolute terms) significantly related to the patterns the we identified at the beginning of the chapter, according to the evidence found when analyzing the regions independently?*', the answer is '*Yes, but only up to a point*'. To better answer this question we can refer again to figure 3.13.1, where we can take a look at the axes devoted to science providers and to industry. As we can see, in an imaginary scale from 0 to 4, in both cases we obtain an approximate a 3. It means that for most of the scientific fields and industrial sectors that we have identified as being those in which region has comparative advantage and so should consider a priority, we are able to find evidence, taking a look to the entities of that region, of actual presence around these fields/sectors. However, some biases appear in our analysis, especially due to the fact that, as we have mentioned before, most of these 12 regions are big enough to have all kind of institutions representing most of the research fields/sector, so even if we found evidence for those in which we were interested, it does not mean that others should not be considered a priority according to the evidence.

To the question '*After this study, when identifying priorities from a cross-regional point of view, is it better, worse or irrelevant to compare large (small) regions (in absolute terms) with other large (small) regions?*', the answer is '*It depends*'. If we are looking for different results compared to those we got in chapter 2, then it is irrelevant, as we have already seen. However, some considerations must be made. First, large regions present less biases than small ones due to the larger absolute numbers, which improve the statistical significance. Second, as we have said, larger regions present lower indexes, meaning less clear specialization trends. In this context, to easily identify leaders and followers we should take into account all regions at a time. Third, case studies largely change from large to small regions, especially due to the size and the number of institutions for each one. In the case of small regions, it becomes more difficult to find proper examples that can illustrate the situation and the context for each one. In any case, we can conclude that, when doing the exercise of identifying specialization trends, the size of the region must be taken into account.

To the question '*Can we conclude that it seems easy to establish policies regarding the smart specialization strategy in large regions (in absolute terms) compared to the smaller ones?*', the answer is '*Not at all*'. Actually, it is *au contraire*. These regions have a larger number of institutions and so a larger number of inputs and outputs, making the analysis to establish priorities more difficult. Additionally, larger regions are in general more diverse in terms of scientific fields and industrial sectors, and they present lower rates of specialization, which also makes more complicated to evaluate which are the priorities that should be prioritized.

After these remarks we can conclude that it is indeed possible to define specialization patters and that it seems logical to make it comparing similar regions, in terms of their absolute numbers, when trying to identify some models that would help to establish a methodology to define leaders and followers that will be supposed to exchange knowledge. However, the specialization rates that we find when analyzing them are not significant and robust enough, while they present many biases coming from the large heterogeneity among them. Definitively, with the aim of defining some priorities in which focus larger efforts, even if comparing similar regions would help, evidence is not enough and other mechanisms other than picking winners from a top-down point of view should be considered.

4. Benchmarking of regional proposals towards the smart specialization strategy

In chapter 2, we analyzed the specialization trends of the European regions in terms of scientific capacities and industrial activities, aiming to see if it was possible to identify fields and sectors in which each region could specialize. We found that it is possible to identify these trends coming from the data in absolute terms. In chapter 3, we wanted to be more precise in our analysis and we chose the 12 regions with a pondered larger production of scientific articles and employees in the industry. We described in detail the R&D and productive structure of those regions and we found that it is indeed possible, not only to identify specialization trends, but also to relate it to the evidence of the regional structures. Now we aim to evaluate whether the regions, when defining their own smart specialization strategies, are able, not only to determine which are the priorities associated to their specialization trends, but also to establish concrete measures or actions towards the implementation of the strategy.

As an initiative of the Smart Specialization Platform, different regions, but also states, have presented their own proposals to achieve a model based on the smart specialization strategy (S3). Different meetings have taken place to evaluate these proposals. The first one took place in Seville (Andalusia, Spain) and since then many other have taken place. Many regions have presented their proposals under a common title of "Towards a RIS3 strategy" until now. Most of the presentations came from NUTS 2 regions, but there have been some exceptions, and there have been presentations from a state point of view, like Portugal or Hungary, some presentations at a NUTS 1 level, like Belgium or the United Kingdom, or NUTS 3 level, like Finland. Following the same logic that we have used for chapters 2 and 3, we are going to considerate only NUTS 2 level regions, except for Germany and the United Kingdom. We evaluate the proposals in alphabetical order. In Annex D, there is a list of the 30 presentations that we have analyzed, together with the name of the authors and the date and venue where they presented it.

The presentations at the different peer reviews hosted by the S3 Platform have had, in general terms, a common structure, aiming to make them comparable. They include data regarding the economic structure of the region, their policies around the regional innovation strategies, the governance system, the comparison beyond the region's boundaries, the entrepreneurial dynamics of the region, the implementation strategy and the related budget, and a self-assessment around the presentation. Many presentations include additional information; others do not include all the sections. We wanted to extract only the information that helps to understand the top-down approaches of the proposals.

Our benchmarking of initiatives has been structured in three sections for each region: the governance model that they implement, the analysis on their own context and the main comparative advantages that they have identified, and the actions and measures that they are implementing or will implement towards the S3. We focus on the top-bottom approach of the presentations, not entering in detail in the bottom-up definition, usually based on the so called 'entrepreneurial discovery process'. The description that we provide aims to present the main points of the different presentations, synthetizing the available materials in the three described sections, which include the following information:

- **S3 governance:** it aims to analyze which is the role of the different agents participating in the definition and implementation of the policy. In most of the cases, the regional government is in charge of the whole process and they are supported by other institutions. The tripe / quadruple helix model has been also used in some cases and it is presented as the way the decision bodies collect information from other agents related to innovation to define the appropriate measures.
- **Analysis of the context and detected comparative advantages:** presentations give some data and evaluation on the strengths and weaknesses of the regions, analyzing their context regarding mainly their regional innovation strategies (in which the S3 is supposed to have its role). Additionally, most of the regions have already identified which are their main comparative advantages and priorities in the definition of their strategies.
- **Top-down proposals for the S3:** we aim to include the proposals that the different regions have presented as their first initiatives towards the S3. In most cases, they still must develop concrete measures, so we can only mention which are their priorities when developing policies that may lead to the S3.

We must have in mind that, in most of the cases, these strategies (based on presentations) are not final versions, but pre-proposals presented under the S3 Platform criteria. Last versions are expected to be presented during 2014, after the end of our research period.

The main objective of this chapter is to establish whether the proposals coming from the decision bodies of the different European regions go along with the theoretical definition of the top-down approach around the concept of smart specialization strategy. After the analysis on the data of most of the European regions in chapter 2, and the more concrete evaluation of the structure of the 12 regions that we presented in chapter 3, now we take a look at the point of view and the strategies that are being defined by those agents which are and will be in charge of the implementation of the smart specialization strategies.

4.1. Analysis of 30 proposals on the regional innovation smart specialization strategies

The following sub-sections present the analysis of the approaches presented by regional representatives in alphabetical order. The length of the each evaluation depends on the useful information for our analysis that each presentation has, which has been structured in the three mentioned sections.

4.1.1. Algarve, Portugal

S3 governance: the S3 is coordinated by the Regional Development and Coordinating Commission of Algarve (CCDR), in charge of the development of a regional partnership that includes the main sectorial associations as representatives of the private sector, and the University of Algarve. Another relevant institution is the Regional Agency for Innovation and Development of Algarve (ARIDA) in charge of promoting the knowledge dissemination, being a tool in the implementation of the S3 and supporting the promotion of the applied research, especially in the identified main sectors. They will all work under the regional system of research, technological development and innovation defined by the region.

Analysis of the context and detected comparative advantages: in terms of scientific capacities, they identify as their main areas of expertise those related to the sea, fisheries, and biosciences and biotechnology. They evaluate positively their efforts to define and develop clustering initiatives. They have established a distinction of consolidated sectors (tourism and maritime) and emerging sectors (agrofood, ICTs, renewable energies, and health and life sciences). They have already some experience in regional innovation policies; they have had their experiences under programs like Ettirse, INNOVAlgarve, or their Regional Operational Programs. However, they are aware of their weaknesses like the low investment in R&D, the constrains in the relations between research institutions and companies, or the productivity problems.

Top-down proposals for the S3: under the S3, they define some pre-proposals of measures to be undertaken. For example, the aim to develop the maritime cluster which has already some innovative content, to introduce new technologies to revitalize the traditional industries, or to base the tourism sector as the key element to develop new technology and knowledge based industries. Nevertheless, the want to reduce the seasonal dependence on the tourism, reinforcing other sectors, and develop niches of excellence in advanced areas. They specify that it is important to diversify the economic base of Algarve creating more added value and employment. In this direction, they see that one of the priorities is to create proper polices and tools to facilitate the implementation of the process, which is still in an initial phase, like most of the regional European S3 processes.

4.1.2. Alsace, France

S3 governance: they have defined a project group for the implementation of the S3, with an operational committee. Decisions are to be validated by the regional authorities jointly with the state through their steering committee for innovation. They aim to use the S3 and its context to develop the model of the quadruple helix, engaging the most relevant actors.

Analysis of the context and detected comparative advantages: their define as one of their main strengths their diversified economy with large companies and SMEs, creating an important industrial sector. They have established 5 competitiveness clusters in the sectors of bio sciences, vehicles, fibers, energy, and water. Additionally, they have 6 regional clusters in the sectors of food, wine, ICTs, textile materials, environment, and house furnishing. They have defined 3 regional convergences in green economy, health and wellness, and humanities and social issues, which are their priorities towards the S3.

Top-down proposals for the S3: they do not mention any specific measures or plans to be undertaken towards the S3. However, regarding their regional innovation strategy, they aim to enlarge the culture of innovation in the SMEs, develop companies' skills to carry on innovative projects, promote public-private partnerships to perform R&D, and promote the region internationally.

4.1.3. Aragón (Aragon), Spain

S3 governance: the regional ministry of industry and innovation is in charge of the definition of the S3, and they have established a core working group. Additionally their 9 regional ministries are involve, according to their own competences. They have also had some meetings with different social and economic partners.

Analysis of the context and detected comparative advantages: Aragón has already developed different programs to promote innovation, like their own regional R&D&I, their regional plans for R&D and technology transfer, or their programs to support the innovation. In this context, since 2013 they are starting to implement the S3. The Regional Innovation Scoreboard defines the region as an innovation follower, the second best group among the European regions. They mention that they have a few strong sectors, good research infrastructures, and an industrial tradition. However, they are facing a decrease on the investment in R&D and a lack of global strategy. They have defined as key challenges the climate change and the ageing population. According to their presentation, Aragón has established six priority sectors but they do not mention which ones. Regarding the areas that they establish as a priority, they have defined some main challenges, like depopulation, health, smart transport, energy and climate change, or food security, among other. If we take a look at their strengths they mention health and biotech, agrofood, logistics and transport, automotive sector, materials, or energy and natural resources.

Top-down proposals for the S3: they do not describe specific measures or pilot actions to undertake towards the S3. They just mention that they aim to reinforce the cooperation with other regions in some fields and that they want to take into account the non-technological innovation.

4.1.4. Attiki (Attica), Greece

S3 governance: Greece has a pretty centralized system. Their process is defined and led by the central government of the state, through their General Secretary for Research and Technology (Ministry of Development). The regional government has a restricted role. Additionally, they mention the central and regional governments have different points of view regarding the implementation of the strategy. They have involved representatives from the quadruple helix on the stakeholders groups.

Analysis of the context and detected comparative advantages: according to the Regional Innovation Scoreboard, Attiki is an innovation follower, in a better position than the rest of the Greek regions (notice that it includes the capital of the state, Athens, which might create a bias). Among their weaknesses, they mention the low expenditure in R&D, which has been decreasing due to the last years' economic crises. Additionally, like in many other region, they face problems regarding the transformation of the R&D results into innovation and a low connection between research institutions and companies. However, among their strengths, they underline the fact that they have a large number of universities and public research institutions, performing high excellence R&D, according to their publications. They have implemented a program of technological clustering for the 2007-2013. Regarding the sectors in which they appear to be more specialized, they mention high-tech sectors (electronics, chemical engineering, ICTs, biomedicine, etc.), and other sectors like tourism or energy, among other.

Top-down proposals for the S3: they do not mention any specific plans or measures to be undertaken. However, they have some priorities when developing their regional innovation plan, based in the regional growth, attracting investment, creating new jobs, improving the capacities of the companies to be less dependent on the public sector, or improving their infrastructure. The S3 may play a role in all these objectives, but it has not been yet defined.

4.1.5. Bratislavský (Bratislava), Slovakia

S3 governance: they have not properly defined a governance mechanism for the implementation of the S3. The regional government, jointly with the Slovak Ministry of Education and Science, are to coordinate it. They aim to involve representatives from the quadruple helix, but they are aware that more involvement from the business sector is needed.

Analysis of the context and detected comparative advantages: Bratislava is a developed region in Slovakia, but less developed than the European average. They have a low rate of expenditure in R&D; by a 1.2% of the GDP in 2012. They mention that there is a high concentration of companies and financial institutions in the region, with full employment. They have defined a dynamic development of the Slovak R&D ICTs companies. They have critical mass on basic and applied research in the main smart specialization domains that they have prioritized, which are: materials (for construction, electronics, diagnostic, or intelligent surfaces), ICTs (for security, navigation systems, robotics, etc.), and biotech (molecular biology, diagnostics, or biology active materials).

Top-down proposals for the S3: they do not mention specific measures or plans, but they have established 3 priorities related to the regional innovation strategy: European and international excellence, commercialization of the R&D results, and the needs of the local and the global industry.

4.1.6. Centre (Center), France

S3 governance: regarding the regional innovation strategies, the body in charge is the Innovation Regional Strategic Committee. They have established an innovation operational committee which works with a territorial strategic intelligence unit and different working groups in order to define the potential specialization areas. They are all connected to the central government of France, who is also responsible of the implementation of the strategy.

Analysis of the context and detected comparative advantages: they started to implement their regional innovation strategy in 2009, establishing some measures towards the promotion of the innovation. Among their main strengths, they mention a good rate of private R&D in France, an important rate of industries, and well-established clustering initiatives. However, as their weaknesses they mention the poor specialization in high tech sectors, or the low cooperation between research institutions and companies, among other. They think they have a great potential to develop their tourism and agriculture sectors. They are in the process of defining their main priorities, which will be based in the 4Cs that we mentioned in chapter 1: targeted choice, cooperation possibilities, critical mass, and competitive advantage.

Top-down proposals for the S3: they do not mention specific actions or plans. They are still defining their S3 and the priorities that they aim to establish.

4.1.7. Emilia-Romagna, Italy

S3 governance: the regional government is the coordinator of the whole strategy. They have the support of a consortium of different agents based on a tripe helix model called ASTER, and another institution called ERVET, which supports the design of policies by the government. The Regional Council will be in charge of approving the S3 as part of the whole regional innovation strategy.

Analysis of the context and detected comparative advantages: Emilia-Romagna has been implementing policies towards a knowledge based economy since 2002, looking to define a framework of actions to implement a whole regional ecosystem of innovation, looking to increase the regional competitiveness. Through this framework, they have established three main pillars: the stimulation of R&D in companies (especially SMEs), the promotion of the industrial research and technology transfer from universities and research institutions to the companies, and the evolution of industrial cluster towards a knowledge dimension, promoting collaborative research and technology transfer. They have also defined two main challenges and, according to these challenges, they have selected some priority clusters. First challenge is the upgrade of the technology level and competitiveness of those clusters which are key for the regional specialization model. In this direction, they have identified three main clusters: agrofood, construction, and mechatronics. The second challenge is the reinforcement of the emerging clusters that have a high innovative potential, with two related clusters: health industry and creativity and culture.

Top-down proposals for the S3: after the analysis that has led to the definition of the specialization strategies, they aim to establish some policy instruments. For example, they look to support autonomous R&D projects proposed by SMEs, but also strategic projects proposed by industrial research laboratories, working on societal challenges. They also want to support new start-ups, bringing KETs into clusters. However, no concrete measures for S3 are mentioned.

4.1.8. Illes Balears (Balearic Islands), Spain

S3 governance: the regional government is in charge for the definition of the S3, through their Economic Vice-presidency for Promotion of Business and Employment and their regional Ministry of Education, Culture and Universities. For the more technical aspects, the institutions in charge are the Balearic Foundation for Innovation and Technology (BIT) and the Balearic Park for Innovative Technology (PARCBIT). Additionally, they have applied the quadruple helix with consultations to representatives from clusters, technology and knowledge centers, companies, and universities

Analysis of the context and detected comparative advantages: they still have a low rate of expenditure in R&D, which was by 0.8% in 2010. However, they have been working on the promotion of innovation for many years. Illes Balears has been developing a plan for science, technology and innovation since 2001 (2001-2004, 2005-2008, 2009-2012). In the definition of the next one, for the period 2013-2017, they will include the concept of smart specialization in their strategy. Tourism is the sector in which they are highly specialized and they want to continue its promotion. Around this sector we can find many related domains that have been growing: ICTs, environmental and sea technologies, life sciences, health, biotechnology, etc. Related to these sectors, they have created some cluster to promote R&D&I and business activities.

Top-down proposals for the S3: through their plan for science, technology and innovation 2013-2017, which includes the S3, they aim to apply some measures to consolidate the scientific and technological base of the region, promote the generation of knowledge in some strategic areas (they do not mention in which), boost links among research and industry, encourage the creation of new innovative companies, etc. However they do not define concrete actions.

4.1.9. Islas Canarias (Canary Islands), Spain

S3 governance: they do not concrete on their system but they mention than the process is coordinated by the Presidency of the Regional Government, through the Canary Islands Agency for Research, Innovation and Information Society.

Analysis of the context and detected comparative advantages: Islas Canarias in an overseas region. They present a low rate of expenditure in R&D. To work towards the research and innovation, they have implemented three Canary Plans for R&D&I (2003-2006, 2007-2010, and 2011-2015). According to their capacities and their critical mass, they define their priorities, based on excellence, as the following sectors: astrophysics and astronomy, tourism, marine environment, biotech, renewable energies, and ICTs, all them identified under their regional innovation plan for 2011-2015.

Top-down proposals for the S3: they do not mention any specific plans or actions towards the implementation of the S3. They are planning the definition of the whole strategy.

4.1.10. Jihomoravský kraj (South Moravia), Czech Republic

S3 governance: there is a national coordination (since November 2012) of the S3, through the Ministry of Education, Youth and Sports. Their governance system establishes a steering committee which works through a coordination committee and the regional innovation strategy manager, which has connections with the representatives coming from the government, education system, R&D system, innovative companies, and communication system.

Analysis of the context and detected comparative advantages: among their weaknesses, they mention that they have no powers over research, just over innovation. Additionally, they have a low budget for innovation, and most of it comes from the Structural Funds, managed by at a national level. However, among their strengths, they identify the knowledge base potential of the region, the relative low labor costs in the unified market, their tradition in sophisticated industrial production, and a large critical mass of graduates, engineers, and researchers. On the other side, there is a lack of entrepreneurs, and it is necessary to reorient the public research institutions to make improve their research capacities. They mention some special relevance for the following sectors: ICTs, mechanical engineering, electronic and scientific instruments, and life sciences.

Top-down proposals for the S3: from a national perspective, they are already hiring S3 regional managers. In more general terms, regarding their regional innovation strategy, in Jihomoravský kraj they are working on their framework towards 2020 with the vision of developing the region's potential in innovation, looking to increase the private expenditure in R&D, the number of ERC grants, etc. They aim to connect companies and R&D institutions to identify some sectors and priorities, objectives, and actions. However, no specific measures or plans are mentioned.

4.1.11. Kujawsko-Pomorskie (Kujawy-Pomerania), Poland

S3 governance: they propose a model base on the quadruple helix model, looking for the cooperation of public authorities, universities and research centers, industry, and final users. The regional governmental body is to coordinate the process. The partners helping in the process are the economic council of the region, the board of rectors of the public and private key universities, the regional innovation council, as well as experts in relevant fields of science, economy, and management.

Analysis of the context and detected comparative advantages: developed industry, especially in the sectors of food, medical services, automotive sector, transportation, plastic products, ICTs, and chemicals. They have an important number of highly competitive large companies and their universities have a high potential to perform scientific and technological projects. They establish astronomy as the specialization scientific field of the state. They are aware of the weaknesses of the region, such the lack of cooperation between universities and companies, the low expenditure (public and private) in R&D activities, the low level of innovation in the SMEs, and a weak system for technology transfer.

Top-down proposals for the S3: given the low innovation rates of the Kujawsko-Pomorskie, the region has a great opportunity to define actions aimed to improve the system. They are working in a general regional innovation plan, where the smarts specialization strategy is to be one of the key elements. They will concentrate efforts on a selected thematic fields, and they will support the development of regional economy spheres looked upon as the most promising, always trying to identify which are the sectors with the highest return that will help to rise the inflows from exports, to develop the whole innovation process, and to have the largest social impact and the best regional development, improving the competitiveness. They are still in process of defining the regional innovation strategy that will have associated policies and concrete measures.

4.1.12. La Réunion (Réunion), France

S3 governance: they have established a strategic committee integrated by a state representative, a regional council representative, a department council representative, and the president of the regional committee for innovation. Additionally, there is a technical team composed by a regional committee for innovation, with a president and representatives from different entities and members of the strategic committee, and a operators committee, with representatives from organizations related to innovative projects or companies.

Analysis of the context and detected comparative advantages: La Réunion is an overseas European region, with high rates of unemployment (29% in 2010) and poverty (49% in 2008). However they have growth rate of the GDP (4.5% from 2007 to 2012). They mention that, historically, their main strengths have been the sugar industries and the construction. In 2010 they launched their regional innovation strategy and, in 2011, the regional scheme for economic development, establishing 6 key sectors: biotech / life sciences, sea / fishing / water, energy, ICTs, tourism, and environment. These sectors are associated to 6 clusters.

Top-down proposals for the S3: they aim to implement a bottom-up process regarding their regional innovation strategy, and the governance policies should allow both bottom-up and top-down initiatives. Even if no concrete measures are mentioned, they have defined 8 strategic orientations through which they aim to raise the level of qualification, improve the innovation in companies, or implement more innovative projects, among other.

4.1.13. Languedoc-Roussillon, France

S3 governance: they define a steering committee, with a president, associated to a technical committee of the region, where we can find the regional innovation agency and a dedicated team for the project, following the quadruple helix model, involving different agents in the consultation. They are in charge to build the system to be implemented.

Analysis of the context and detected comparative advantages: according to the Regional European Scoreboard, Languedoc-Roussillon is an average innovator region, with a high expenditure in R&D (around 3% where two thirds come from public funds). They have a higher rate of innovative companies than the average rate of France and the EU. According to their study, their main research fields are agronomy and environmental sciences, health, ICTs and engineering, chemistry, and earth sciences and water. Regarding the industrial sectors, they have developed a diagram showing a relation between the number of employees of each sector and their performance in R&D&I. According to this, some of the most relevant sectors in the region are the water management, the agricultural services, the ICTs, or the technologies related to aging.

Top-down proposals for the S3: regarding the S3, they have pre-identified 40 fields that must be evaluated by the committees and consultants in order to select those in which the region may have larger competitive advantages. Additionally, they have launched a website (www.3s-en-LR.com) to identify 10 domains to be validated. Their criteria for choosing the priorities is related to (in a period of 5 – 7 years' time) the economic impact for the region, the innovations and their commercial applications, the national and international market targets, the transformation of the activities, the creation of a common vision for partners, the cross-sectorial possibilities, the offshored activities, the chances for leadership in Europe, the need for public funds, and the differentiation.

4.1.14. Lietuva (Lithuania)

S3 governance: the case of Lithuania, like in other cases, is a little different, since the state is in itself the only region, so there is only the central government of the state, no regional actors. To develop the S3, they have defined an international independent group supported by different expert groups from the academia, the industry and the public institutions. Their proposals are to be evaluated by the coordination group, consisting in ministries and implementing agencies and, after that, by the strategic R&D&I Council led by the Prime Minister and, finally, by the government.

Analysis of the context and detected comparative advantages: in terms of scientific capacities, they observe some comparative advantage in physics and materials engineering, chemistry, biosciences, environment, and clinical medicine. On the other side, regarding to the industrial activities, and according to a report of Enterprise Lithuania from 2013, their main sectors (by turnover in 2012) are the manufacture of refined petroleum products, followed by the manufacture of food products, chemical products, and furniture; these sectors are, at the same time, those experiencing a higher growth, so they can be defined as those in which the region is specialized. If we take a look at the context, they identify some weak points such the lack of connections between science and the industry, the low investment in R&D, or the low productivity. However, they have been developing some initiatives, such the "Valleys", clustering initiatives established around some cities to promote specific sectors. According to this, they define their preliminary priority sectors, which are: efficient energetics and sustainable environment, materials and manufacturing technologies, health, agrofood, and transportation and logistics.

Top-down proposals for the S3: besides the promotion of the priority sectors that we have mentioned, Lithuania aims to improve their system. Among the measures that should be established, they know that there are some priorities, like the modernization and strengthening of the knowledge based growth, the further technological upgrading, the further strengthening of the competitive advantages, the definition of new markets and products, the shift of production factors towards high-tech and skilled labor, and the facilitation of radical innovation to support the commercialization in the European and international markets. However, concrete measures are still to be defined.

4.1.15. Lubelskie (Lublin), Poland

S3 governance: the regional administration of the Lubelskie region is in charge of the development of the S3. They will debate the initiatives with different agents related to the academia and the industry, as well as with some entrepreneurs. In general terms, when considering the whole regional innovation strategy for Lubelskie, the regional administration is in charge of it and in the decision making process there is also an innovation council and a steering committee.

Analysis of the context and detected comparative advantages: they have done a very job evaluating the context and the potentialities of the region. The smart specialization strategy appears also in the Polish framework, and their plan for 2012-2020 around the innovative and efficient economy strategy, including the Polish roadmap for research infrastructure, the national research program, or the technology foresight for industry sectors, which has identified 10 technological fields. The region has 67entities performing R&D activities (45 of them are companies). However, the region is still considered a modest innovator by the Regional Innovation Scoreboard. Regarding the scientific capacities of the region, they have identified some fields in which they are more competitive: chemical technologies, environmental engineering, health, or animal sciences, among other. In general, according to the S3, they have established some priority sectors: bioeconomy, health and wellness services, IT and control engineering, and low carbon emission, looking to establish interconnections and synergies. They have chosen their specialization according to the previous identification of internal potentialities, according to the number of companies and employees, the level of integration and cooperation, or their efficiency rates. They have also taken into account the potential cooperation between the different institutions in the fields that have been identified as key priorities.

Top-down proposals for the S3: Lubelskie is one of the regions that has made a greater effort to define measures towards the S3. As we have said, they have already identified some priorities in which they will work first. Regarding the S3, they have established three main priorities: to increase the ability of the industry to create, absorb and implement innovations in the areas of regional specialization, to increase the ability of research and business entities to create and commercialize new knowledge and technologies related to the areas of specialization, and to strengthen the innovation environment towards the S3. Additionally, they have defined six smart pilot projects: smart incubation (for innovative companies in the specialization areas), smart services (to meet innovative needs of the companies), smart cooperation (to define a cooperation network for entities aiming to work in the areas of specialization), smart researchers (a program to support young researchers conducting applied research in the areas of specialization), smart research areas (to develop a regional interdisciplinary research program in some areas of specialization), and the smart use of local resources (to implement a model for an improved use of the local resources for bioeconomy and supplementing sectors).

4.1.16. Malta

S3 governance: the case of Malta, as in other cases, is a little different, since the state is in itself the only region, so there is only the central government of the state, no regional actors. The Malta Council for Science and Technology is the coordinator. The ministries related to the process are the Ministry for Education and Employment, the Ministry for Economy, Investment and SMEs, the Ministry of European Affairs, and other sectorial ministries. Additionally, other institutions participating in the process for the implementation of the S3 are the University of Malta, the Parliamentary Secretariat for Research, Innovation, Youth and Sport, the association Malta Enterprise, and the Parliamentary Secretariat for EU funds. An advisory group has been set up to propose R&D&I measures according to the innovation plans.

Analysis of the context and detected comparative advantages: they have a highly business-driven system, which is defined by their National Strategic Plan for Research and Innovation (2007-2020). They are now defining the 2020 strategy, which will still put special emphasize on the business orientating, with a larger focus on societal challenges and the development of thematic strategies for particular sectors. They have significant investments in a well-established higher education system, with a large potential. They have identified the following tentative priorities in terms of specialization: tourism, maritime services, aerospace cluster, health, high added-value manufacturing, ICTs, and climate change adaptation.

Top-down proposals for the S3: they plan to build on the existing high value-added sectors and to strength other large economic sectors through innovation, as well as to increase the international collaboration. They have established some priorities and action lines, like the setting-up of support measures for an overall enabling framework at the national level. They think that it is important to invest in knowledge generation to reinforce the identified niches and to build critical mass in R&D, focused in interdisciplinary research. They stress the fact that it is important to build on the existing strengths, to address the local challenges, and to clear the links to R&D investments and academic collaborations.

4.1.17. Marche, Italy

S3 governance: the general management is hold by the regional government, and the drafting is made by a regional manager, consultants and academics. There is a scientific committee with university and independent experts. They have also established a stakeholders' round table with business and social representatives, as well as those coming from the financial system, the knowledge institution, chamber of commerce, and innovation and technology transfer centers.

Analysis of the context and detected comparative advantages: they still have a low rate of expenditure in R&D, which was by 0.7% in 2009. Additionally, they have low rates of productivity, and a low development of their research and innovation activities. However, they underline that they have a high concentration of manufacturing and entrepreneurial activities, a high export capacity, and a good high education system. Regarding the S3, they have identified some key enabling technologies: new materials, ICTs and electronics, mechanics and energy, and biotech. Regarding the industrial sectors, they present some advantages in mechanics, home electronics, furniture, or shoes, among other. KETs and industry combined create some areas in which the region could center its S3: home automation, mechatronics, green and sustainable manufacturing, and health and wellbeing.

Top-down proposals for the S3: they define a strategy going from the vision (based on an innovative cluster structure based on smart specialization) to some priorities that must lead to some specific actions coming from different funds: the European Regional Development Fund (ERDF), the European Social Fund (ESF), the European Agricultural Fund for Rural Development (EAFRD), and the funds coming from the state and the regional governments. However, they still must to define a plan where they concrete the actions and specific policies.

4.1.18. Nord-Pas de Calais, France

S3 governance: they do not present their governance system, in case they have one. They just mention that their priorities have been decided by interest groups, consultants, and the national and regional authorities.

Analysis of the context and detected comparative advantages: Nord-Pas du Calais is a region with a low rate of expenditure in R&D compared to France and the whole European Union. They do not mention their regional innovation plans. They have identified some sectors that have been identified as priorities: railway transport, food and health, commerce, automotive sector, construction, mechanical engineering, advanced materials, energy, waste management, and digital services.

Top-down proposals for the S3: they do not mention any proposals towards the definition and implementation of the S3.

4.1.19. Northern Ireland, United Kingdom

S3 governance: there is not a concrete definition of the governance structure for the implementation of the S3 in the region. They just mention that this is related to an executive committee in a governmental program, which is connected to an economic strategy sub-committee, as well as to the innovation strategy – innovation council. Their tasks, though, are not described.

Analysis of the context and detected comparative advantages: the region sees as a priority the promotion of the R&D&I. They are preparing an innovation strategy, still to be defined. They are still under the European average in terms of expenditure in R&D, and they are in a low position in the innovation scoreboard. In their study, they present a good definition of their specialization trends, based on the exploitation capabilities of their markets and their technological scientific capacities. Regarding the technologies, they have established as their priorities the advanced manufacturing, the advanced materials, the life sciences, the ICTs, and the agrofood. In terms of clusters, they have identified as their main priorities the sectors of ICTs, agrofood, sustainable energy, advanced materials, life and health sciences, and advanced engineering.

Top-down proposals for the S3: they do not mention any specific plans or actions towards the S3. They are to coordinate their regional innovation strategy with their whole economic strategy, which includes the innovation and the R&D.

4.1.20. País Vasco (Basque Country), Spain

S3 governance: they do not mention which is the governance system, which will depend on the Department of Industry, Innovation, Trade, and Tourism of the regional government.

Analysis of the context and detected comparative advantages: they have a pretty good rate of expenditure in R&D, which has been growing by 10% each year since 1996. They have 11 consolidated clusters, and 9 are being developed. They have developed an institutionalized Regional Network of Science, Technology, and Innovation (RVCTI), integrated by the main actors performing R&D. The Basque Country has a strong industrial tradition, especially in the sectors of machinery and tools, automotive, metal, and electronics. They define some targeted markets / challenges that are to be their priorities: ageing society, digital domains, transport and mobility, renewable energies, and science-based industry. Around these sectors, they have defined cross-technology domains: bio sciences, nano sciences, and advanced manufacturing.

Top-down proposals for the S3: they do not define any specific plans or measures towards the S3. They mention though some challenges that they want to relate to this strategy: the establishment of partnerships at a global scale, the strengthen of international business activities, or the promotion of collaborative R&D, among other.

4.1.21. Piemonte (Piedmont), Italy

S3 governance: the coordinator is the Business Activities Department of the Research and Innovation Directorate. They implement a system based on the quadruple helix collaboration model, involving these actors through periodical consultations. The governance mechanisms are a defined through a regional committee and the innovation clusters. They are aligned to the regional Research and Innovation Strategy, which has a regional committee, a scientific commission, and an evaluation team.

Analysis of the context and detected comparative advantages: they have been developing innovation clusters; there are 12 of them, covering most of the sectors, and especially aimed to support the competitiveness of SMEs. They establish 8 main fields of specialization: aerospace, agrofood, clean technologies, smart communities, mobility, mechatronics, life sciences, and textile. Around these clusters, they establish as the main KETs the fields of biotechnology, nanotechnology, advanced manufacturing systems and new materials, and ICTs.

Top-down proposals for the S3: they do not define any specific measures or concrete plans.

4.1.22. Pomorskie (Pomerania), Poland

S3 governance: they propose a model base on the quadruple helix model, looking for the cooperation of public authorities, universities and research centers, industry, and final users. The regional governmental body is to coordinate the process. The partners helping in the process are the economic council of the region, the board of rectors of the public and private key universities, the regional innovation council, as well as experts in relevant fields of science, economy, and management.

Analysis of the context and detected comparative advantages: developed industry, especially in the sectors of food, medical services, automotive sector, transportation, plastic products, ICTs, and chemicals. They have an important number of highly competitive large companies and their universities have a high potential to perform scientific and technological projects. They establish astronomy as the specialization scientific field of the state. They are aware of the weaknesses of the region, such the lack of cooperation between universities and companies, the low expenditure (public and private) in R&D activities, the low level of innovation in the SMEs, and a weak system for technology transfer.

Top-down proposals for the S3: given the low innovation rates of the Kujawsko-Pomorskie, the region has a great opportunity to define actions aimed to improve the system. They are working in a general regional innovation plan, where the smarts specialization strategy is to be one of the key elements. They will concentrate efforts on a selected thematic fields, and they will support the development of regional economy spheres looked upon as the most promising, always trying to identify which are the sectors with the highest return that will help to rise the inflows from exports, to develop the whole innovation process, and to have the largest social impact and the best regional development, improving the competitiveness. They are still in process of defining the regional innovation strategy that will have associated policies and concrete measures.

4.1.23. Puglia (Apulia), Italy

S3 governance: the process is managed by the Industrial Research and Innovation Service of the Economic Development, Labor and Innovation Policies Department of the region. Implementing bodies and regional stakeholders are involved in order to define the proper strategy and apply it. A steering committee is to be set up.

Analysis of the context and detected comparative advantages: Puglia implemented its first regional innovation strategy in the late 90s, and they set up their first regional R&D strategy in 2001. In 2004 they created their Regional Agency for Technology and Innovation (ARTI), to promote innovation and technology transfer. Even if they have done important efforts, they still mention some weak points like the poor connection between universities and companies or the low rate of expenditure in R&D activities. The region has a large experience around clustering initiatives and they have also established four technological districts in the sectors of KITs, agrofood, mechatronics, and renewable energies. In 2009, through their research and innovation strategy, they identified their priorities: aerospace, agro industries, cultural heritage, biotech and life sciences, energy and environment, logistics and production technologies, mechanics and mechatronics, new materials and nanotech, and ICTs.

Top-down proposals for the S3: there is no mention to any specific actions of plans towards the S3. However, following the European 2020 strategy, they aim to implement regional innovation partnerships, innovation services, living labs, programs around the concept of pre-commercial procurement, etc. All this may promote the S3. They are especially interested in promoting the innovation activities as a tool to achieve more and better employability.

4.1.24. Rhône-Alpes, France

S3 governance: they propose a system according to the quadruple helix model, where the coordinator is the Rhône-Alpes region and includes representatives from the central government of the state, local governments and cities, social and economies actors, clusters, companies, research institutions, technology platforms and user associations. The board of the initiatives is to be composed by the regional representatives and those coming from the local governments, the regional innovation agencies (ARDI and OSEO), the regional chamber of commerce and the alliance of universities. A steering committee will be also defined.

Analysis of the context and detected comparative advantages: Rhône-Alpes is, according the Regional Innovation Scoreboard, among the top regions performing R&D (5th in terms of expenditure in 2012). The regions is the leader in France in collaborative R&D projects and they have 7 of the top 20 clusters in the state. They are the second main region in France (after Île-de-France) in terms of scientific and technological research, including 9 academic research communities based on societal challenges. The sectors in which they consider they have the main competitive advantage are chemicals, plastics, mechanics, healthcare, and electronics.

Top-down proposals for the S3: they plan the organization of the regional innovation system along key sectors such as health, clean technologies, energy, mobility, electronics, and materials. They aim to support the setting up of new industries or the transformation of the existing ones at crosses boundaries like, for example, plastronics, robiotics, nanobiotech, etc. Through the S3 they aim to improve the innovation system through the efficiency associated to the strategy, as well as to define better funding mechanisms and better policies for SMEs and innovation actors (more concrete measures are still to be defined).

4.1.25. Sachsen (Saxony), Germany

S3 governance: there is no mention to the governance system.

Analysis of the context and detected comparative advantages: according to the Regional Innovation Scoreboard, Sachsen is a leader innovator. Their strengths are, among other, their high public R&D expenditure and the number of product or process technological innovations. On the other hand, their weaknesses are the low number of innovative SMEs or the public-private collaboration. They have a well-structured industry, defining as the key sectors the mechanical engineering, the electrical industry, and the manufacture of vehicles. All these sectors have a long tradition, are very intense in innovation and R&D activities, and a high rate of export. Regarding the scientific capacities, they mention as their main competitive advantages microelectronics, nanotechnologies, photonics, advanced materials, manufacturing technologies, and biotechnologies.

Top-down proposals for the S3: they do not specify concrete measures or actions to be undertaken towards the S3. However, they have defined their key challenges as setting priorities (specialize), improve the knowledge transfer to markets, or improve the framework for innovation, among other.

4.1.26. Sicilia (Sicily), Italy

S3 governance: there is no mention to the governance system.

Analysis of the context and detected comparative advantages: they mention that the region has a low role when defining the R&D&I policies, existing a lack of proper governance of the regional research network. Their regional innovation strategy was more oriented towards an infrastructural approach form 2000 to 2006, but they have been trying to focus in some priorities since then. They say that, even if there is a highly qualified human capital, the results are low (in terms of patents, spin-off companies, etc.). They have been working in the definition of clusters (agrofood, tourism, ICTs, etc.), and they have scientific and technological expertise on some KETs with high growth trends such micro and nanotechnologies or biotech. On the other hand, they are aware that there are weak links between research institutions and companies. They establish some sectors in which they have competitive advantage: micro and nano systems, biotech and health sciences, sustainable energies, agroindustry, and sea activities, as well as tourism.

Top-down proposals for the S3: they plan to select priorities according to the already existent patterns in Sicilia, focusing in those areas in which the region has already good results, those in which applications present the most widespread potential impact. In this direction, they aim to upgrade the clusters with the highest potential in terms of economic performance and employment, to reinforce the region's presence in the global system, and to enhance the innovative productive tissue, centering the attention in the targeted unsatisfied societal needs. Additionally, they mention the need for a stronger interaction between the different agents in charge of defining the policies and the funding systems, and they find the need for a stronger involvement of new stakeholders in the design of these tools, which must be more innovative in the future, even if they do not mention concrete examples.

4.1.27. Świętokrzyskie, Poland

S3 governance: their governance system is to be related to the innovation system stakeholders in Swietokrzyskie, where the innovation council is in charge, and it receives the authorization and the support of the regional assembly, the regional management board, the regional government, companies, universities, local governments, the regional development bureau, and the final users. The relations among these agents are not defined though.

Analysis of the context and detected comparative advantages: the region faces some important problems, such one of the highest unemployment rates in Europe, not too many successful companies, and low rates of competitiveness and exports. They are implementing the regional innovation strategy for the period 2005-2013. They have defined some priority sectors according to the S3: energetic efficiency, conferences and fairs, health and spa, metallurgic industries, and design (horizontal sector).

Top-down proposals for the S3: no concrete measures have been defined to support the S3. However, they have established a concrete schedule for next steps that had to be undertaken in 2013 towards the definition and implementation of the S3.

4.1.28. Toscana (Tuscany), Italy

S3 governance: they do not mention their governance system; they just specify that the whole action plan is to be approved by the regional government.

Analysis of the context and detected comparative advantages: even if they mention that their expenditure in R&D is low, it is by the average of the EU regions. The region is based on manufacturing of fashion (textile, leather, jewelry), paper, furnishing, shipbuilding, and mechanics. They mention that the fast growing sectors are, among other, robotics, nanotech, aerospace, biomedicine, pharmacology, or renewable energies.

Top-down proposals for the S3: they have defined a path towards the definition and implantation of the regional innovation S3, divided in 5 phases (analysis, policy framework, thematic working groups, action plan, and institutional validation). They aim to promote a smart territory, the energy, smart manufacturing, social innovation, and research and human resources, in a policy mix framework which must still be more concreted.

4.1.29. Vest (West), Romania

S3 governance: they do not concrete about the S3 governance, they just define their regional system for innovation-related activities. The decision-making body is the Regional Development Council, and they will deliberate about the S3. Additionally, the Regional Development Agency will be in charge of the planning and management of funds, the attraction of investment to the region, and the clustering initiatives.

Analysis of the context and detected comparative advantages: the region has been growing in the last years in economic terms. They have a well-established industrial area. They were the first Romanian region to develop a regional innovation strategy for the period 2005-2008. Another strategy was defined for the period 2009-2013. This one must lead to the S3, which will be a key element in the strategy 2014-2020. While the previous one was more focused in the priorities of automotive industries and ICTs, defined around clusters, as well as eco-innovation and the implementation of the digital agenda, the next strategy will take into account new sectors, like sustainable construction, and horizontal themes. So, in general, they consider as strategic sectors the ICTs, automotive industry, construction, agrofood, and energy efficiency.

Top-down proposals for the S3: no specific measures or plans towards the S3 are defined. However, they indicate that the region want to develop their regional innovation strategies around the concept of smart specialization. They have established a program based on 10 steps that must allow them to define their strategy, which will include some priorities around the S3 context.

4.1.30. Wales, United Kingdom

S3 governance: there is no mention to the governance system.

Analysis of the context and detected comparative advantages: they explain that their economy is changing from heavy industrial to service led, but still the manufacturing is comparatively more important in Wales that in the rest of the UK. As a weakness, they mention that they have a low rate of business expenditure in R&D and a lack of critical mass. Wales was one of the first regions that defined and implemented regional science and technology plans (first one in 1996) and they have been working on new programs since then. Last one they mention s the Science for Wales 2012, which identifies some big challenges in the areas in which the region appears to have some strengths: life sciences and health, low carbon energy and the environment, advanced engineering and materials, and ICTs and digital. These areas are to be the priorities in their S3.

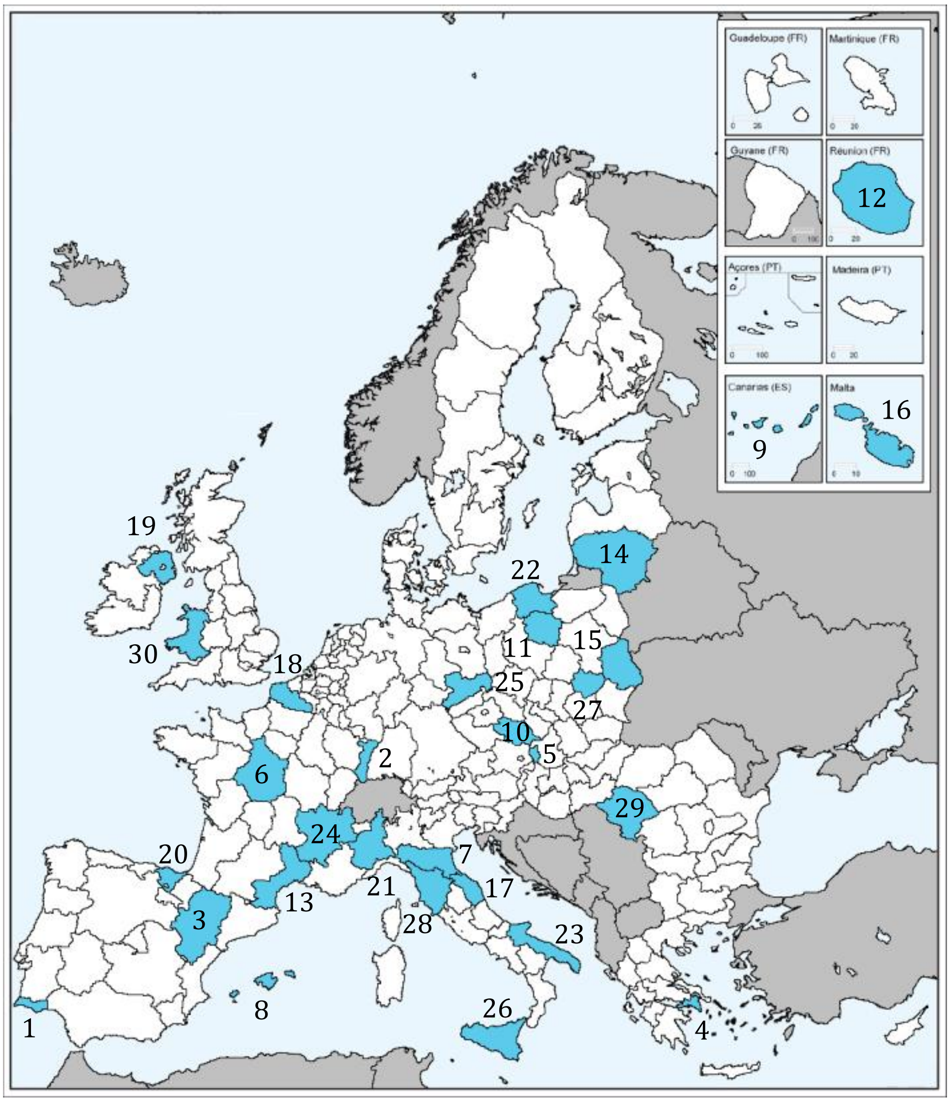
Top-down proposals for the S3: they do not define any specific measures or action plans that are going to be implemented towards the S3. They just mention that action plans are being developed following the S3. They establish that their regional government will only develop actions when they consider that they are the best-established to do so.

4.2. Final remarks and conclusions

Main conclusions around the evaluation of the 30 presentations can be found in table 4.2.1, which presents an overview of the three most relevant aspects to be considered: the presence of all kind of actors related to innovation in the governance model, the concrete establishment of competitive advantages and priorities, and the definition of measures and programs towards the implementation of the strategy. Colors on the table cells follow this logic (related to the question on the top of the column):

- Green: good performance.
- Yellow: dubious or vague information about the performance.
- Red: bad performance or without information.

Figure 4.2.1. Map of the situation of the analyzed regions (numbers correspond to table 4.2.1)



Source: Own elaboration

As the table shows, no region has three green cells. This evidences the fact that, even if regions are working in the definition of their regional innovation smart specialization strategies, there is still a long way to go. When defining the governance of the whole strategy, it is expected that the regional authorities will take the leadership. However, it is important that agents coming from the different institutions represented on the quadruple helix model (industry, research, public sector, and final users) are involved. Most of the regions work under this model but in many cases it still must be more developed to ensure the participation of all kind of actors. On the other hand, some regions just do not mention their governance system. Almost all regions are more concrete when establishing which are their competitive advantages and the priorities they want to promote towards the S3. As the table shows, almost all the presentations analyzed the different strengths and weaknesses of the region in order to define sectors, fields, and/or challenges that have been identified as key by the region. Nevertheless, there is a lack of proposals for concrete actions or programs in almost all presentations. Even if the regions seem to be able to define some priorities, they still have not designed policies and related programs to develop the strategy. Only a few regions have started to define some pre-proposals on this direction.

After the analysis on the different presentations, we can say that the European regions are doing an important effort to define their regional innovation strategies around the concept of the S3. However, if they are already working on it, they still have to analyze all the priorities that they have established and work on the definition and implementation of the proper policies, but our study shows that no concrete measures have been written down yet, so now, after the evaluation of the assets of the region, it is time to start creating the tools to begin carrying the strategy out.

Table 4.2.1. Comparison of the 30 analyzed RIS3 presentations and their specificities

	Does the governance system involve representatives from the main actors in the regional innovation strategies?	Do they define concrete priorities towards the S3 according to their comparative advantages?	Do they plan concrete any actions and proposals regarding the regional innovation which fit the S3?
1. Algarve	Yes. It is coordinated by their regional commission in charge of the development, which include representatives from different institutions.	Yes, they identify some areas of expertise, which are to be their priority under the S3.	They build proposals under general objectives (reduce unemployment, economic growth), but more detailed initiatives must be defined towards the S3, since it is not clear enough.
2. Alsace	They will use the S3 to develop the quadruple model for the strategy, but not yet well specified.	They have defined 5 competitiveness clusters in the and 6 regional clusters covering the main areas.	No specific measures mentioned, only their general objectives on regional innovation.
3. Aragón	They have a working group, but it is not clear if the composition involves all kind of actors.	They are able to define their strengths and the main challenges that are to be prioritized.	They do not mention any concrete measures.
4. Attiki	Centralized system in the state. Regionally, they do involve agents from the quadruple helix model.	They establish some specialization sectors, which are taken into account in their innovation strategies.	No specific measures mentioned, only their general objectives on regional innovation.
5. Bratislavský	They mention that they want to involve representatives from the different involved actors, but more concretion is needed.	Yes, they establish some sectors or fields in which they appear to be most specialized.	No specific measures mentioned, only their general objectives on regional innovation.
6. Centre (FR)	They have different working groups, but they do not specify their composition.	They are in process of defining the sectors / fields that are to be prioritized.	They do not mention any concrete measures.
7. Emilia-Romagna	ASTER, which supports the governance, is a consortium of representatives from the triple helix model.	Following the S3, they have identified three main sectors (clusters) and two emerging ones.	They are defining policy instruments around the S3, which are still to be more concretely described.
8. Illes Balears	Yes. Through the agencies involved, they are in contact with representatives from the quadruple helix model.	They promote those sectors with a larger growth potential, but they focus especially in just one: tourism, not mentioning others concretely.	Their innovation plan includes the S3. However, they must define concrete actions.
9. Islas Canarias	They do not mention it.	They do define some priorities, based on critical mass and excellence.	They do not mention any concrete measures.
10. Jihomoravský kraj	Yes, they are connected to the representatives from the different types of actors.	They establish some specific sectors, the most relevant for them.	They are already hiring S3 managers. However, they must still specify more concrete measures.

Continuation of table 4.2.1.

	Does the governance system involve representatives from the main actors in the regional innovation strategies?	Do they define concrete priorities towards the S3 according to their comparative advantages?	Do they plan concrete any actions and proposals regarding the regional innovation which fit the S3?
11. Kujawsko-Pomorskie	Yes, they involve different agents following the quadruple helix model under the coordination of the regional government.	They mention the most developed industries but it is not clear whether those are or not the priorities.	The S3 plays a key role in their regional innovation strategy, focusing in some clusters / areas. They must still define more concrete measures though.
12. La Réunion	They have a committee with representatives from those agents related to innovation but they do not concrete which and how.	They have established 6 key sectors, which are associated to 6 clusters.	They have established 8 strategic orientations around the S3 but they still must define concrete measures.
13. Languedoc-Roussillon	They mention a team dedicated to the project which follows the quadruple helix model.	They have identified the relevant scientific areas and the sectors in which they have competitive advantage.	They have defined some priorities but actions on these priorities must still be defined.
14. Lietuva	They have established an international group with different representatives, but they do not specify if they also have representatives from the region.	They have established priority sectors and they have defined some initiatives around them.	No specific measures mentioned, only their general objectives on regional innovation.
15. Lubelskie	They say they will debate the initiative with different agents from academia and industry, as well as entrepreneurs, but they do not specify if they will have an active role.	Yes, they have identified some priority sectors related to the S3.	They have defined 6 main pilot projects towards the S3 around the concept of the strategy and the priorities identified.
16. Malta	They list some involved institutions, and more or less they represent all kind of actors, but more concretion would be needed about their role.	They mention some tentative priorities in terms of specialization.	They have defined some priorities but actions on these priorities must still be defined.
17. Marche	They have a scientific committee and a stakeholders' round where the different kinds different agents are represented.	They have established some areas / sectors that could center the initiatives around the S3.	They have defined a plan from the vision to some priorities, but they still must define more concrete measures.
18. Nord - Pas de Calais	They do not mention it.	They have identified some sectors that have been established as priorities.	They do not mention any concrete measures.
19. Northern Ireland	They do not mention it.	Yes, they do define some sectors that are their priorities.	They do not mention any concrete measures.

Continuation of table 4.2.1.

	Does the governance system involve representatives from the main actors in the regional innovation strategies?	Do they define concrete priorities towards the S3 according to their comparative advantages?	Do they plan concrete any actions and proposals regarding the regional innovation which fit the S3?
20. País Vasco	They do not mention it.	They define some targeted markets or challenges that are to be their priorities.	No specific measures mentioned, only their general objectives on regional innovation.
21. Piemonte	Yes, they have a system based on the quadruple helix model, involving different actors.	They establish 8 main fields of specialization, around which they propose some KETs.	They do not mention any concrete measures.
22. Pomorskie	They propose a model based on the quadruple helix model, fostering cooperation among different actors.	They mention one specialization scientific field and their most advanced industries, but they do not concrete if those are the priorities.	No specific measures mentioned, only their general objectives on regional innovation.
23. Puglia	They mention the involvement of different stakeholders but they do not concrete which and how.	They do define some priorities according to the specialization trends.	No specific measures mentioned, only their general objectives on regional innovation.
24. Rhône-Alpes	They present a model based on the quadruple helix and coordinated by the regional authority.	They mention some sector in which they have more competitive advantage and on which define their strategies.	They have identified some priority fields, but concrete measures are still to be defined.
25. Sachsen	They do not mention it.	Yes, they define sectors and fields with a larger competitive advantage.	No specific measures mentioned, only general objectives.
26. Sicilia	They do not mention it.	They establish some sectors in which they have competitive advantage.	They are defining some priorities and measures fitting the S3.
27. Świętokryskie	They present a model in which main related agents are involved.	They have defined some priority sectors according to the S3.	They do not mention any concrete measures.
28. Toscana	They do not mention it.	They mention the traditional sectors and those with a larger growth, but they do not say if those are the priorities.	They have done some advances through the definition of policies, but specific actions are still to be concreted.
29. Vest	They do not mention it.	Yes, they define some sectors which are to be the priority.	No specific measures mentioned, only their general objectives.
30. Wales	They do not mention it.	They have identified challenges around those sectors in which the region seems to be specialized towards the S3.	They do not mention any concrete measures.

Source: Own elaboration

5. Final remarks and conclusions. The S3 dilemma: smart versus stupid specialization strategy

5.1. Accomplishment of objectives and contrast of propositions

The intend of the thesis is not to seek for conclusions allowing us to judge whether the smart specialization strategy is the right one when addressing the policies around innovation for the next years, our goal was to evaluate if the existing specialization trends in the Union support the idea that identifying priorities under this context is possible or not. However, it is important to say this identification of priorities may lead to a misunderstanding of the smart specialization as a larger concept. Relating to it, this evaluation of regional context to detect patterns that can support the idea of the whole framework is just a part of its global goals, so it is important to clarify that, for us, in this work, the smart specialization strategy is the supporting background, but not the topic itself.

5.1.1. Research limitations

While developing our work, we have faced some limitations which affect our study and, most likely, to all the literature around the concept of smart specialization strategy.

First relevant limitation is the *lack of previous literature*. As we mentioned in chapter 1, this is a rather new concept, less than ten years old. Academic publications have not yet reached a large volume. Not being able to take a look to many previous studies and analyses makes more complicated to contrast the different hypothesis and propositions. On the other side, as also stated in chapter 1, smart specialization relates to many other concepts and it can be also studied regarding the impact it has from and to them.

A related restriction is that *this concept is still in development*, adapting the policy according to its objectives. Empirical studies are easy to be undertaken when they consider a concrete concept which is not subject to changes. This is not the case of smart specialization since, even if it is a rather fixed concept, it can still suffer some changes when the policy is completely developed in the following years. The analysis of the specialization trends must be adapted to these small conceptual changes, and the interpretations of our analysis would change too.

A third limitation is the *lack of existing data*. We have already mentioned this problem in previous chapters. The EU has not yet developed a proper and homogeneous system to cluster date on science, technology, industry and innovation both at national and regional level. Data on Eurostat is available for industrial activities, but the criteria to collect this data is not homogenous across the states, and it leads to different biases. In the case of scientific activities, no proper data base has been yet developed, which led us to design a new one for our purposes, as explained in chapter 2.

Another constraint is the fact that regions have very *heterogeneous systems*, which complicated the objective study, always requiring a more homogeneous perspective. If all regions were similar, fewer biases would appear, and when we talk about similarity we do not only refer to the volume of the activities, but also to how they are structured, the regional policies behind them, the structures, etc. These large disparities make that analyses can be hardly developed if we aim to introduce a harmonized perspective to be able to establish comparisons.

A last limitation is that there are still *no possibilities to develop an ex-post analysis*. The time horizon is here a constraint, since we can only evaluate the specialization patterns of the EU regions in the framework of the smart specialization strategy when it is still being developed, and we cannot introduce analyses on how well these trends fit in the final policy. We can now establish these patterns but further research must be undertaken to evaluate them in the whole framework.

5.1.2. Evaluation of the objectives' accomplishment

Objective 1: Provide a new, homogeneous and comprehensive overview of the specialization patterns in the EU regions, for both scientific and industrial activities.

We have probably presented one of the most complete overviews for most of the EU regions at the same time, for both scientific and industrial activities. Additionally, we have introduced a brand new data set based on the publications from the leader R&D institutions in each of these regions. To measure specialization patterns, we have used the Balassa index, since it is the most used proxy and it provides a logical and clear rate, which can be easily used to compare regions in a homogeneous way. In this framework, chapter 2 provides this new and comprehensive overview, allowing readers to visualize specialization patterns in Europe for science and industry.

Objective 2: Evaluate whether there are preexisting specialization trends in the EU regions or not.

In chapter 2, through the goal established in objective 1, we developed a mapping of the regional specialization patterns in most of the EU regions (except those for which we could not find data or it was statistically insignificant). This objective has been, so, achieved, for we identified the preexisting specialization trends, which must be understood as the basis for a top-down perspective of the smart specialization strategy.

Objective3: Establish whether the existing specialization patterns in the EU regions are consistent enough to be taken into account when defining measures towards the smart specialization strategy.

To talk about the accomplishment of this objective, we must mostly focus on the Balassa indexes, their value and their statistical significance. High rates for this index can be considered significant, but this is not always the case, especially for bigger regions (in absolute terms), given their larger and more diverse volume of scientific and industrial activities. Even if the index provides a good overview of the significance in terms of its own value, potential contrasts should be undertaken in future studies to evaluate its robustness.

Objective 4: Evaluate whether the comparisons among regions can be homogeneously done or if some other criteria must be applied.

In chapter 2 we analyzed all regions as if they were equal in absolute terms, focusing on the comparative advantages. However, evidence and logic lead us to think that large regions (in absolute terms) have very different structures than smaller ones, and these differences must be taken into account. In order to illustrate these disparities, in chapter 3 we focused only in 12 large regions, aiming to compare those ones with a similar volume of scientific and industrial activities. Nevertheless, we found that specialization patterns do not differ much when we consider just these last ones than when we were considering most of the regions.

Objective 5: Analyze whether a top-down approach for deciding the specialization fields / sectors is easy to be applied or not.

This objective was probably the main base to design the research questions and further propositions, since we did not only want to evaluate the specialization patterns in the EU regions but also identify if these trends allow us to significantly design top-down strategies that, added to the entrepreneurial discovery process aimed by the whole policy, can lead regions to the right scheme under which they can apply their programs. Through the general overview of chapter 2, the detailed descriptive analysis of chapter 3 for some regions, and the evaluation of the 30 proposals in chapter 4, we accomplish this objective, since we have considered all the perspectives around this top-down approach.

5.1.3. Answering the research questions

After the different sections in the four previous chapters, it is now time to evaluate the different results and conclusions by answering the research questions that we presented in chapter 1, which must lead us to evaluate and contrast the thesis propositions.

Research question 1: Are there preexisting specialization patterns in the EU regions regarding the scientific and industrial activities?

Yes, there are. As presented in chapter 2, is totally possible to identify specialization trends for both scientific and industrial activities in every EU region. Balassa index allows to rate these patterns, but other proxies could be used as other authors did, as mentioned in chapter 1. The identified preexisting specialization trends are the key issue for a top-down perspective of the smart specialization strategy.

Research question 2: Are these patterns (in case there are) statistically significant to be considered in a top-down approach of the strategy?

Yes, but not enough. Probably, if we were just taking into account the small European regions (in terms of their volume of scientific and industrial activities) we would find statistical significance in most cases. However, for large regions, specialization indexes are usually low, which do not allow us to talk about clear patterns. In a top-down approach, it must be taken into account that some regions are too diverse, and choosing priorities becomes complicated given the low significance of the proxies.

Research question 3: Should large and small regions (in absolute terms for scientific articles and number of employees) be compared independently or not?

Yes, they should. Specialization indexes are not the only large differences when considering regions' size; their structure is also very different. Large regions have very complex and diverse organizations, with expertise in many fields and sectors, and they cluster a large number of agents that interact among them, generating different spillovers than smaller regions, whit larger specialization rates and simpler structures. Even if it is possible to take a look at them in an aggregated way, as we did in chapter 2, independent analyses are also very recommended.

Research question 4: Are the institutions and entities linked to innovation, science and technology in the EU regions linked to the framework defined under the smart specialization strategy?

Not that much. In an aggregated way, regions may be planning their strategies, considering all agents related to science, technology, industry and innovation at the same time. However, if we consider institutions one by one, we see that they do not have, in general, many characteristics linked to the smart specialization goals, especially the one related to the interconnectivity among institutions, in a transregional European level. Strategies should therefore be planned in a way that they create incentives to the different entities to interact with others outside their influence area, aiming to create synergies coming from their cooperation.

Research question 5: Do the already existing regional proposals towards the smart specialization strategy take into account the specialization patterns coming from a general comparison with the other EU regions?

No, most of them do not. The analyzed proposals aim to show which are the priorities chosen, but most of them center their study on an indoors perspective, more than on a comparison with other regions and states. Even if some of the proposals do take a look at some other regions to compare capacities, it is extremely important that final strategies consider a global framework when establishing priorities. Experts designed by the European Commission should also put more pressure to regional agencies defining the strategies so they take it into account.

Research question 6: Does specialization seem to be the right policy for the EU regions or diversification would become a more certain bet?

It is not clear enough. In our study, as well as in the literature and the experts' opinion, we could find arguments to defend specialization as the proper way to prioritize some key fields and sectors in which a region can achieve excellence. However, arguments in favor to diversify as much as possible also exist and they are logic, relevant and empirical-based. Academics behind the concept of smart specialization insist in the fact that it is not a policy aiming to focus only in some specific sectors, but to promote the most relevant ones for each region. Nevertheless, we should evaluate how ready is Europe and its regions (understood as all the agents developing their activities in them) to accept the opportunity cost behind smart specialization, even in those cases in which the specialization patterns are not that clear or that significant. Is the EU ready to specialize? The most logic answer is that, before doing so, the general structure related to innovation should still evolve towards a system in which smart specialization can be a process more than a medium-run goal.

5.1.4. Contrast of propositions

The contrast of propositions becomes the corollary of our work and the whole thesis. Arguments used to evaluate them must be then considered then as the main conclusions.

Proposition 1: There are some specialization trends in the EU regions regarding their scientific and industrial activities but, in most of the cases, they are not significant enough.

We have proven this proposition. Following chapter 2's conclusions, we have seen that, even if data bases should be improved to find less biased results, it is possible to identify specialization patterns. However, they do not seem to be significant enough in most of the cases, when we aim to use the indexes to define leaders and followers, given that they present large differences among them.

Proposition 2: It is possible to establish leaders and followers for every scientific field and industrial sector, but there exist many biases to be taken into account.

We have proven this proposition. As we have seen in chapter 2, for each scientific field and industrial sector we are able to identify leaders (higher indexes) and follower (lower indexes). However, for some fields and sectors this distinction is so clear, while in others deviations of the indexes are not large enough to talk about robust results.

Proposition 3: There is not a large correlation between the scientific production in some fields for a region and the industrial sectors to which these fields should be linked to.

We have proven this proposition. As we concluded in section 2.3, there are some logical correlations between scientific fields and industrial sectors in the same knowledge and innovation area, but these correspondences are not large neither consistent.

Proposition 4: Specialization patterns are biased by concentration, since for both scientific and industrial activities, indexes are high.

We have proven this proposition. Concentration is present in all scientific fields and industrial sectors, and their indexes are rather high, above 0.5 (Gini index) in most cases and in average. Even if we do not talk about extra-large indexes, concentration is a fact, and concentration biases specialization, since they are two linked concepts which always present very large rates of correlation, as it was mentioned in chapter 1's state of art.

Proposition 5: Larger regions (in absolute terms) present lower indexes of specialization, meaning they have a larger rate of diversification.

We have proven this proposition. As it has been mentioned different times in some sections of the thesis, smaller regions seem to be more specialized than larger. This fact has its own logic, for they are more complex and they have a larger number of agents working in many different fields and sectors.

Proposition 6: Regional institutions are, in general, aligned to the patterns of regional specialization, when we consider them as a whole.

We have partially proved this proposition. From an aggregated point of view, and following chapter 3's analyses, we can say that, in general, there is a correlation between the identified specialization patterns and the characteristics of the institutions when we consider them from a general overview, but more information on the characteristics and particularities of these institutions would be needed in order to provide with better conclusions.

Proposition 7: Even if, as a whole, regions are in general ready to implement a smart specialization strategy, individual regional institutions are still far from being aligned to its main goals.

We have proved this proposition. In chapter 3's regional analyses, we have identified that if we aim to analyze institutions from a micro level, we see that they are still far from being aligned to a strategy in which they should grow under the established priorities, and the entrepreneurial discovery process do not seem to be related to them either. It will not be easy to introduce the concept and the policy to these individual entities. Regarding the agencies in charge of promoting innovation, we can say that their alignment to the strategy differs a lot from one region to another.

Proposition 8: Designs of regional smart specialization strategies can easily incorporate some priorities based on cross-border analyses on scientific and industrial activities.

We have partially proved this proposition. Even if it is true that, from a general overview based on the comparison of all regions, some leaders, followers and, therefore, priorities can be established, it is not that easy to incorporate them in the different strategies, for many other variables (regional structures, agents, other data, etc.) must be taken into account, as we have seen.

Proposition 9: Smart specialization, when analyzed from a top-down perspective, taking into account the specialization patterns, seems to be able promote efficiency in front of diversification in the EU regions, according to the existing trends and the framework in which it will operate.

We have partially proved this proposition. Under the logic of the smart specialization strategy, defining some priorities, considering the specialization patterns, seems to have its logic when we talk about the improvement of efficiency, more than when promoting diversification. However, it is still not clear up to which point specialization in the best option, and our work do not present results that are robust enough to defend one concept in front of the other.

5.2. Top-down suitability of the smart specialization

5.2.1. Evaluation of the potential top-down establishment of priorities

As an academic concept, smart specialization strategy is based on the entrepreneurial discovery process, as it was presented in chapter 1. In this direction, agents involved in science, technology, industrial activities and, in more general terms innovation, should be in charge of identifying those specialization areas and fields in which a region should grow excellence and focus towards an integrated European framework. These agents are expected to provide the key of the definition of the regional strategies and, in most cases, proposals for the implementation of the policy at a regional level consider their opinion through consultations, working groups and other tools that have supported the implementation of this entrepreneurial discovery process.

However, those in charge of defining the regional strategy, and thus gather the information they obtain to identify priorities, are, in most cases, the regional administrations. Having them the last word, the top-down approach becomes also a fact. Even if the entrepreneurial discovery process is essential, the analysis of the aggregated data to identify patterns that may lead to support in the identification of priorities is also indispensable it the strategies aim to be based on objective information.

In some cases, the priorities identified through the entrepreneurial discovery process and the evaluation of the existing data may differ. Choosing is always tricky and it may lead to some doubts when results do not match. In this case a question appears: what is more appropriate, to follow the results coming from the entrepreneurial point of view or rely on the available information that public administrations could use to define the strategy?

Experts and academics of the concept have stated that a mix of both is required to establish the right priorities, but many other factors also affect besides these two, including political pressures coming from strategic industrial agents like large corporations, diversity on the critical mass, etc. In this context, many variables are to be identified and taken into account, making more difficult the implementation of a top-down approach to the strategy.

After all our study through its four chapters, aiming to focus more in the top-down perspective than in the bottom-up one, we can establish some conclusions coming from the our learnings: (i) a homogeneous top-down perspective cannot be implemented in all strategies' definition given the large disparities among the regions, (ii) objective data on scientific and industrial activities is not consistent enough to follow an exclusive top-down approach based on the information obtained by the public agencies in charge of defining the strategy, (iii) there are many biases affecting data that can be used to identify trends and consequent priorities, while institutions are also very diverse in their structures, which becomes a large complication for designing strategies following an objective top-down methodology, and (iv) a mix of bottom-up and top-down perspectives seems to be the right solution since none of them alone appear to be appropriate enough by themselves alone.

5.2.2. From the definition to the implementation

Our work has been mostly focused on the analysis of the specialization patterns of the EU regions in a framework in which the strategies were being defined. However, even if a proper definition is essential in this context, the implementation will be even more complex given the large number of parameters that we have been discussing along the four previous chapters, regarding the large differences among the regions, the existent biases, etc.

A question that arises is whether the priorities identified under the logic of the smart specialization strategies are those in which the region should invest the most. Many experts and policy makers have expressed their doubts under the question 'what if we chose wrong?'. Apparently, the policy does not intend to be a closed instrument, but an adaptable one which should be able to be adjusted if evidence shows that other priorities or strategies must be chosen. However, agencies in charge or defining the policy do not want to be mistaken, as it may seem obvious, but I could have led through a less-desirable path in which many region aim to specialize in as many fields and sectors as possible, instead of establishing more concrete priorities.

In any case, with right or wrong priorities, it is time to implement the regional strategies for the present period. First calls on structural funds under the context of the policy are expected to be launched in late 2014 and regions should be ready to take their strategies and apply them. However, implementation initiatives are still vague, and the Commission should now be more active on giving enough tools to the regions so they can properly develop the policy. Another problem will then appear: monitoring the implementation of the different strategies to be able to evaluate whether it is effective or not, given the main objectives that were ex-ante fixed.

In the end, identifying specialization patterns and priorities has no sense if the results coming from the implementation do not prove that these patterns were significant and the policy, once implemented, really reaches the targeted goals.

5.2.3. The smart specialization strategy in the long run. Smart versus stupid

Most likely, we will not be able to extract clear conclusion regarding the policy in the short run. Its implementation's methodology is crucial, of course, but empirical results will not be able in the next months or years, and we will need to wait until the strategies are completely structured and developed in the European regions.

The main question remains: will smart specialization lead to more efficient systems of innovation, science, technology and industry? We have seen that specialization patterns are there, and that it is possible to identify leaders (which should develop key enabling technologies) and followers (which should focus more on applications), but this do not prove that specialization is necessarily better than diversification, or that by establishing a mechanism based on the election of some priorities, a more efficient system is guaranteed.

What would happen if, after some years, it is found that the policy has not led to an improvement of the European capacities for science, industry and innovation in general? It is important to underline here that we have seen many different regional contexts and many diverse structures that will require to be taken into account when each region implements their own strategy. Additionally, as we have also said, one of the goals of the policy is the cooperation among the European regions, and up to now a mechanism has not yet been established to achieve that purpose. We must also remember that many people believe that the market itself should decide whether specialization or diversification is the right choice. In the end, experts and policy makers do not adapt the framework to the basic requirements for the proper development of the policy, there is an important risk: switching from a smart to a stupid specialization strategy.

5.3. Next steps and further research

There is still a long way to run. We find ourselves at the very beginning of the development of the smart specialization strategy. As we have already said, it is now time to focus on the implementation instead of the definition. However, some steps must still be taken towards a better system to establish priorities according to the specialization trends.

Further research is also needed, especially now that strategies will be developed. In this context, we have identified five main fields for further research:

i) *Theoretical models around the concept of smart specialization strategy:* all studies linked to this concept (including our work) are based on empirical approaches, but a theoretical framework should also be provided to contrast theory and empirical results.

iI) *More empirical studies to determine specialization patterns:* even if there is already some literature evaluating the specialization trends in the EU (including our work), more research should be undertaken, improving data bases in order to achieve more consistent results.

iiI) *Indicators' improvement:* the lack of concrete indicators to measure efficiency in the framework of specialization is a problem that requires to be overcome towards the analysis of the policy and its implementation. Better proxies are then required to study the economic implications of the strategy.

iv) *Monitoring the implementation*: studies about the implementation of the different regional strategies should be undertaken, focusing in an organizational way, in order to identify best practices that can help other regions.

v) *Suitability of the smart specialization strategy in the different regional innovation strategies:* smart specialization is to be introduced in all innovation strategies at a European level; however, not much has been yet studied about how this policy can fit in the different organizational systems that exist for different regions. It should be evaluated if some changes should be introduced in the concept so it adapts to different regional innovation strategies.

We began our study by saying that 'five years ago, smart specialization was an unknown and abstract concept that was appearing for the very first time (…)'. On the other hand, what will happen in five years? It is expected that the policy will be already implemented and all those grey issues that still present some doubts will be already clarified. In any case, only though a constant and complete academic study of the concept, we will be able to evaluate whether the strategy leads to more efficient systems or not.

The logic seems clear enough, the first steps walked. Now it is time to provide all the tools that are required to implement the strategy, including a proper mechanism to coordinate regions' actions to interconnect them, promote their collaboration and ensure that the goals of the smart specialization strategy, which are very logic, reasonable, and even necessary, are accomplished.

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http://www.electroluxappliances.com/
http://www.hexagon.com/en/index.htm
http://suls.se/
http://en.kista.com
http://www.stockholm-life.se/en/

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http://www.4icu.org/nl/
http://www.thehagueuniversity.com/
http://www.hogeschoolrotterdam.nl/

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http://www.apmterminals.com/
http://www.boskalis.com/home.html
http://www.archirodon.net/
http://www.arcelormittalna.com/index.htm
http://www.shell.com/
http://www.fugro.com/
http://www.maritimebyholland.com/

ANNEXES

Annex A. Lists on absolute and relative advantage for European regions in scientific capacities and industrial activities

A.1. Lists on scientific capacities

A.1.1. Top 10% regions performing research in agriculture, food sciences and fisheries (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Île-de-France (France)	❖ Nyugat-Dunántúl (Hungary)
❖ Gelderland (Netherlands)	❖ Warminsko-Mazurskie (Poland)
❖ Andalucía (Spain)	❖ Algarve (Portugal)
❖ Hovedstaden (Denmark)	❖ Alentejo (Potugal)
❖ Border, Midland and Western (Ireland)	❖ Gelderland (Netherlands)
❖ Catalunya (Spain)	❖ Extremadura (Spain)
❖ Comunidad Valenciana (Spain)	❖ Región de Murcia (Spain)
❖ Midtjylland (Denmark)	❖ Midtjylland (Denmark)
❖ Baden-Württemberg (Germany)	❖ Castilla-la-Mancha (Spain)
❖ Prov. Oost-Vlaanderen (Belgium)	❖ Jihozápad (Czech Republic)
❖ Comunidad de Madrid (Spain)	❖ Közép-Danúntúl (Hungary)
❖ Emilia-Romagna (Italy)	❖ Andalucía (Spain)
❖ Lombardia (Italy)	❖ Észak-Alföld (Hungary)
❖ Scotland (United Kingdom)	❖ Castilla y León (Spain)
❖ Bayern (Germany)	❖ Bourgogne (France)
❖ Prov. Vlaams-Brabant (Belgium)	❖ Puglia (Italy)
❖ Niedersachsen (Germany)	❖ Comunidad Foral de Navarra (Spain)

A.1.2. Top 10% regions performing research in biology sciences, biotechnology and biomedicine (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Île-deFrance (France)	❖ Salzburg (Austria)
❖ London (United Kingdom)	❖ Sothern and Eastern (Ireland)
❖ Bayern (Germany)	❖ Groningen (Netherlands)
❖ Baden-Württemberg (Germany)	❖ Alsace (France)
❖ Scotland (United Kingdom)	❖ Dél-Dunántúl (Hungary)
❖ South East (United Kingdom)	❖ Nyugat-Dunántúl (Hungary)
❖ Nordrhein-Westfalen (Germany)	❖ Languedoc-Roussillon (France)
❖ Hovedstaden (Denmark)	❖ Syddanmark (Denmark)
❖ East of England (United Kingdom)	❖ Provence-Alpes-Côte d'Azur (France)
❖ Catalunya (Spain)	❖ Gelderland (Netherlands)
❖ Lombardia (Italy)	❖ Midtjylland (Denmark)
❖ Stockholm (Sweden)	❖ Észak-Alföld (Hungary)
❖ North West (United Kingdom)	❖ Scotland (United Kingdom)
❖ Etelä-Suomi (Finland)	❖ Sachsen-Anhalt (Germany)
❖ Zuid-Holland (Netherlands)	❖ Podlaskie (Poland)
❖ Yorkshire and The Humber (United Kingdom)	❖ Óstra Mellansverige (Sweden)
❖ Border, Midland and Western (Ireland)	❖ Marche (Italy)

A.1.3. Top 10% regions performing research in chemistry (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Île-deFrance (France)	❖ Severovýchod (Czech Republic)

❖ Nordrhein-Westfalen (Germany)	❖ Lubelskie (Poland)
❖ Bayern (Germany)	❖ Nord-Vest (Romania)
❖ Baden-Württemberg (Germany)	❖ Zachodniopomorskie (Poland)
❖ South East (United Kingdom)	❖ Bretagne (France)
❖ Catalunya (Spain)	❖ Közép-Dunántúl (Hungary)
❖ Praha (Czech Republic)	❖ Alsace (France)
❖ Mazowieckie (Poland)	❖ Prov. Hainaut (Belgium)
❖ Rhône-Alpes (France)	❖ Wielkopolskie (Poland)
❖ London (United Kingdom)	❖ Dolnoslaskie (Poland)
❖ Scotland (United Kingdom)	❖ Vest (Romania)
❖ Comunidad Valenciana (Spain)	❖ Yugozapaden (Bulgaria)
❖ Andalucía (Spain)	❖ Kujawsko-Pomorskie (Poland)
❖ Comunidad de Madrid (Spain)	❖ Galicia (Spain)
❖ Lombardia (Italy)	❖ Dél-Alföld (Hungary)
❖ Emilia-Romagna (Italy)	❖ Centro (Portugal)
❖ East of England (United Kingdom)	❖ Bucaresti-Ilfov (Romania)

A.1.4. Top 10% regions performing research in ICTs, Computing and Imaging (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Île de France (France)	❖ Nordjylland (Denmark)
❖ London (United Kingdom)	❖ Voreio Aigaio (Greece)
❖ Baden-Württemberg (Germany)	❖ Lubuskie (Poland)
❖ Bayern (Germany)	❖ Kypros (Cyprus)
❖ South East (United Kingdom)	❖ Nord-Vest (Romania)
❖ Scotland (United Kingdom)	❖ Noord-Brabant (Netherlands)
❖ Nordrhein-Westfalen (Germany)	❖ Overijssel (Netherlands)
❖ Lombardia (Italy)	❖ Prov. Limburg (Belgium)
❖ Comunidad de Madrid (Spain)	❖ Dytiki Ellada (Greece)
❖ Catalunya (Spain)	❖ Anatoliki Makedonia, Thraki (Greece)
❖ Hovedstaden (Denmark)	❖ Oberösterreich (Austria)
❖ Noord-Holland (Netherlands)	❖ Castilla-la-Mancha (Spain)
❖ Zuid-Holland (Netherlands)	❖ Sud-Vest Oltenia (Romania)
❖ Prov. Vlaams-Brabant (Belgium)	❖ Franche-Comté (France)
❖ Lazio (Italy)	❖ Comunidad Valenciana (Spain)
❖ Comunidad Valenciana (Spain)	❖ Moravskoslezsko (Poland)
❖ Wales (United Kingdom)	❖ Bourgogne (France)

A.1.5. Top 10% regions performing research in physics, astrophysics and energy (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Île-de-France (France)	❖ Lazio (Italy)
❖ Lazio (Italy)	❖ Prov. Hainaut (Belgium)
❖ Nordrhein-Westfalen (Germany)	❖ Canarias (Spain)
❖ Baden-Württemberg (Germany)	❖ Oberösterreich (Austria)
❖ South East (United Kingdom)	❖ Illes Balears (Spain)
❖ London (United Kingdom)	❖ Latvija (Latvia)
❖ Bayern (Germany)	❖ Rhône-Alpes (France)
❖ Rhône-Alpes (France)	❖ Rheinland-Pfalz (Germany)
❖ Scotland (United Kingdom)	❖ Auvergne (France)
❖ East of England (United Kingdom)	❖ Bratislavský kraj (Slovakia)
❖ Mazowieckie (Poland)	❖ Cantabria (Spain)
❖ Praha (Czech Republic)	❖ Mazowieckie (Poland)
❖ Catalunya (Spain)	❖ Yugozapaden (Bulgaria)

❖ North West (United Kingdom) ❖ Lombardia (Italy) ❖ Comunidad de Madrid (Spain) ❖ Toscana (Italy)	❖ Umbria (Italy) ❖ Bucaresti-Ilfov (Romania) ❖ Malopolskie (Poland) ❖ Vzhodna Slovenija (Slovenia)

A.1.6. Top 10% regions performing research in environment and sustainability (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Île-de-France (France)	❖ Alentejo (Portugal)
❖ Scotland (United Kingdom)	❖ Bremen (Germany)
❖ London (United Kingdom)	❖ Algarve (Portugal)
❖ South East (United Kingdom)	❖ Voreio Aigaio (Greece)
❖ Baden-Württemberg (Germany)	❖ Brandenburg (Germany)
❖ Catalunya (Spain)	❖ Eesti (Estonia)
❖ Nordrhein-Westfalen (Germany)	❖ Jihozápad (Czech Republic)
❖ Yorkshire and The Humber (United Kingdom)	❖ Salzburg (Austria)
❖ East of England (United Kingdom)	❖ Warminsko-Mazurskie (Poland)
❖ Andalucía (Spain)	❖ Sjælland (Denmark)
❖ Hovedstaden (Denmark)	❖ Basilicata (Italy)
❖ Bayern (Germany)	❖ Scleswig-Holstein (Germany)
❖ Wales (United Kingdom)	❖ Auvergne (France)
❖ Toscana (Italy)	❖ Southern and Eastern (Ireland)
❖ South West (United Kingdom)	❖ Centru (Romania)
❖ Etelä-Suomi (Finland)	❖ Illes Balears (Spain)
❖ Gelderland (Netherlands)	❖ Andalucía (Spain)

A.1.7. Top 10% regions performing research in medical sciences (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ London (United Kigndom)	❖ Limburg (Netherlands)
❖ Île-de-France (France)	❖ Dél-Dunántúl (Hungary)
❖ Bayern (Germany)	❖ Syddanmark (Denmark)
❖ Baden-Württemberg (Germany)	❖ Noord-Holland (Netherlands)
❖ Lombardia (Italy)	❖ Utrech (Netherlands)
❖ Nordrhein-Westfalen (Germany)	❖ Abruzzo (Italy)
❖ Hovedstaden (Denmark)	❖ Stockholm (Sweden)
❖ Noord-Holland (Netherlands)	❖ Tirol (Austria)
❖ Zuid-Holland (Netherlands)	❖ Zuid-Holland (Netherlands)
❖ Stockholm (Sweden)	❖ Groningen (Netherlands)
❖ Catalunya (Spain)	❖ Lombardia (Italy)
❖ South East (United Kingdom)	❖ Itä-Suomi (Finland)
❖ Scotland (United Kingdom)	❖ London (United Kingdom)
❖ Lazio (Italy)	❖ Hovedstaden (Denmark)
❖ Berlin (Germany)	❖ Västsvergie (Sweden)
❖ Prov. Vlaams-Brabant (Belgium)	❖ Sydsverige (Sweden)
❖ Niedersachsen (Germany)	❖ Rheinland-Pfalz (Germany)

A.1.8. Top 10% regions performing research in mathematics (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Île-de-France (France)	❖ Sud-Vest Oltenia (Romania)
❖ Nordrhein-Westfalen (Germany)	❖ Lubuskie (Poland)
❖ London (United Kingdom)	❖ Nord-Vest (Romania)
❖ South East (United Kingdom)	❖ Vest (Romania)

❖ Catalunya (Spain) ❖ Andalucía (Spain) ❖ Baden-Württemberg (Germany) ❖ Lombardia (Italy) ❖ Scotland (United Kingdom) ❖ Comunidad de Madrid (Spain) ❖ Lazio (Italy) ❖ Bayern (Germany) ❖ Praha (Czech Republic) ❖ Toscana (Italy) ❖ Prov. Vlaams-Brabant (Belgium) ❖ North West (United Kingdom) ❖ Berlin (Germany)	❖ Voreio Aigaio (Greece) ❖ Oberösterreich (Austria) ❖ Podkarpackie (Poland) ❖ Prov. Limburg (Belgium) ❖ Bucaresti-Ilfov (Romania) ❖ Kypros (Cyprus) ❖ Basse-Normandie (France) ❖ Nord – Pas-de-Calais (France) ❖ Southern and Eastern (Ireland) ❖ Vzhodna Slovenija (Slovenia) ❖ France-Comté (France) ❖ Kujawsko-Pomorskie (Poland) ❖ Nord-Est (Romania)

A.1.9. Top 10% regions performing research in materials sciences (2007-2011) in absolute and relative terms

Absolute Advantage	**Comparative Advantage**
❖ Île-de-France (France) ❖ Nordrhein-Westfalen (Germany) ❖ Baden-Württemberg (Germany) ❖ Bayern (Germany) ❖ South East (United Kingdom) ❖ Rhône-Alpes (France) ❖ London (United Kingdom) ❖ Mazowieckie (Poland) ❖ Praha (Czech Republic) ❖ Yorkshire and The Humber (United Kingdom) ❖ East of England (United Kingdom) ❖ Scotland (United Kingdom) ❖ North West (United Kingdom) ❖ Hessen (Germany) ❖ Prov. Vlaams-Brabant (Belgium) ❖ Comunidad de Madrid (Spain) ❖ Catalunya (Spain)	❖ Nord-Est (Romania) ❖ Severovýchod (Czech Republic) ❖ Podkarpackie (Poland) ❖ Latvija (Latvia) ❖ Prov. Hainaut (Belgium) ❖ Overijssel (Netherlands) ❖ Vest (Romania) ❖ Bucaresti-Ilfov (Romania) ❖ Yugozapaden (Bulgaria) ❖ Oberösterreich (Austria) ❖ Centru (Romania) ❖ Dytiki Ellada (Greece) ❖ Centro (Portugal) ❖ Lietuva (Lithuania) ❖ Nord-Vest (Romania) ❖ Moravskolezsko (Czech Republic) ❖ Vzhodna Slovenija (Slovenia)

A.1.10. Top 10% regions performing research in animal sciences (2007-2011) in absolute and relative terms

Absolute Advantage	**Comparative Advantage**
❖ Scotland (United Kingdom) ❖ Île-de-France (France) ❖ Hovedstaden (Denmark) ❖ Prov. Oost-Vlaanderen (Belgium) ❖ South West (United Kingdom) ❖ London (United Kingdom) ❖ Bayern (Germany) ❖ Catalunya (Spain) ❖ Utrecht (Netherlands) ❖ Lombardia (Italy) ❖ East of England (United Kingdom) ❖ Berlin (Germany) ❖ Wien (Austria) ❖ Hessen (Germany) ❖ North West (United Kingdom) ❖ South West (United Kingdom)	❖ Nyugat-Danántúl (Hungary) ❖ Warminsko-Mazurskie (Poland) ❖ Región de Murcia (Spain) ❖ Jihozápad (Czech Republic) ❖ Prov. Liège (Belgium) ❖ Thessalia (Greece) ❖ Prov. Oost-Vlaanderen (Belgium) ❖ Alentejo (Portugal) ❖ Utrecht (Netherlands) ❖ South West (United Kingdom) ❖ Strední Morava (Czech Republic) ❖ Scotland (United Kingdom) ❖ Extremadura (Spain) ❖ Lietuva (Lithuania) ❖ Sardegna (Italy) ❖ Marche (Italy)

❖ Border, Midland and Western (Ireland)	❖ Dolnoslaskie (Poland)

A.1.11. Top 10% regions performing research in physiology and pharmacology (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Île-de-France (France)	❖ Dél-Alföld (Hungary)
❖ London (United Kingdom)	❖ Marche (Italy)
❖ Hovedstaden (Denmark)	❖ Abruzzo (Italy)
❖ Nordrhein-Westfalen (Germany)	❖ Podlaskie (Poland)
❖ Bayern (Germany)	❖ Sardegna (Italy)
❖ Baden-Württemberg (Germany)	❖ Saarland (Germany)
❖ Lombardia (Italy)	❖ Limburg (Netherland)
❖ Toscana (Italy)	❖ Sachsen-Anhalt (Germany)
❖ Emilia-Romagna (Italy)	❖ Dél-Dunántúl (Hungary)
❖ Scotland (United Kingdom)	❖ Lubelskie (Poland)
❖ Prov. Vlaams-Brabant (Belgium)	❖ Comunidad Foral de Navarra (Spain)
❖ Lazio (Italy)	❖ Syddanmark (Denmark)
❖ Catalunya (Spain)	❖ Haute-Normandie (France)
❖ South East (United Kingdom)	❖ Itä-Suomi (Finland)
❖ Berlin (Germany)	❖ Sicilia (Italy)
❖ Stockholm (United Kingdom)	❖ Campania (Italy)
❖ Praha (Czech Republic)	❖ Hovedstaden (Demark)

A.1.12. Top 10% regions performing research in engineering (2007-2011) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ London (United Kingdom)	❖ Centru (Romania)
❖ Île-de-France (France)	❖ Moravskoslezsko (Czech Republic)
❖ South East (United Kingdom)	❖ Nordjylland (Denmark)
❖ Scotland (United Kingdom)	❖ Zachodniopomorskie (Poland)
❖ Zuid-Holland (Netherlands)	❖ Podkarpackie (Poland)
❖ Lombardia (Italy)	❖ Noord-Brabant (Netherlands)
❖ Baden-Württemberg (Germany)	❖ Vzhodna-Slovenija (Slovenia)
❖ Nordrhein-Westfalen (Germany)	❖ Overijssel (Netherlands)
❖ East of England (United Kingdom)	❖ Sud-Vest Oltenia (Romania)
❖ Lazio (Italy)	❖ Lietuva (Lithuania)
❖ Yorkshire and The Humber (United Kingdom)	❖ Poitou-Charentes (France)
❖ Catalunya (Spain)	❖ Kypros (Cyprus)
❖ Comunidad de Madrid (Spain)	❖ Vest (Romania)
❖ Wales (United Kingdom)	❖ Cantabria (Spain)
❖ North West (United Kingdom)	❖ Anatoliki Makedonia, Thraki (Greece)
❖ Hovedstaden (Denmark)	❖ Lorraine (France)
❖ Bayern (Germany)	❖ Dytiki Ellada (Greece)

A.1.13. List of regions according to their specialization in research for the period 2007 – 2011 (in brackets the Balassa index for that region and research field)

Agriculture, Food Sciences and Fisheries	Biology Sciences, Biotechnology, Biomedicine
Mitjylland (Denmark) – 3.46	Baden-Württemberg (Germany) – 1.15
Schleswig-Holstein (Germany) – 2.59	Bayern (Germany) – 1.17
Iperios (Greece) – 1.58	Niedersachsen (Germany) – 1.17
Comunidad Foral de Navarra (Spain) – 2.63	Provence-Alpes-Côte d'Azur (France) – 1.37
Aragón (Spain) – 2.61	South East (United Kingdom) – 1.20
Castilla y León (Spain) – 2.86	

Castilla-la-Mancha (Spain) – 3.22 Extremadura (Spain) – 3.91 Catalunya (Spain) – 1.47 Andalucía (Spain) – 2.87 Bourgogne (France) – 2.85 Emilia-Romagna (Italy) – 1.59 Puglia (Italy) – 2.65 Sicilia (Italy) – 1.67 Közep-Dunántúl (Hungary) – 3.13 Észak-Alföld (Hungary) – 2.87 Gelderland (Netherlands) – 4.08 Norte (Portugal) – 2.20 Algarve (Portugal) – 5.06 Alentejo (Portugal) – 4.20	

Chemistry	ICTs, Computing and Imaging
Yugozapaden (Bulgaria) – 1.94 Praha (Czech Republic) – 1.52 Severovýchod (Czech Republic) – 4.69 Mecklenburg-Vorpommern (Germany) – 1.60 Galicia (Spain) – 1.87 Comunidad Valenciana (Spain) – 1.70 Alsace (France) – 2.18 Bretagne (France) – 2.32 Aquitaine (France) – 1.66 Dél-Alföld (Hungary) – 1.85 Malopolskie (Poland) – 1.46 Lubelskie (Poland) – 2.56 Wielkopolskie (Poland) – 2.04 Pomorskie (Poland) – 1.54	Région de Bruxelles-Capitale (Belgium) – 1.33 Prov. Vlaams-Brabant (Belgium) – 1.26 Nordjylland (Denamrk) – 3.76 Border, Midland and Western (Ireland) – 1.26 Voreio Aigaio (Greece) – 3.56 Comunidad de Madrid (Spain) – 1.49 Luxembourg (Luxembourg) – 1.25 Länsi-Suomi (Finland) – 1.29 Northern Ireland (United Kingdom) – 1.29

Physics, Astrophysics and Energy	Environment and Sustainability
Nordrhein-Westfalen (Germany) – 1.25 Rheinland-Pfalz (Germany) – 1.57 Illes Balears (Spain) – 1.81 Canarias (Spain) – 1.93 Île-de-France (France) – 1.33 Midi-Pyrénées (France) – 1.27 Rhône-Alpes (France) – 1.59 Piemonte (Italy) – 1.23 Umbria (Italy) – 1.47 Lazio (Italy) – 2.20 Mazowieckie (Poland) – 1.49	Sjælland (Denmark) – 2.25 Bradenburg (Germany) – 2.85 Bremen (Germany) – 3.63 Hamburg (Germany) – 1.52 Eesti (Estonia) – 2.54 Auvergne (France) – 2.06 Languedoc-Roussillon (France) – 1.69 Salzburg (Austria) – 2.35 Etelä-Sumoi (Finland) – 1.32 Pohjois-Suomi (Finland) – 1.65 Övre Norrland (Sweden) – 1.70 North East (United Kingdom) – 1.68 Yorkshire and The Humber (U. Kingdom) – 1.55 East of England (United Kingdom) – 1.31 Wales (United Kingdom) – 1.46

Medical Sciences	Mathematics
Syddanmark (Denmark) – 1.95 Liguria (Italy) – 1.36 Lombardia (Italy) – 1.59 Veneto (Italy) – 1.38 Fruli-Venezia Giulia (Italy) – 1.31 Dél-Dunántúl (Hungary) – 2.16 Groningen (Netherlands) – 1.63 Noord-Holland (Netherlands) – 1.80	Prov. Limburg (Belgium) – 2.78 Southern and Eastern (Ireland) – 2.59 Basse-Normandie (France) – 2.61 Nord – Pas-de-Calais (France) – 2.60 Franche-Comté (France) – 2.47 Basilicata (Italy) – 2.24 Kypros (Cyprus) – 2.67 Közép-Magyarország (Hungary) – 1.55

Zuid-Holland (Netherlands) – 1.63 Limburg (Netherlands) – 2.92 Tirol (Austria) – 1.63 Stockholm (Sweden) – 1.65 Sydsverige (Sweden) – 1.43 Västsverige (Sweden) – 1.45 London (United Kingdom) – 1.51	Oberösterreich (Austria) – 3.04 Lubuskie (Poland) – 6.18 Kujawsko-Pomorskie (Poland) – 2.33 Lisboa (Portugal) – 1.59 Nord-Vest (Romania) – 3.71 Bucaresti – Ilfov (Romania) – 2.68 Sud-Vest Oltenia (Romania) – 6.18 Vest (Romania) – 3.59 Východné Slovensko (Slovakia) – 1.96 West Midlands (United Kingdom) – 1.49

Materials Sciences	Animals Sciences
Prov. Hainaut (Belgium) – 2.99 Thüringen (Germany) – 1.72 Dytiki Ellada (Greece) – 2.18 País Vasco (Spain) – 1.93 Haute-Normandie (France) – 1.82 Lorraine (France) – 2.08 Pays de la Loire (France) – 1.79 Latvija (Latvia) – 3.05 Steiemark (Austria) – 1.33 Lódzkie (Poland) – 1.82 Slaskie (Poland) – 2.03 Podkarpackie (Poland) – 3.23 Centro (Portugal) – 2.13 Nord-Est (Romania) – 4.89 Zahodna Slovenija (Slovenia) – 1.91 Bratislavský kraj (Slovakia) – 1.75	Prov. Antwepen (Belgium) – 1.84 Prov. Oost-Vlaanderen (Belgium) – 3.41 Prov. Liège (Belgium) – 3.91 Jihozápad (Czech Republic) – 4.07 Jihovýchod (Czech Republic) – 1.90 Stední Morava (Czech Republic) – 2.34 Berlin (Germany) – 1.52 Hessen (Germany) – 1.50 Sachsen (Germany) – 1.48 Kentriki Makedonia (Greece) – 1.59 Thessalia (Greece) – 3.85 Región de Murcia (Spain) – 4.29 Centre (France) – 1.58 Nyugat-Dunántúl (Hungary) – 14.44 Utrecht (Netherlands) – 2.62 Wien (Austria) – 1.51 Dolnoslaskie (Poland) – 1.94 Warminsko-Mazurskie (Poland) – 12.48 South West (United Kingdom) – 2.51 Scotland (United Kingdom) – 2.22

Physiology and Pharmacology	Engineering
Hovedstaden (Denmark) – 1.57 Saarland (Germany) – 1.92 Sachsen-Anhalt (Germany) – 1.90 Toscana (Italy) – 1.57 Marche (Italy) – 2.19 Abruzzo (Italy) – 2.17 Campania (Italy) – 1.61 Sardegna (Italy) – 2.10 Podlaskie (Poland) – 2.10 Itä-Suomi (Finland) – 1.75 Östra Mellansverige (Sweden) – 1.32	Moravskoslezsko (Czech Republic) – 3.53 Anatoliki Makedonia, Thraki (Greece) – 2.14 Attiki (Greece) – 1.51 Kriti (Greece) – 1.29 Cantabria (Spain) – 2.25 Poitou-Charentes (France) – 2.40 Calabria (Italy) – 1.80 Lietuva (Lithuania) – 2.44 Overijssel (Netherlands) – 2.61 Noord-Brabant (Netherlands) – 2.67 Zachodniopomorskie (Poland) – 3.19 Centru (Romania) – 4.34 Vzhodna Slovenija (Slovenia) – 2.65 North West (United Kingdom) – 1.24 East Midlands (United Kingdom) – 1.55

A.2. Lists on industrial activities

A.2.1. Top 10% regions in the industrial sectors of food and beverages (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Bayern (Germany)	❖ Iperios (Greece)
❖ Nordrhein-Westfalen (Germany)	❖ Peloponnisos (Greece)
❖ Catalunya (Spain)	❖ Thessalia (Greece)
❖ Lombardia (Italy)	❖ Kentriki Makedonia (Greece)
❖ Baden-Württemberg (Germany)	❖ Alentejo (Portugal)
❖ Emilia-Romagna (Italy)	❖ Kriti (Greece)
❖ Mazowieckie (Poland)	❖ Dél-Alföld (Hungary)
❖ Wielkopolskie	❖ Dytiki Ellada (Greece)
❖ Andalucía (Spain)	❖ Lubelskie (Poland)
❖ Lietuva (Lithuania)	❖ Podlaskie (Poland)
❖ Scotland (United Kingdom)	❖ Border, Midland and Western (Ireland)
❖ Veneto (Italy)	❖ La Rioja (Spain)
❖ Slaskie (Poland)	❖ Macklenburg-Vorpommern (Germany)
❖ Castilla y León (Spain)	❖ Sterea Ellada (Greece)
❖ Piemonte (Italy)	❖ Syddanmark (Denmark)
❖ South West (United Kingdom)	❖ Región de Murcia (Spain)
❖ Hessen (Germany)	❖ Voreio Aigaio (Greece)

A.2.2. Top 10% regions in the industrial sectors of textile, leather and wearing (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Norte (Portugal)	❖ Norte (Portugal)
❖ Lombardia (Italy)	❖ Severozapaden (Bulgaria)
❖ Toscana (Italy)	❖ Yuzhen Tsentralen (Bulgaria)
❖ Veneto (Italy)	❖ Marche (Italy)
❖ Lódzkie (Poland)	❖ Toscana (Italy)
❖ Marche (Poland)	❖ Severen Tsentralen (Bulgaria)
❖ Emilia-Romagna (Italy)	❖ Lódzkie (Poland)
❖ Nord-Vest (Romania)	❖ Nord-Est (Romania)
❖ Yugozapaden (Bulgaria)	❖ Vest (Romania)
❖ Centru (Romania)	❖ Nord-Vest (Romania)
❖ Catalunya (Spain)	❖ Centru (Romania)
❖ Yuzhen tsentralen (Bulgaria)	❖ Sud-Est (Romania)
❖ Nord-Est (Romania)	❖ Sud – Muntenia (Romania)
❖ Piemonte (Italy)	❖ Veneto (Italy)

A.2.3. Top 10% regions in the industrial sectors of wood and furniture, cork and paper (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Nordrhein-Westfalen (Germany)	❖ Warminsko-Mazurskie (Poland)
❖ Lombardia (Italy)	❖ Norra Mellansverige (Sweden)
❖ Veneto (Italy)	❖ Småland med öarna (Sweden)
❖ Wielkopolskie (Poland)	❖ Lubuskie (Poland)
❖ Bayern (Germany)	❖ Friuli-Venezia Giulia (Italy)
❖ Baden-Württemberg (Germany)	❖ Stedné Slovensko (Slovakia)
❖ Norte (Portugal)	❖ Itä-Suomi (Finland)
❖ Lietuva (Lithuania)	❖ Wielkopolskie (Poland)
❖ Catalunya (Spain)	❖ Mellersta Norrland (Sweden)
❖ Toscana (Italy)	❖ Voreio Aigaio (Greece)
❖ Comunidad Valenciana (Spain)	❖ Länsi-Suomi (Finland)
❖ North West (United Kingdom)	❖ Marche (Italy)
❖ Nord-Vest (Romania)	❖ Övre Norrland (Sweden)
❖ Centru (Romania)	❖ Anatoliki Makedonia, Thraki (Greece)

❖ Emilia-Romagna (Italy) ❖ Warminsko-Mazurskie (Poland)	❖ Podkarpackie (Poland) ❖ Kujawsko-Pomorskie (Poland)

A.2.4. Top 10% regions in the industrial sector of manufacture of coke and refined petroleum products (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Nordrhein-Westfalen (Germany)	❖ Hamburg (Germany)
❖ Zuid-Holland (Netherlands)	❖ Sicilia (Italy)
❖ Sicilia (Italy)	❖ Zuid-Holland (Netherlands)
❖ Hamburg (Germany)	❖ Sud – Muntenia (Romania)
❖ Slaskie (Poland)	❖ Sardegna (Italy)
❖ Lombardia (Italy)	❖ Alentejo (Portugal)
❖ Sud – Muntenia (Romania)	❖ Slaskie (Poland)
❖ Etelä-Suomi (Finland)	❖ Közép-Dunántúl (Hungary)
❖ Attiki (Greece)	❖ Attiki (Greece)
❖ Lazio (Italy)	❖ Etelä – Suomi

A.2.5. Top 10% regions in the industrial sector of manufacture of chemicals and chemical products (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Nordrhein-Westfalen (Germany)	❖ Zeeland (Netherlands)
❖ Bayern (Germany)	❖ Rheinland-Pfalz (Germany)
❖ Lombardia (Italy)	❖ Prov. Antwerpen (Belgium)
❖ Rheinland-Pfalz (Germany)	❖ Limburg (Netherlands)
❖ Hessen (Germany)	❖ Sachsen-Anhalt (Germany)
❖ Catalunya (Spain)	❖ Sterea Ellada (Greece)
❖ Baden-Württemberg (Germany)	❖ Hessen (Germany)
❖ North West (United Kingdom)	❖ Sud-Vest Oltenia (Romania)
❖ Niedersachsen (Germany)	❖ Prov. Hainaut (Belgium)
❖ Prov. Antwerpen (Belgium)	❖ Észak-Magyarország (Hungary)
❖ Mazowieckie (Poland)	❖ Prov. Limburg (Belgium)
❖ Yorkshire and The Humber (United Kingdom)	❖ Nordrhein-Westfalen (Germany)
❖ South East (United Kingdom)	❖ Severozápad (Czech Republic)
❖ Emilia-Romagna (Italy)	❖ Prov. Luxembourg (Belgium)
❖ Comunidad Valenciana (Spain)	❖ Nord West (United Kingdom)
❖ Sachsen-Anhalt (Germany)	❖ Bayern (Germany)
❖ Veneto (Italy)	❖ Catalunya (Spain)
❖ Piemonte (Italy)	❖ Drenthe (Netherlands)

A.2.6. Top 10% regions in the industrial sector of manufacture of basic pharmaceutical products and pharmaceutical preparations (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Baden-Württemberg (Germany)	❖ Prov. Brabant Wallon (Belgium)
❖ Lombardia (Italy)	❖ Hovedstaden (Denmark)
❖ Hessen (Germany)	❖ Southern and Eastern (Ireland)
❖ Catalunya (Spain)	❖ Berlin (Germany)
❖ Lazio (Italy)	❖ Tirol (Austria)
❖ Southern and Eastern (Ireland)	❖ Baden-Württemberg (Germany)
❖ Nordrhein-Westfalen (Germany)	❖ Hessen (Germany)
❖ Hovedstaden (Denmark)	❖ Schleswig-Holstein (Germany)
❖ Comunidad de Madrid (Spain)	❖ Közép-Magyarország (Hungary)

❖ Rheinland-Pfalz (Germany) ❖ Közép-Magyarország (Hungary) ❖ Prov. Brabant Wallon (Belgium) ❖ Berlin (Germany)	❖ Noord-Brabant (Netherlands) ❖ Lazio (Italy) ❖ Wien (Austria) ❖ Attiki (Greece)

A.2.7. Top 10% regions in the industrial sector of non-metallic materials and products (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Bayern (Germany)	❖ Sterea Ellada (Greece)
❖ Nordrhein-Westfalen (Germany)	❖ Západné Slovensko (Slovakia)
❖ Lombardia (Italy)	❖ Severovýchod (Czech Republic)
❖ Baden-Württemberg (Germany)	❖ Podkarpackie (Poland)
❖ Emilia-Romagna (Italy)	❖ Stredni Morava (Czech Republic)
❖ Niedersachsen (Germany)	❖ Swietokrzskie (Poland)
❖ Veneto (Italy)	❖ Centro (Portugal)
❖ Comunidad Valenciana (Spain)	❖ Thüringen (Germany)
❖ Catalunya (Spain)	❖ Közép-Dunántúl (Hungary)
❖ Slaskie (Poland)	❖ Severozápad (Czech Republic)
❖ Hessen (Germany)	❖ Thessalia (Greece)
❖ Piemonte (Italy)	❖ Saarland (Germany)
❖ Rheinland-Pfalz (Germany)	❖ Dolnoslaskie (Poland)
❖ Centro (Portugal)	❖ Východné Slovensko (Slovakia)
❖ East Midlands (United Kingdom)	❖ Prov. Limburg (Belgium)
❖ Mazowieckie (Poland)	❖ Lódzkie (Poland)
❖ Wielkopolskie (Poland)	❖ Jihozápad (Czech Republic)
❖ North West (United Kingdom)	❖ Emilia-Romagna (Italy)

A.2.8. Top 10% regions in the industrial sector of basic metals and metal products (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Lombardia (Italy)	❖ Prov. Brabant Wallon (Belgium)
❖ Nordrhein-Westfalen (Germany)	❖ Berlin (Germany)
❖ Lazio (Italy)	❖ Schleswig-Holstein (Germany)
❖ Prov. Brabant Wallon (Belgium)	❖ Attiki (Greece)
❖ Berlin (Germany)	❖ Tirol (Austria)
❖ Attiki (Greece)	❖ Lazio (Italy)
❖ North West (United Kingdom)	❖ Hamburg (Germany)
❖ Zuid-Holland (Netherlands)	❖ Zuid-Holland (Netherlands)
❖ Toscana (Italy)	❖ Lombardia (Italy)
❖ Schleswig-Holstein (Germany)	❖ Vzhodna Slovenija (Slovenia)

A.2.9. Top 10% regions in the industrial sectors of computer, electric, electronic and optical products (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Nordrhein-Westfalen (Germany)	❖ Sterea Ellada (Greece)
❖ Bayern (Germany)	❖ Rheinland-Pfalz (Germany)
❖ Lombardia (Italy)	❖ Západné Slovenso (Slovakia)
❖ Baden-Württemberg (Germany)	❖ Severozápad (Czech Republic)
❖ Rheinland-Pfalz (Germany)	❖ Podkarpackie (Poland)
❖ Niedersachsen (Germany)	❖ Stredni Morava (Hungary)
❖ Hessen (Germany)	❖ Limburg (Netherlands)
❖ Catalunya (Spain)	❖ Prov. Limburg (Belgium)

❖ Emilia-Romagna (Italy) ❖ Veneto (Italy) ❖ Comunidad Valenciana (Spain) ❖ North West (United Kingdom) ❖ Piemonte (Italy) ❖ Mazowieckie (Poland) ❖ Slaskie (Poland) ❖ East Midlands (United Kingdom) ❖ Yorkshire and The Humber (United Kingdom) ❖ Centro (Portugal)	❖ Severovýchod (Czech Republic) ❖ Zeeland (Netherlands) ❖ Thüringen (Germany) ❖ Bayern (Germany) ❖ Sachsen-Anhalt (Germany) ❖ Prov. Luxembourg (Belgium) ❖ Centro (Portugal) ❖ Közép-Dunántúl (Hungary) ❖ Swietokryskie (Poland) ❖ Prov. Hainaut (Belgium)

A.2.10. Top 10% regions in the industrial sectors of motor vehicles and transport equipment (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Lombardia (Italy) ❖ Nordrhein-Westfalen (Germany) ❖ Lazio (Italy) ❖ Prov. Brabant Wallon (Beligium) ❖ Berlin (Germany) ❖ Attiki (Greece) ❖ North West (United Kingdom) ❖ Zuid-Holland (Netherlands) ❖ Toscana (Italy) ❖ Schleswig-Holstein (Germany)	❖ Prov. Brabant Wallon (Belgium) ❖ Berlin (Germany) ❖ Tirol (Austria) ❖ Schleswig-Holstein (Germany) ❖ Attiki (Greece) ❖ Lazio (Italy) ❖ Lombardia (Italy) ❖ Vzhodna Slovenija (Slovenia) ❖ Zahodna Slovenija (Slovenia) ❖ Hamburg (Germany)

A.2.11. Top 10% regions in the industrial sectors of electricity, gas, steam and air conditioning supply (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Nordrhein-Westfalen (Germany) ❖ Baden-Württemberg (Germany) ❖ Bayern (Germany) ❖ Slaskie (Poland) ❖ Mazowieckie (Poland) ❖ Niedersachsen (Germany) ❖ Bucaresti – Ilfov (Romania) ❖ Lietuva (Lithuania) ❖ Yugozapaden (Bulgaria) ❖ Lombardia (Italy) ❖ Scotland (United Kingdom) ❖ Hessen (Germany) ❖ South East (United Kingdom) ❖ Sud-Vest Oltenia (Romania) ❖ Lódzkie (Poland) ❖ Lazio (Italy) ❖ West Midlands (United Kingdom)	❖ Sud-Vest Oltenia (Romania) ❖ Zeeland (Netherlands) ❖ Severozapaden (Bulgaria) ❖ Východné Slovensko (Slovakia) ❖ Yugoiztochen (Bulgaria) ❖ Dél-Dunántúl (Hungary) ❖ Opolskie (Poland) ❖ Övre Norrland (Sweden) ❖ Észak-Magyarország (Hungary) ❖ Slaskie (Poland) ❖ Valle d'Aosta / Vallée d'Aoste (Italy) ❖ Lódzkie (Poland) ❖ Zachodniopomorskie (Poland) ❖ Sud-Est (Romania) ❖ Yugozapaden (Bulgaria) ❖ Saarland (Germany) ❖ Lubelskie (Poland)

A.2.12. Top 10% regions in the industrial sectors of water supply, sewerage, waste management and remediation activities (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Nordrhein-Westfalen (Germany) ❖ South East (United Kingdom) ❖ Lombardia (Italy)	❖ Východné Slovensko (Slovakia) ❖ Dél-Dunántúl (Hungary) ❖ Sicilia (Italy)

❖ Campania (Italy) ❖ Andalucía (Spain) ❖ Slaskie (Poland) ❖ Lazio (Italy) ❖ Catalunya (Spain) ❖ Sicilia (Italy) ❖ Bucaresti – Ilfov (Romania) ❖ North West (United Kingdom) ❖ East of England (United Kingdom) ❖ Scotland (United Kingdom) ❖ South West (United Kingdom) ❖ West Midlands (United Kingdom) ❖ London (United Kingdom) ❖ Mazowieckie (Poland) ❖ Veneto (Italy)	❖ Campania (Italy) ❖ Stredné Slovensko (Slovakia) ❖ Sud-Est (Romania) ❖ Észak-Magyarország (Hungary) ❖ Algarve (Portugal) ❖ Sardegna (Italy) ❖ Border, Midland and Western (Ireland) ❖ Észak-Alföld (Hungary) ❖ Západné Slovensko (Slovakia) ❖ Severozápad (Czech Republic) ❖ Canarias (Spain) ❖ Közép-Dunántúl (Hungary) ❖ Severoiztochen (Bulgaria) ❖ Puglia (Italy) ❖ Nyugat-Dunántúl (Hungary)

A.2.13. Top 10% regions in the industrial sector of construction (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Lombardia (Italy) ❖ Catalunya (Spain) ❖ Nordrhein-Westfalen (Germany) ❖ Andalucía (Spain) ❖ Bayern (Germany) ❖ Comunidad de Madrid (Spain) ❖ South East (United Kingdom) ❖ Baden-Württemberg (Germany) ❖ Comunidad Valenciana (Spain) ❖ Veneto (Italy) ❖ North West (United Kingdom) ❖ Lazio (Italy) ❖ Niedersachsen (Germany) ❖ East of England (United Kingdom) ❖ Norte (Portugal) ❖ Emilia-Romagna (Italy) ❖ London (United Kingdom) ❖ Scotland (United Kingdom) ❖ Mazowieckie (Poland) ❖ Piemonte (Italy)	❖ Dytiki Makedonia (Greece) ❖ Anatoliki Makedonia, Thraki (Greece) ❖ Ionia Nisia (Greece) ❖ Notio Aigaio (Greece) ❖ Algarve (Portugal) ❖ Kriti (Greece) ❖ Voreio Aigaio (Greece) ❖ Região Autónoma dos Açores (Portugal) ❖ Região Autónoma da Madeira (Portugal) ❖ Peloponnisos (Greece) ❖ Iperios (Greece) ❖ Dytiki Ellada (Greece) ❖ Prov. Luxembourg (Belgium) ❖ Extremadura (Spain) ❖ Luxembourg (Luxembourg) ❖ Illes Balears (Spain) ❖ Valle d'Aosta / Vallée d'Aoste (Italy) ❖ Andalucía (Spain) ❖ Attiki (Greece) ❖ Principado de Asturias (Spain)

A.2.14. Top 10% regions in the industrial sectors of transportation and storage (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ Nordrhein-Westfalen (Germany) ❖ Hessen (Germany) ❖ London (United Kingdom) ❖ Lombardia (Italy) ❖ Bayern (Germany) ❖ Mazowieckie (Poland) ❖ Catalunya (Spain) ❖ Comunidad de Madrid (Spain) ❖ Baden-Württemberg (Germany) ❖ Niedersachen (Germany) ❖ South East (United Kingdom) ❖ Lazio (Italy)	❖ Åland (Finland) ❖ Bremen (Germany) ❖ Hamburg (Germany) ❖ Bratislavský kraj (Slovakia) ❖ Noord-Holland (Netherlands) ❖ Liguria (Italy) ❖ Hessen (Germany) ❖ Canarias (Spain) ❖ Pohjois-Suomi (Finland) ❖ Prov. Vlaams-Brabant (Belgium) ❖ Nordrhein-Westfalen (Germany) ❖ Mazowieckie (Poland)

❖ East of England (United Kingdom) ❖ North West (United Kingdom) ❖ Andalucía (Spain) ❖ West Midlands (United Kingdom) ❖ South West (United Kingdom) ❖ Yorkshire and The Humber (United Kingdom)	❖ Luxembourg (Luxembourg) ❖ London (United Kingdom) ❖ Hovedstaden (Denmark) ❖ Berlin (Germany) ❖ Praha (Czech Republic) ❖ Niederösterreich (Austria)

A.2.15. Top 10% regions in the industrial sector of information and communication products and technologies (2009) in absolute and relative terms

Absolute Advantage	Comparative Advantage
❖ London (United Kingdom) ❖ Nordrhein-Westfalen (Germany) ❖ South East (United Kingdom) ❖ Comunidad de Madrid (Spain) ❖ Bayern (Germany) ❖ Lombardia (Italy) ❖ Baden-Württemberg (Germany) ❖ Lazio (Italy) ❖ Hessen (Germany) ❖ Mazowieckie (Poland) ❖ Stockholm (Sweden) ❖ North West (United Kingdom) ❖ Catalunya (Spain) ❖ East of England (United Kingdom) ❖ Bucaresti – Ilfov (Romania) ❖ Közép-Magyarország (Hungary) ❖ West Midlands (United Kingdom) ❖ Noord-Holland (Netherlands)	❖ London (United Kingdom) ❖ Région de Bruxelles-Capitale (Belgium) ❖ Stockholm (Sweden) ❖ Utrecht (Netherlands) ❖ Hovedstaden (Denmark) ❖ South East (United Kingdom) ❖ Wien (Austria) ❖ Noord-Holland (Netherlands) ❖ Comunidad de Madrid (Spain) ❖ Praha (Czech Republic) ❖ Hamburg (Germany) ❖ Southern and Eastern (Ireland) ❖ Groningen (Netherlands) ❖ Berlin (Germany) ❖ Közép-Magyarország (Hungary) ❖ Lazio (Italy) ❖ Prov. Vlaams-Brabant (Belgium) ❖ Flevoland (Netherlands)

A.1.16. List of regions according to their specialization in research for the period 2007 – 2011 (in brackets the Balassa index for that region and research field)

Food and beverages	Textile, leather and wearing
Sjælland – 1.63 Syddanmark – 2.05 Midtylland – 1.75 Mecklenburg-Vorpommern – 2.21 Border, Midland and Western – 2.47 Kentriki Makedonia – 2.94 Thessalia – 3.37 Iperios – 5.03 Dtytiki Ellada – 2.64 Peloponnisos – 3.40 Kriti – 2.77 La Rioja – 2.23 Castilla y León – 1.93 Castilla-la-Mancha – 1.47 Extremadura – 1.93 Región de Murcia – 2.04 Lubelskie – 2.50 Podlaskie – 2.48 Alentejo – 2.94	Prov. West-Vlaanderen – 2.48 Severozapaden – 4.96 Severn tsentralen – 4.21 Yuzhen tsentralen – 4.88 Vento – 2.84 Toscana – 4.30 Umbria – 2.24 Marche – 4.63 Észak-Alföld – 1.98 Voralberg – 2.38 Lódzkie – 3.96 Norte – 6.82 Nord-Vest – 3.54 Centru – 3.49 Nord-Est – 3.82 Sud-Est – 3.03 Vest – 3.70

Wood and furniture, cork and paper	Manufacture of coke and refined petroleum products
Provincia Autonoma Bolzano/Bozen – 1.99 Fruili-Venezia Giulia – 3.49 Molise – 1.70 Steiermark – 2.22 Wielkopolskie – 2.72 Lubuskie – 3.52 Kujawsko- Pomorskie – 2.17 Warminsko-Mazurskie – 3.83 Pomorksie – 1.93 Stredné Slovensko – 3.17 Itä-Suomi – 2.96 Länsi-Suomi – 2.49 Småland med öarna – 1.65 Norra Mellansverige – 3.72 Mellersta Norrland – 2.59	Région de Bruxelles-Capitale – 3.68 Hamburg – 15.18 Eesti – 4.99 Piemonte – 2.08 Liguria – 3.83 Sardegna – 6.62 Nyugat-Dunántúl – 2.10 Dél-Alföld – 4.88 Zuid-Holland – 8.54 Slaskie – 5.73 Sud – Muntenia – 8.39 Etelä-Suomi – 5.07 Västsverige – 4.94 East Midlands – 2.63

Manufacture of chemicals and chemical products	Manufacture of basic pharmaceutical products and pharmaceutical preparations
Prov. Antwerpen – 3.97 Prov. Limburg – 2.10 Prov. Oost-Vlaanderen – 1.52 Prov. Hainaut – 2.23 Prov. Luxembourg – 1.91 Severozápad – 1.94 Bayern – 1.73 Nordrhein-Westfalen – 2.02 Rheinland-Pfalz – 4.52 Sachsen-Anhalt – 2.46 Drenthe – 1.58 Zeeland – 5.26 Limburg – 2.99 Yorkshire and the Humber – 2.63	Hovedstaden – 7.12 Baden-Württemberg – 3.18 Hessen – 3.16 Southern and Eastern – 6.38 Catalunya – 2.40 Kypros – 1.20 Közép-Magyarország – 3.07 Noord-Brabant – 3.01 Wien – 2.63 Lisboa – 1.63 Östra Mellansverige – 1.65 Sydsverige – 1.79

Non-metallic materials and products	Basic metals and metal products
Prov. Namur – 1.56 Strední Cechy – 1.61 Severovýchod – 2.12 Jihovýchod – 1.38 Strední Morava – 2.08 Nordjylland – 1.35 Thüringen – 1.99 Comunidad Foral de Navarra – 1.34 Comunidad Valenciana – 1.60 Provincia Autonoma Trento – 1.31 Emilia-Romagna – 1.62 Podkarpackie – 2.12 Swietokryskie – 2.04 Centro – 2.02 Západné Slovensko – 2.49	Niedersachsen – 1.73 Attiki – 5.70 Aragón – 1.38 Abruzzo – 1.60 Sicilia – 3.42 Közép-Dunántúl – 8.18 Overijssel – 1.27

Computer, electric, electronic and optical products	Motor vehicles and transport equipment
Sterea Ellada – 2.59 País Vasco – 1.15 Oberösterreich – 1.48	Prov. Brabant Wallon – 31.92 Berlin – 8.52 Schleswig-Holstein – 6.11

	Lombardia – 3.94 Lazio – 5.44 Flevoland – 1.96 Tirol – 6.46 Bucaresti – Ilfov – 2.02 Vzhodna Slovenija – 3.94 Zahona Slovenija – 3.64 North East – 2.69 North West – 2.61 Northern Ireland – 2.17

Electricity, gas, steam and air conditioning supply	Water supply, sewerage, waste management and remediation activities
Yugoitochen – 2.51 Jihozápad – 1.64 Saarland – 2.05 Sachsen – 1.53 Valle d'Aosta – 2.27 Latvija – 2.00 Lietuva – 1.98 Észak-Magyarország – 2.36 Burgenland – 1.66 Kärnten – 1.80 Malopolskie – 1.52 Zachodniopomorskie – 2.26 Dolnoslaskie – 1.75 Opolskie – 2.37 Sud-Vest Oltenia – 4.06 Övre Norrland – 2.37	Prov. Liège – 1.45 Severoiztochen – 1.75 Moravskoslezsko – 1.65 Canarias – 1.77 Campania – 2.22 Puglia – 1.73 Basilicata – 1.64 Calabria – 1.69 Dél-Dunántúl – 2.49 Východné Slovensko – 3.17 South West – 1.36 Wales – 1.55 Scotland – 1.38

Construction	Transportation and storage
Anatoliki Makedonia, Thraki – 3.07 Dytiki Makedonia – 3.54 Ionia Nisia – 3.04 Voreio Aigaio – 2.60 Notio Aigaio – 3.02 Galicia – 1.54 Principado de Asturias – 1.66 Cantabria – 1.54 Illes Balears – 1.78 Andalucía – 1.69 Luxembourg – 1.79 Gelderland – 1.26 Algarve – 2.68 Região Autónoma dos Açores – 2.41 Região Autónoma da Madeira – 2.33	Brandenburg – 1.25 Bremen – 3.08 Friesland – 1.22 Niederösterreich – 1.36 Salzburg – 1.26 Mazowieckie – 1.43 Bratislavský kraj – 2.01 Pohjois-Suomi – 1.50 Åland – 3.33

Information and communication products and technologies
Prov. Vlaams-Brabant – 1.80 Yugozapaden – 1.32 Praha – 2.13 Comunidad de Madrid – 2.23 Groningen – 1.93 Utrecht – 2.91 Noord-Holland – 2.32 Stockholm – 3.01

West Midlands – 1.41
East of England – 1.40
London – 1.35
South East – 3.65

Annex B. Regressions tables from section 2.3

(Legend for independent variables at the end of this Annex)

B.1. Food and beverages

Modelo 1: MCO, usando las observaciones 1-131
Variable dependiente: People

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	9255,29	1504,91	6,150	1,09e-08	***
A	6,11433	4,91514	1,244	0,2160	
B	-5,16555	2,82202	-1,830	0,0697	*
C	14,9330	3,29410	4,533	1,40e-05	***
D	-4,47135	5,17328	-0,8643	0,3892	
E	0,281378	1,01713	0,2766	0,7825	
F	-3,79869	2,31535	-1,641	0,1035	
G	3,65260	1,06742	3,422	0,0009	***
H	0,212924	6,59183	0,03230	0,9743	
I	0,611394	4,82813	0,1266	0,8994	
J	13,3209	7,55059	1,764	0,0803	*
K	-19,9889	8,99723	-2,222	0,0282	**
L	0,818618	2,86700	0,2855	0,7757	

Media de la vble. dep.	21359,21	D.T. de la vble. dep.	17327,58
Suma de cuad. residuos	1,50e+10	D.T. de la regresión	11282,16
R-cuadrado	0,615189	R-cuadrado corregido	0,576056
F(12, 118)	15,72035	Valor p (de F)	2,40e-19
Log-verosimilitud	-1401,394	Criterio de Akaike	2828,787
Criterio de Schwarz	2866,165	Crit. de Hannan-Quinn	2843,975

Sin considerar la constante, el valor p más alto fue el de la variable 9 (H)

B.2. Textile, wearing and leather

Modelo 1: MCO, usando las observaciones 1-108
Variable dependiente: People

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	6345,62	3419,61	1,856	0,0666	*
A	10,9056	8,44098	1,292	0,1995	
B	-10,2913	5,89510	-1,746	0,0841	*
C	7,11810	7,02000	1,014	0,3132	
D	-11,4212	10,5327	-1,084	0,2810	
E	-1,42521	2,05184	-0,6946	0,4890	
F	-9,64912	4,77035	-2,023	0,0459	**
G	4,68292	2,19229	2,136	0,0352	**
H	4,46137	12,6197	0,3535	0,7245	
I	6,25414	11,3936	0,5489	0,5843	
J	27,2384	16,6327	1,638	0,1048	
K	-3,54834	16,7857	-0,2114	0,8330	
L	11,0353	6,93730	1,591	0,1150	

Media de la vble. dep.	15824,11	D.T. de la vble. dep.	24166,24
Suma de cuad. residuos	4,72e+10	D.T. de la regresión	22285,85
R-cuadrado	0,244942	R-cuadrado corregido	0,149567
F(12, 95)	2,568184	Valor p (de F)	0,005445
Log-verosimilitud	-1227,584	Criterio de Akaike	2481,168
Criterio de Schwarz	2516,036	Crit. de Hannan-Quinn	2495,306

Sin considerar la constante, el valor p más alto fue el de la variable 12 (K)

B.3. Wood and furniture, cork and paper

Modelo 1: MCO, usando las observaciones 1-140
Variable dependiente: People

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	7952,16	1631,07	4,875	3,18e-06	***
A	9,03620	4,26589	2,118	0,0361	**
B	-3,62822	2,68881	-1,349	0,1796	
C	6,79099	3,35510	2,024	0,0451	**
D	-8,01957	4,88173	-1,643	0,1029	
E	0,997430	1,07472	0,9281	0,3551	
F	-4,56928	2,33404	-1,958	0,0525	*
G	3,23675	0,975203	3,319	0,0012	***
H	5,71806	6,37499	0,8970	0,3714	
I	4,51825	5,11756	0,8829	0,3790	
J	7,97422	7,69529	1,036	0,3021	
K	-20,2485	8,30708	-2,438	0,0162	**
L	2,22186	2,95297	0,7524	0,4532	

Media de la vble. dep.	15665,14	D.T. de la vble. dep.	14845,05
Suma de cuad. residuos	1,92e+10	D.T. de la regresión	12290,79
R-cuadrado	0,373696	R-cuadrado corregido	0,314518
F(12, 127)	6,314747	Valor p (de F)	1,13e-08
Log-verosimilitud	-1510,154	Criterio de Akaike	3046,309
Criterio de Schwarz	3084,550	Crit. de Hannan-Quinn	3061,849

Sin considerar la constante, el valor p más alto fue el de la variable 13 (L)

B.4. Coke and refined petroleum products

Model 1: OLS, using observations 1-74
Dependent variable: People

	coefficient	std. error	t-ratio	p-value	
const	63.0517	198.356	0.3179	0.7517	
A	0.0205026	0.454354	0.04512	0.9642	
B	-1.03669	0.339610	-3.053	0.0034	***
C	0.650679	0.543912	1.196	0.2362	
D	-0.874410	0.725581	-1.205	0.2328	
E	0.149175	0.111775	1.335	0.1870	
F	0.641963	0.265911	2.414	0.0188	**
G	0.421535	0.118800	3.548	0.0008	***
H	-0.501007	1.04035	-0.4816	0.6318	
I	0.466195	0.703859	0.6623	0.5102	
J	-0.375736	1.06858	-0.3516	0.7263	
K	-0.963313	1.13201	-0.8510	0.3981	
L	0.303695	0.331671	0.9157	0.3635	

Mean dependent var	858.5270	S.D. dependent var	1306.036
Sum squared resid	64837542	S.E. of regression	1030.976
R-squared	0.479293	Adjusted R-squared	0.376859
F(12, 61)	4.679033	P-value(F)	0.000024
Log-likelihood	-611.2847	Akaike criterion	1248.569
Schwarz criterion	1278.522	Hannan-Quinn	1260.518

Excluding the constant, p-value was highest for variable 2 (A)

B.5. Chemical products

```
Model 1: OLS, using observations 1-143
Dependent variable: People

             coefficient   std. error   t-ratio   p-value
  --------------------------------------------------------
  const      114.146       974.921       0.1171   0.9070
  A            1.94909       2.43093     0.8018   0.4241
  B           -2.32330       1.60258    -1.450    0.1495
  C            5.40646       2.02088     2.675    0.0084   ***
  D           -6.19592       2.93675    -2.110    0.0368   **
  E            0.964969      0.644305    1.498    0.1366
  F           -1.92036       1.34714    -1.426    0.1564
  G            2.67693       0.583580    4.587    1.04e-05 ***
  H            4.12220       3.84535     1.072    0.2857
  I            5.03669       3.06810     1.642    0.1031
  J            4.05005       4.62662     0.8754   0.3830
  K          -11.3549        5.00359    -2.269    0.0249   **
  L           -1.88123       1.77297    -1.061    0.2906

Mean dependent var   6410.322   S.D. dependent var   10711.07
Sum squared resid    7.16e+09   S.E. of regression   7422.567
R-squared            0.560360   Adjusted R-squared   0.519778
F(12, 130)           13.80804   P-value(F)           4.50e-18
Log-likelihood      -1470.550   Akaike criterion     2967.099
Schwarz criterion    3005.616   Hannan-Quinn         2982.751

Excluding the constant, p-value was highest for variable 2 (A)
```

B.6. Pharmaceutical products

```
Model 1: OLS, using observations 1-112
Dependent variable: Workers

             coefficient   std. error   t-ratio    p-value
  --------------------------------------------------------
  const       29.7882      605.850       0.04917   0.9609
  A            1.98284       1.36893     1.448     0.1506
  B           -1.96282       0.909329   -2.159     0.0333   **
  C            0.539506      1.15788     0.4659    0.6423
  D            1.77804       1.78814     0.9944    0.3225
  E            0.963994      0.354469    2.720     0.0077   ***
  F           -0.609446      0.772018   -0.7894    0.4318
  G            0.370229      0.339985    1.089     0.2788
  H           -0.391008      2.22411    -0.1758    0.8608
  I            1.18374       1.72969     0.6844    0.4953
  J            0.619653      2.64159     0.2346    0.8150
  K            3.45928       2.92330     1.183     0.2395
  L           -1.14863       0.990691   -1.159     0.2491

Mean dependent var   3393.786   S.D. dependent var   5138.614
Sum squared resid    1.52e+09   S.E. of regression   3922.004
R-squared            0.480439   Adjusted R-squared   0.417462
F(12, 99)            7.628801   P-value(F)           7.96e-10
Log-likelihood      -1078.740   Akaike criterion     2183.480
Schwarz criterion    2218.820   Hannan-Quinn         2197.819

Excluding the constant, p-value was highest for variable 9 (H)
```

B.7. Rubber, plastic and non-metallic minerals

Model 1: OLS, using observations 1-145
Dependent variable: Workers

	coefficient	std. error	t-ratio	p-value	
const	5429.73	1597.66	3.399	0.0009	***
A	7.85213	4.03494	1.946	0.0538	*
B	-5.26403	2.65396	-1.983	0.0494	**
C	13.5496	3.33989	4.057	8.46e-05	***
D	-8.48759	4.87880	-1.740	0.0842	*
E	1.70342	1.06909	1.593	0.1135	
F	-6.07026	2.22576	-2.727	0.0073	***
G	4.11607	0.975109	4.221	4.49e-05	***
H	0.0329256	6.48740	0.005075	0.9960	
I	5.03019	5.07830	0.9905	0.3237	
J	10.3307	7.75478	1.332	0.1851	
K	-17.9918	8.35605	-2.153	0.0331	**
L	-0.00973928	2.92962	-0.003324	0.9974	

Mean dependent var	16356.69	S.D. dependent var	17994.89
Sum squared resid	2.01e+10	S.E. of regression	12325.10
R-squared	0.569974	Adjusted R-squared	0.530881
F(12, 132)	14.57987	P-value(F)	5.36e-19
Log-likelihood	-1564.748	Akaike criterion	3155.496
Schwarz criterion	3194.194	Hannan-Quinn	3171.220

Excluding the constant, p-value was highest for variable 13 (L)

B.8. Basic metals and metal products

Model 1: OLS, using observations 1-133
Dependent variable: Workers

	coefficient	std. error	t-ratio	p-value	
const	6969.29	3034.98	2.296	0.0234	**
A	12.6517	7.86468	1.609	0.1103	
B	-14.1183	5.70751	-2.474	0.0148	**
C	8.07858	6.59796	1.224	0.2232	
D	-36.5539	9.93959	-3.678	0.0004	***
E	13.3110	3.97165	3.352	0.0011	***
F	-6.83444	4.75613	-1.437	0.1533	
G	12.0031	2.04519	5.869	3.98e-08	***
H	26.5736	12.3868	2.145	0.0339	**
I	-2.63717	10.7380	-0.2456	0.8064	
J	1.85380	14.6895	0.1262	0.8998	
K	-48.9252	17.6008	-2.780	0.0063	***
L	9.15674	6.51527	1.405	0.1625	

Mean dependent var	25897.80	S.D. dependent var	34834.39
Sum squared resid	6.15e+10	S.E. of regression	22637.75
R-squared	0.616065	Adjusted R-squared	0.577672
F(12, 120)	16.04609	P-value(F)	8.77e-20
Log-likelihood	-1515.520	Akaike criterion	3057.039
Schwarz criterion	3094.614	Hannan-Quinn	3072.308

Excluding the constant, p-value was highest for variable 11 (J)

B.9. Computer, electric, electronic and optical products

```
Model 1: OLS, using observations 1-136
Dependent variable: Workers

             coefficient   std. error   t-ratio   p-value
  --------------------------------------------------------
  const      3380.38       1925.84       1.755    0.0817   *
  A             5.20979       4.73888    1.099    0.2738
  B             0.859375      3.16693    0.2714   0.7866
  C            12.7548        3.90190    3.269    0.0014   ***
  D             1.77147       5.73026    0.3091   0.7577
  E             2.88199       1.25030    2.305    0.0228   **
  F            -7.37512       2.62451   -2.810    0.0058   ***
  G             3.34463       1.13277    2.953    0.0038   ***
  H            -8.23861       7.64013   -1.078    0.2830
  I             8.60572       5.95583    1.445    0.1510
  J             2.08200       9.10898    0.2286   0.8196
  K           -21.3393        9.66273   -2.208    0.0291   **
  L            -9.72486       3.42587   -2.839    0.0053   ***

Mean dependent var   14850.67   S.D. dependent var   22977.21
Sum squared resid    2.52e+10   S.E. of regression   14305.07
R-squared            0.646852   Adjusted R-squared   0.612399
F(12, 123)           18.77466   P-value(F)           1.74e-22
Log-likelihood      -1487.442   Akaike criterion     3000.884
Schwarz criterion    3038.748   Hannan-Quinn         3016.271

Excluding the constant, p-value was highest for variable 11 (J)
```

B.10. Motor vehicles and transport equipment

```
Model 1: OLS, using observations 1-119
Dependent variable: Workers

             coefficient   std. error   t-ratio   p-value
  --------------------------------------------------------
  const      6239.76       3331.72       1.873    0.0638   *
  A             5.67379       7.59134    0.7474   0.4565
  B             4.53661       5.28008    0.8592   0.3922
  C            13.8646        6.40868    2.163    0.0328   **
  D            -1.74662       9.60446   -0.1819   0.8560
  E             2.31525       2.03365    1.138    0.2575
  F            -4.72063       4.43388   -1.065    0.2894
  G             3.04707       1.92749    1.581    0.1169
  H           -12.2376       12.5389    -0.9760   0.3313
  I            12.1924        9.71134    1.255    0.2121
  J           -16.5860       14.9801    -1.107    0.2707
  K           -23.6346       16.4603    -1.436    0.1540
  L           -11.1850        5.52728   -2.024    0.0455   **

Mean dependent var   18086.96   S.D. dependent var   30047.34
Sum squared resid    5.36e+10   S.E. of regression   22495.05
R-squared            0.496516   Adjusted R-squared   0.439518
F(12, 106)           8.711077   P-value(F)           2.44e-11
Log-likelihood      -1354.475   Akaike criterion     2734.951
Schwarz criterion    2771.080   Hannan-Quinn         2749.622

Excluding the constant, p-value was highest for variable 5 (D)
```

B.11. Electricity, gas, steam and air conditioning supply

Model 1: OLS, using observations 1-137
Dependent variable: Workers

	coefficient	std. error	t-ratio	p-value	
const	2124.34	605.438	3.509	0.0006	***
A	-0.553514	1.53072	-0.3616	0.7183	
B	-0.367092	1.06086	-0.3460	0.7299	
C	1.74724	1.24529	1.403	0.1631	
D	-4.53356	1.83121	-2.476	0.0146	**
E	0.989133	0.403463	2.452	0.0156	**
F	-1.55697	0.896396	-1.737	0.0849	*
G	1.03373	0.368932	2.802	0.0059	***
H	5.86862	2.48850	2.358	0.0199	**
I	6.30214	1.91685	3.288	0.0013	***
J	1.96896	2.91115	0.6764	0.5001	
K	-6.45727	3.08083	-2.096	0.0381	**
L	-2.05822	1.11600	-1.844	0.0675	*

Mean dependent var	6168.066	S.D. dependent var	7147.216
Sum squared resid	2.58e+09	S.E. of regression	4565.649
R-squared	0.627939	Adjusted R-squared	0.591933
F(12, 124)	17.43990	P-value(F)	2.36e-21
Log-likelihood	-1341.970	Akaike criterion	2709.941
Schwarz criterion	2747.901	Hannan-Quinn	2725.367

Excluding the constant, p-value was highest for variable 3 (B)

B.12. Water supply, sewerage, waste management, etc.

Model 1: OLS, using observations 1-141
Dependent variable: Workers

	coefficient	std. error	t-ratio	p-value	
const	2524.47	496.153	5.088	1.26e-06	***
A	-0.0364425	1.28137	-0.02844	0.9774	
B	-0.633275	0.864340	-0.7327	0.4651	
C	0.342964	1.03769	0.3305	0.7416	
D	-4.31552	1.52396	-2.832	0.0054	***
E	0.646968	0.335880	1.926	0.0563	*
F	-1.09349	0.738545	-1.481	0.1412	
G	0.538503	0.308140	1.748	0.0829	*
H	10.4533	2.01000	5.201	7.65e-07	***
I	1.02866	1.59670	0.6442	0.5206	
J	3.27865	2.41414	1.358	0.1768	
K	-3.55520	2.56733	-1.385	0.1685	
L	1.26359	0.933641	1.353	0.1783	

Mean dependent var	6929.780	S.D. dependent var	6043.225
Sum squared resid	1.85e+09	S.E. of regression	3805.205
R-squared	0.637506	Adjusted R-squared	0.603522
F(12, 128)	18.75912	P-value(F)	7.72e-23
Log-likelihood	-1355.673	Akaike criterion	2737.345
Schwarz criterion	2775.679	Hannan-Quinn	2752.923

Excluding the constant, p-value was highest for variable 2 (A)

B.13. Construction

Model 1: OLS, using observations 1-151
Dependent variable: Workers

	coefficient	std. error	t-ratio	p-value	
const	19657.5	4450.39	4.417	2.01e-05	***
A	23.4946	11.5497	2.034	0.0438	**
B	-18.4139	7.61653	-2.418	0.0169	**
C	35.9321	9.56045	3.758	0.0003	***
D	-19.1566	13.8877	-1.379	0.1700	
E	5.12912	3.06901	1.671	0.0969	*
F	-5.54447	6.38120	-0.8689	0.3864	
G	9.54163	2.77755	3.435	0.0008	***
H	44.1083	18.2503	2.417	0.0170	**
I	-19.2742	14.5652	-1.323	0.1879	
J	35.4608	22.0053	1.611	0.1094	
K	-73.1565	23.7340	-3.082	0.0025	***
L	22.2081	8.38856	2.647	0.0091	***

Mean dependent var	74086.78	S.D. dependent var	64916.97
Sum squared resid	1.73e+11	S.E. of regression	35392.39
R-squared	0.726542	Adjusted R-squared	0.702763
F(12, 138)	30.55395	P-value(F)	4.68e-33
Log-likelihood	-1789.075	Akaike criterion	3604.150
Schwarz criterion	3643.374	Hannan-Quinn	3620.085

Excluding the constant, p-value was highest for variable 7 (F)

B.14. Transportation and storage

Model 1: OLS, using observations 1-143
Dependent variable: Workers

	coefficient	std. error	t-ratio	p-value	
const	8128.59	4270.40	1.903	0.0592	*
A	2.19229	10.8897	0.2013	0.8408	
B	-14.5027	7.47858	-1.939	0.0546	*
C	11.5431	8.94070	1.291	0.1990	
D	-34.6614	13.1025	-2.645	0.0092	***
E	8.90349	2.87362	3.098	0.0024	***
F	-0.777216	6.03211	-0.1288	0.8977	
G	12.8546	2.63409	4.880	3.05e-06	***
H	62.0058	17.5607	3.531	0.0006	***
I	31.2677	13.7008	2.282	0.0241	**
J	13.3710	20.6022	0.6490	0.5175	
K	-60.9279	22.1098	-2.756	0.0067	***
L	-4.71055	7.85124	-0.6000	0.5496	

Mean dependent var	58268.12	S.D. dependent var	63222.91
Sum squared resid	1.41e+11	S.E. of regression	32915.21
R-squared	0.751858	Adjusted R-squared	0.728953
F(12, 130)	32.82455	P-value(F)	1.35e-33
Log-likelihood	-1683.535	Akaike criterion	3393.070
Schwarz criterion	3431.587	Hannan-Quinn	3408.722

Excluding the constant, p-value was highest for variable 7 (F)

B.15. Information and communication technologies and products

```
Model 1: OLS, using observations 1-143
Dependent variable: Workers

             coefficient   std. error   t-ratio   p-value
  --------------------------------------------------------
  const      -1248.96      2761.04      -0.4524   0.6518
  A            -14.6835       7.04079   -2.085    0.0390   **
  B              4.42705      4.83530    0.9156   0.3616
  C             -7.48671      5.78064   -1.295    0.1976
  D             13.7540       8.47148    1.624    0.1069
  E              6.24665      1.85795    3.362    0.0010   ***
  F             -4.38902      3.90008   -1.125    0.2625
  G              3.53454      1.70308    2.075    0.0399   **
  H             39.5252      11.3539     3.481    0.0007   ***
  I             16.7214       8.85828    1.888    0.0613   *
  J             -3.36834     13.3204    -0.2529   0.8008
  K            -27.5319      14.2952    -1.926    0.0563   *
  L            -12.5304       5.07624   -2.468    0.0149   **

Mean dependent var   33043.55   S.D. dependent var   48510.88
Sum squared resid    5.89e+10   S.E. of regression   21281.43
R-squared            0.823811   Adjusted R-squared   0.807548
F(12, 130)           50.65377   P-value(F)           4.55e-43
Log-likelihood      -1621.173   Akaike criterion     3268.346
Schwarz criterion    3306.863   Hannan-Quinn         3283.997

Excluding the constant, p-value was highest for variable 11 (J)
```

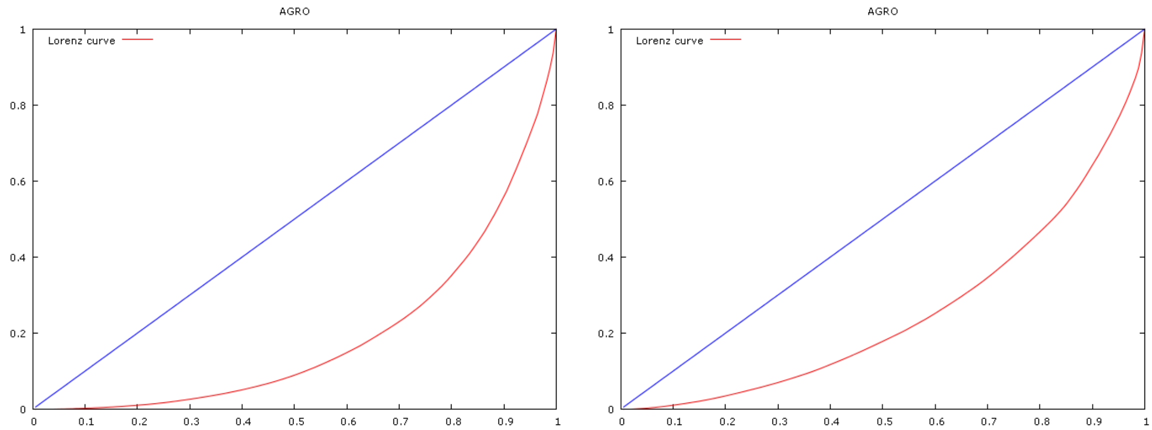
Legend for independent variables:

A: Agriculture, food sciences and fisheries
B: Biology sciences, biotechnology and biomedicine
C: Chemistry
D: ICTs, computing and imaging
E: Physics, astrophysics and energy
F: Environment and sustainability
G: Medical sciences
H: Mathematics
I: Material sciences
J: Animals sciences
K: Physiology and pharmacology
L: Engineering

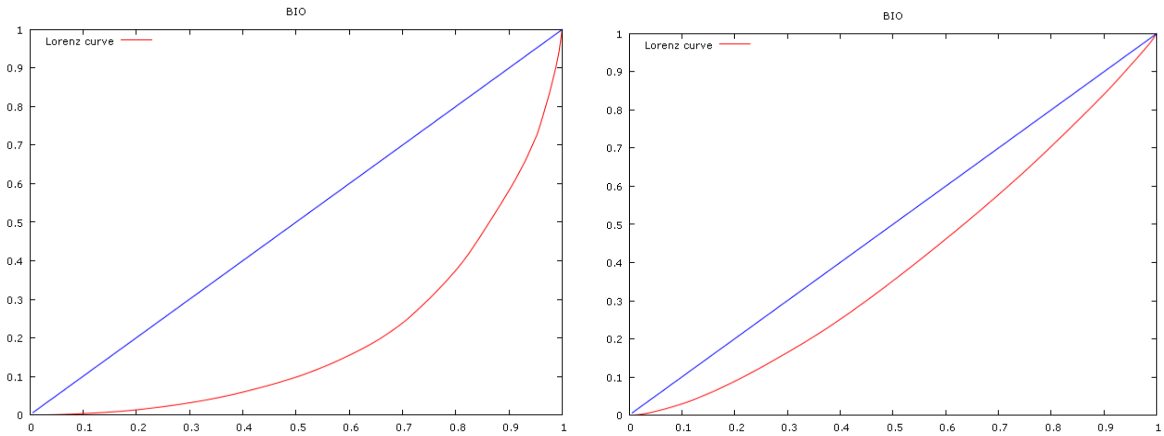
Annex C. Lorenz curves for scientific fields and industrial sectors

C.1. Lorenz curves for scientific fields

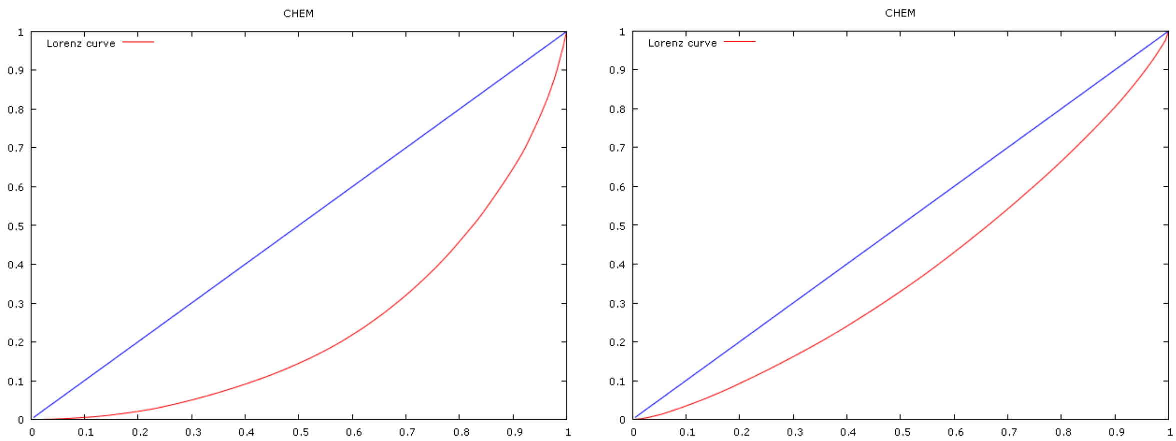
C.1.1. Lorenz curves for agriculture, food sciences and fisheries (in absolute terms on the left and in relative terms on the right)



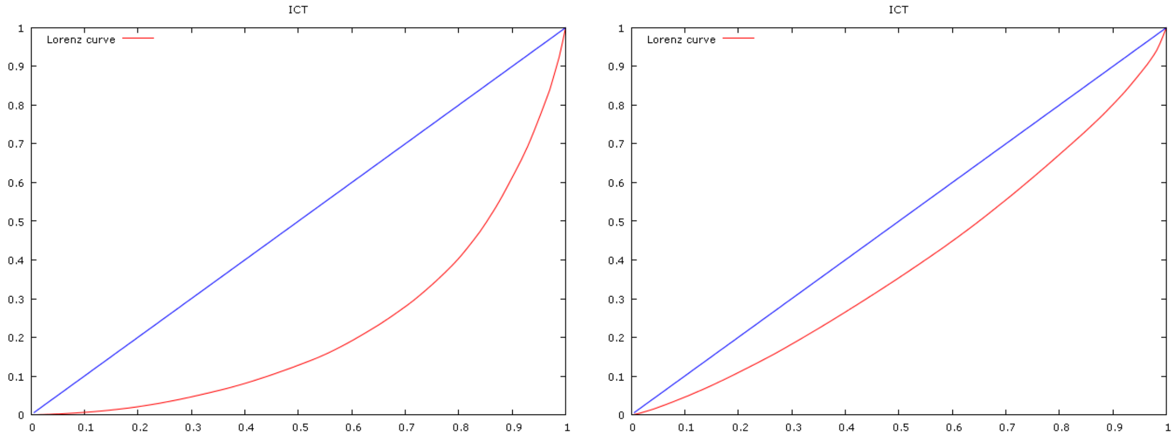
C.1.2. Lorenz curves for biology sciences, biotechnology and biomedicine (in absolute terms on the left and in relative terms on the right)



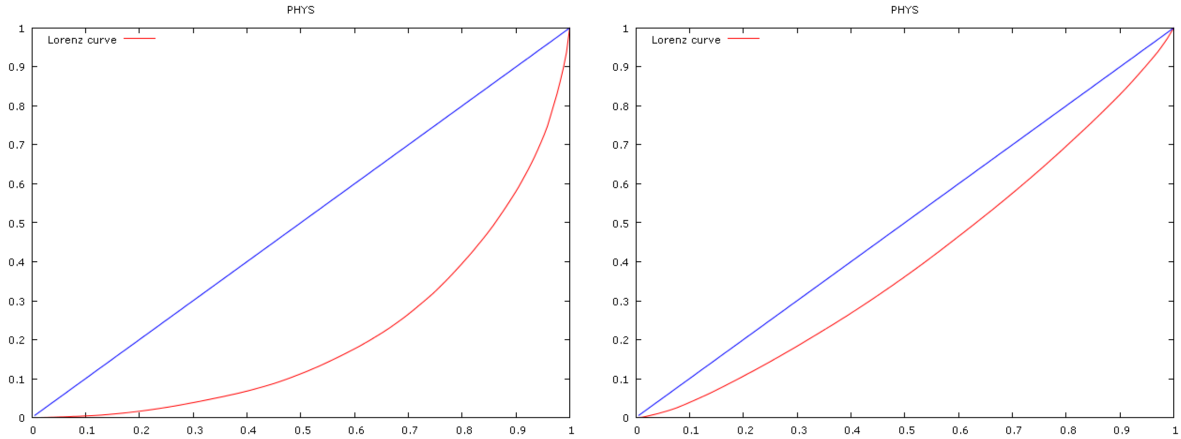
C.1.3. Lorenz curves for chemistry (in absolute terms on the left and in relative terms on the right)



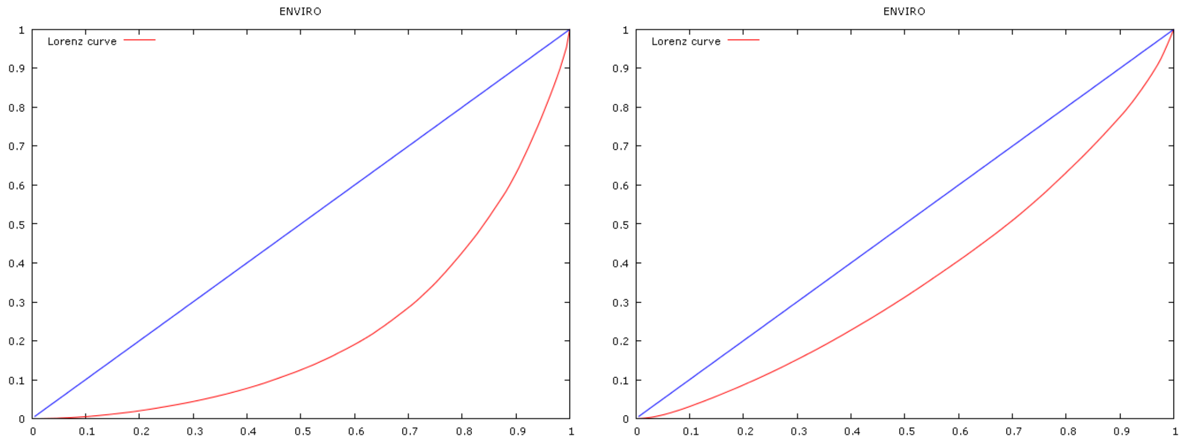
C.1.4. Lorenz curves for information and communication technologies, computing and imaging (in absolute terms on the left and in relative terms on the right)



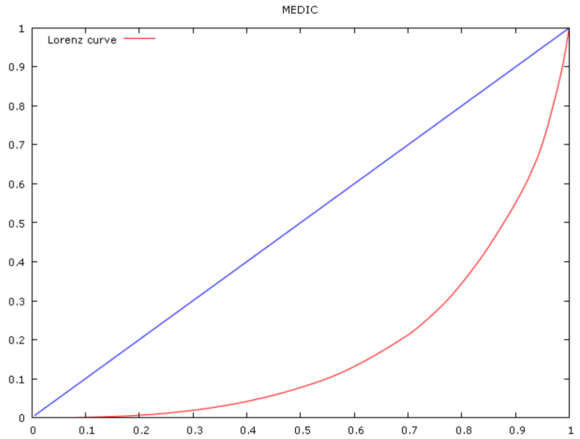
C.1.5. Lorenz curves for physics, astrophysics and energy (in absolute terms on the left and in relative terms on the right)

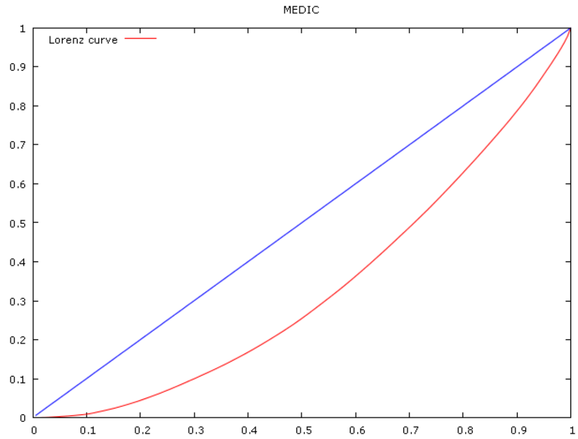


C.1.6. Lorenz curves for environment and sustainability (in absolute terms on the left and in relative terms on the right)

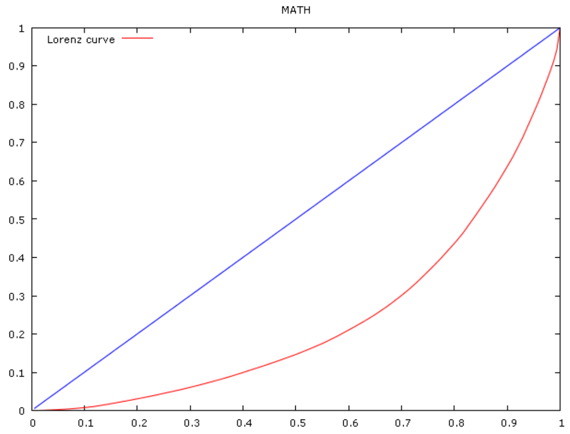


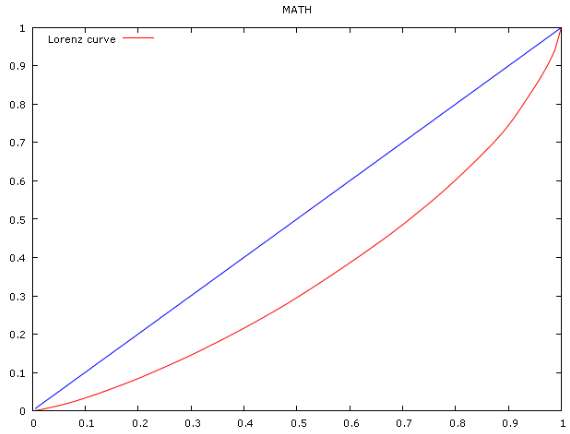
C.1.7. Lorenz curves for medical sciences (in absolute terms on the left and in relative terms on the right)



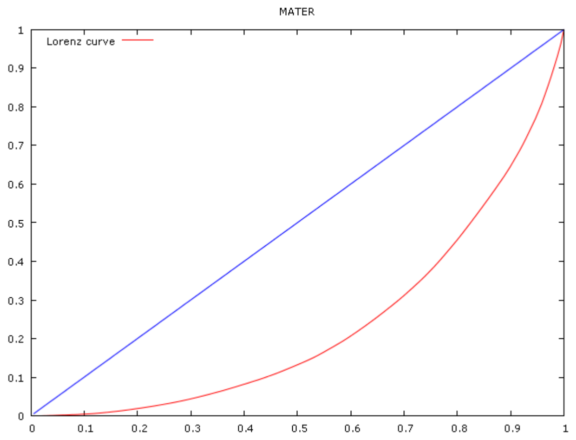


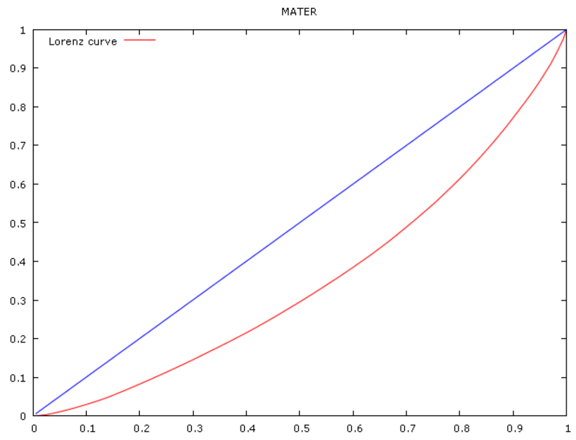
C.1.8. Lorenz curves for mathematics (in absolute terms on the left and in relative terms on the right)



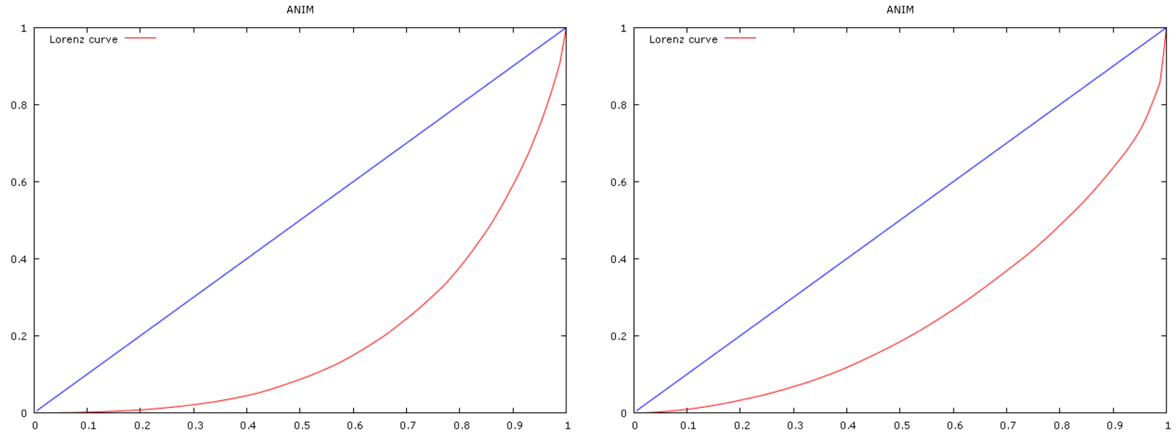


C.1.9. Lorenz curves for materials sciences (in absolute terms on the left and in relative terms on the right)

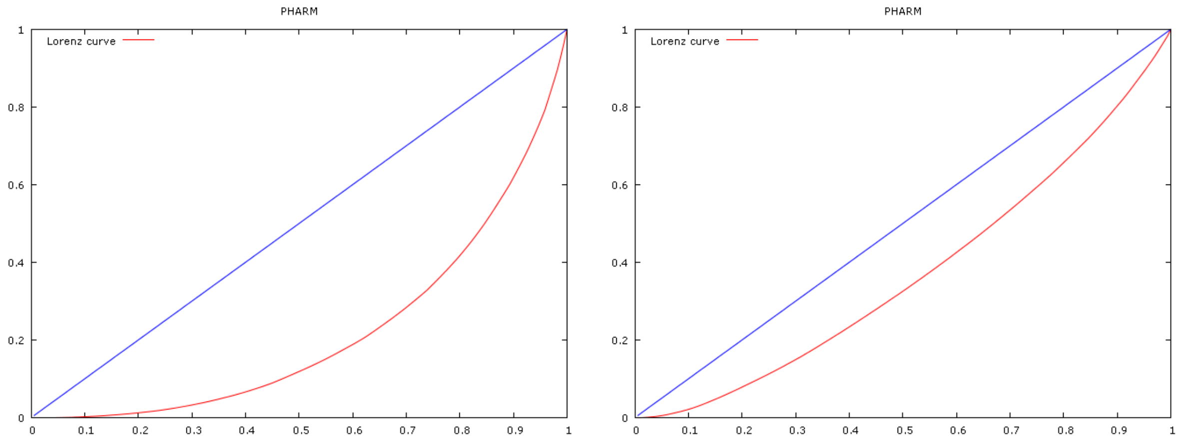




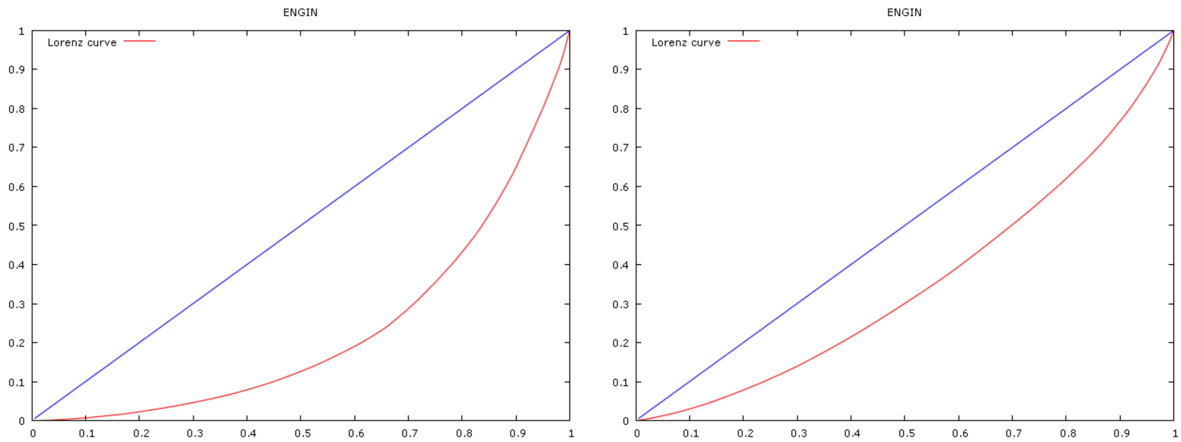
C.1.10. Lorenz curves for animal sciences (in absolute terms on the left and in relative terms on the right)



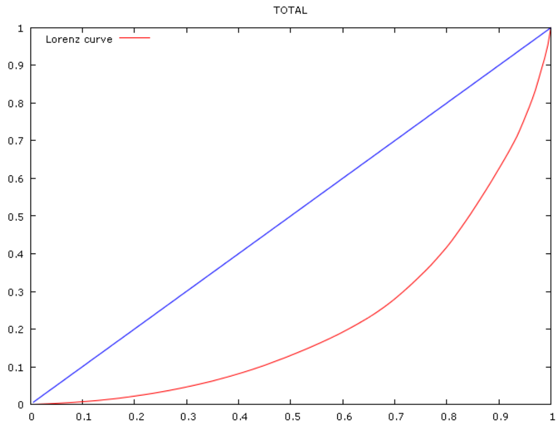
C.1.11. Lorenz curves for physiology and pharmacology (in absolute terms on the left and in relative terms on the right)



C.1.12. Lorenz curves for engineering (in absolute terms on the left and in relative terms on the right)

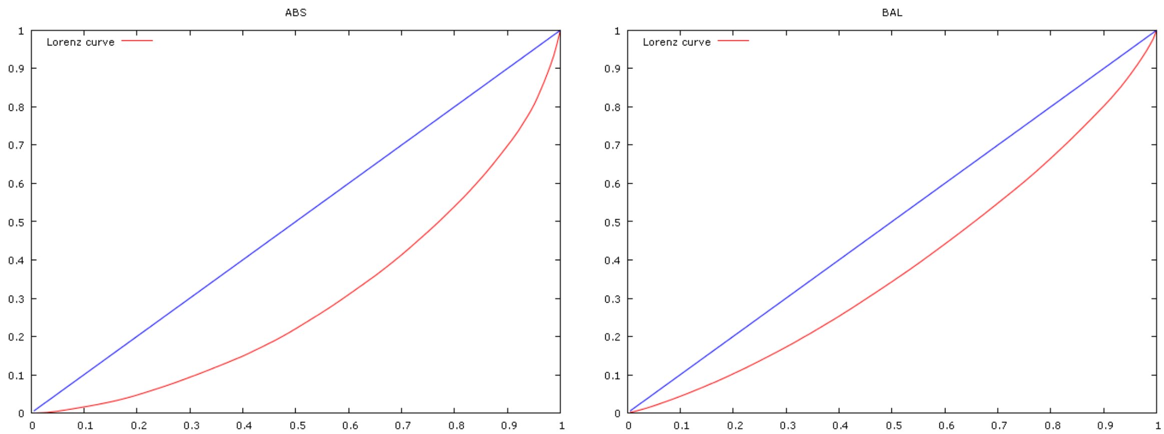


C.1.13. Lorenz curves for all research fields (in absolute terms)

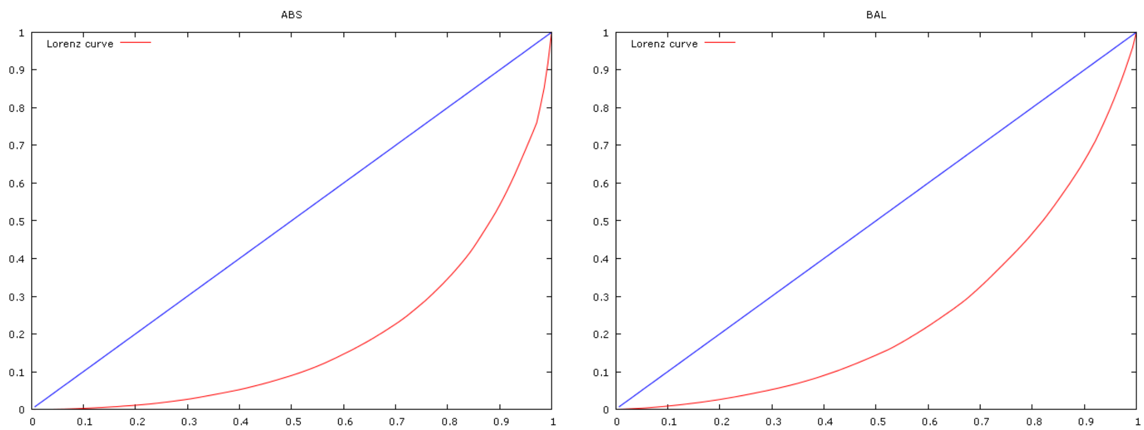


C.2. Lorenz curves for industrial sectors

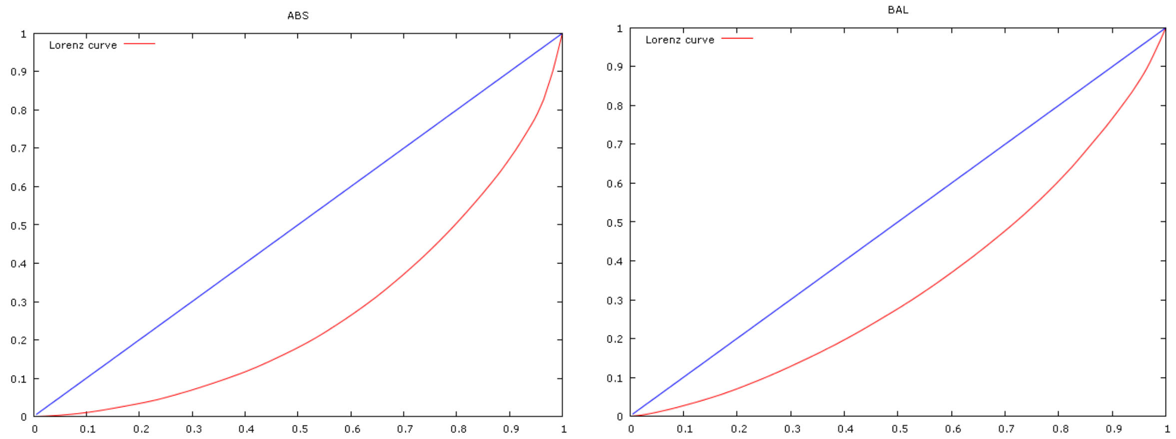
C.2.1. Lorenz curves for food and beverages (in absolute terms on the left and in relative terms on the right)



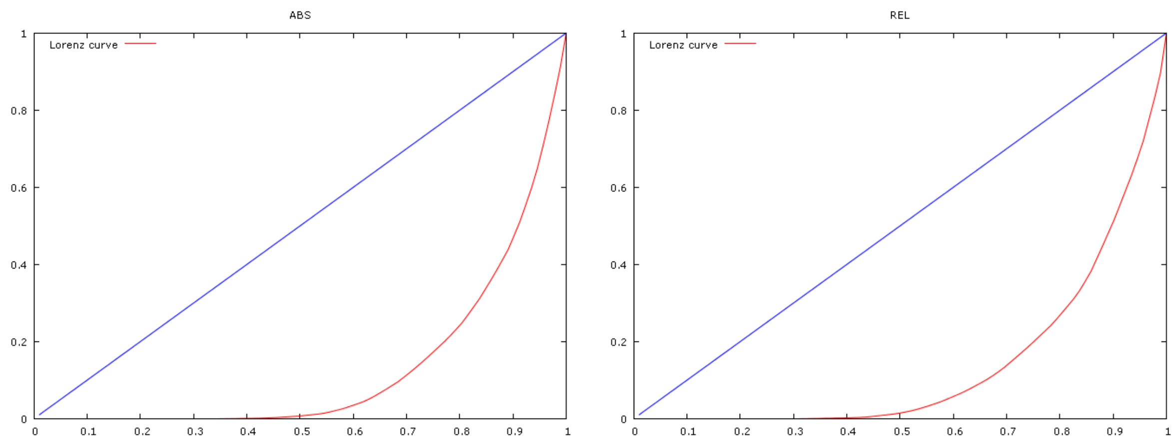
C.2.2. Lorenz curves for food and beverages (in absolute terms on the left and in relative terms on the right)



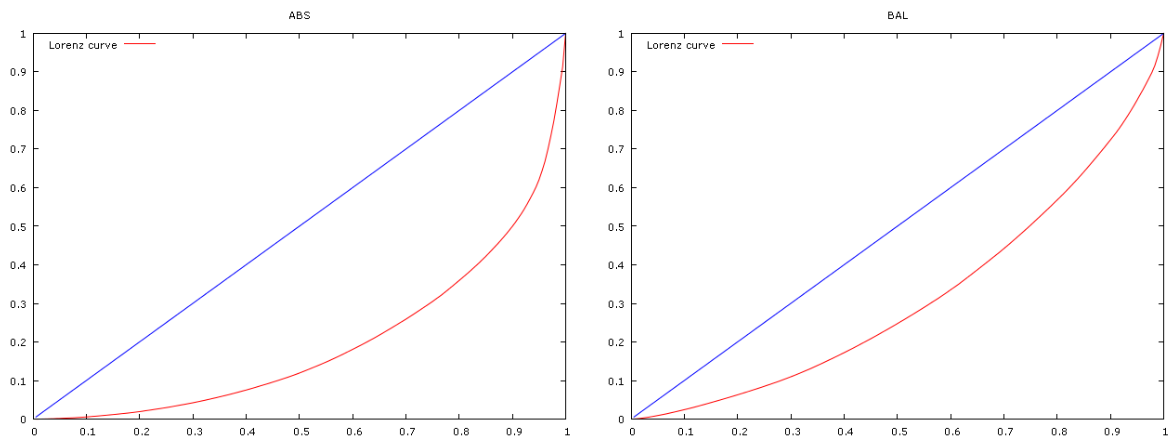
C.2.3. Lorenz curves for wood and furniture, cork and paper (in absolute terms on the left and in relative terms on the right)



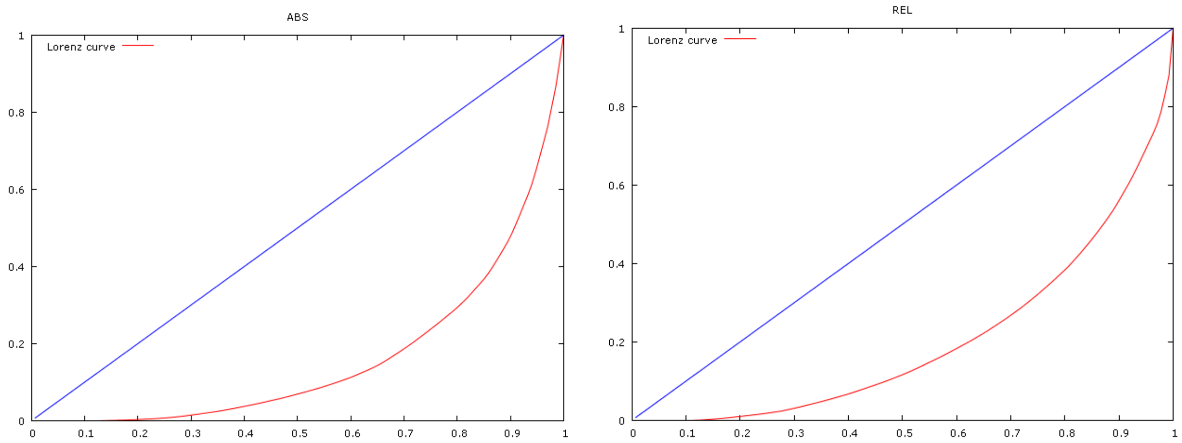
C.2.4. Lorenz curves for manufacture of coke and refined petroleum products (in absolute terms on the left and in relative terms on the right)



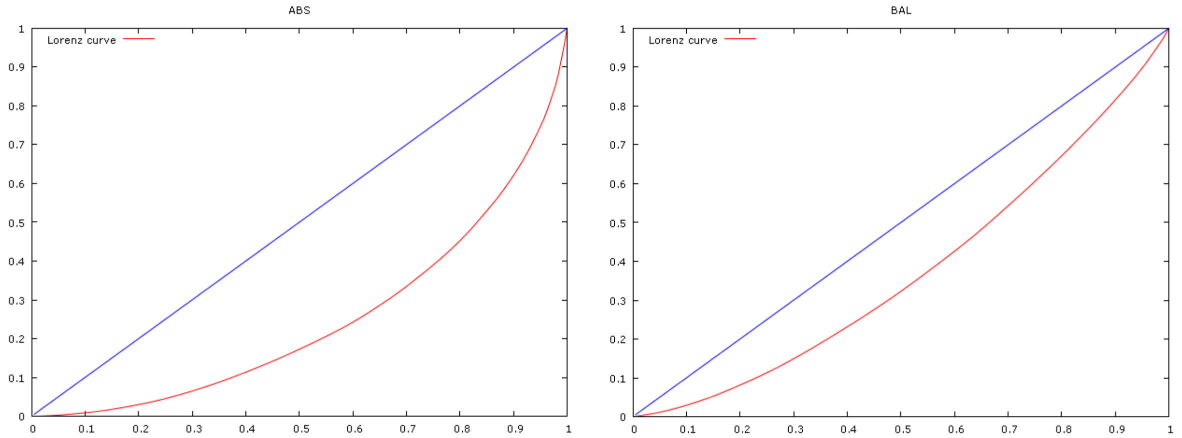
C.2.5. Lorenz curves for manufacture of chemicals and chemical products (in absolute terms on the left and in relative terms on the right)



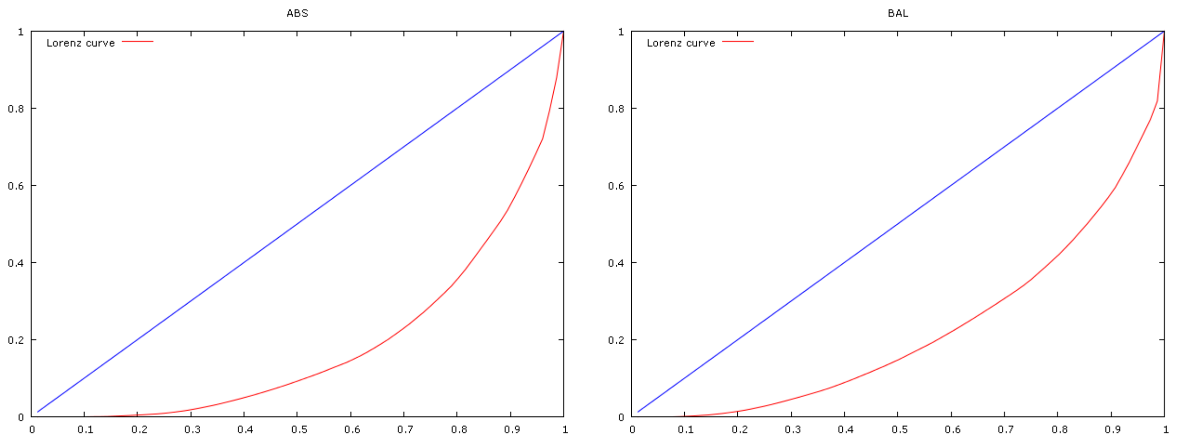
C.2.6. Lorenz curves for manufacture of basic pharmaceutical products and pharmaceutical preparations (in absolute terms on the left and in relative terms on the right)



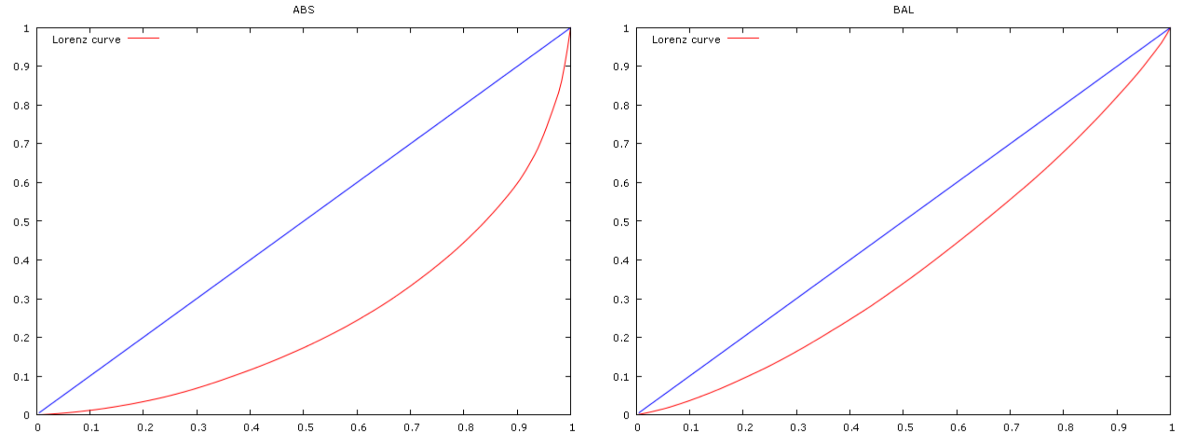
C.2.7. Lorenz curves for non-metallic minerals and products (in absolute terms on the left and in relative terms on the right)



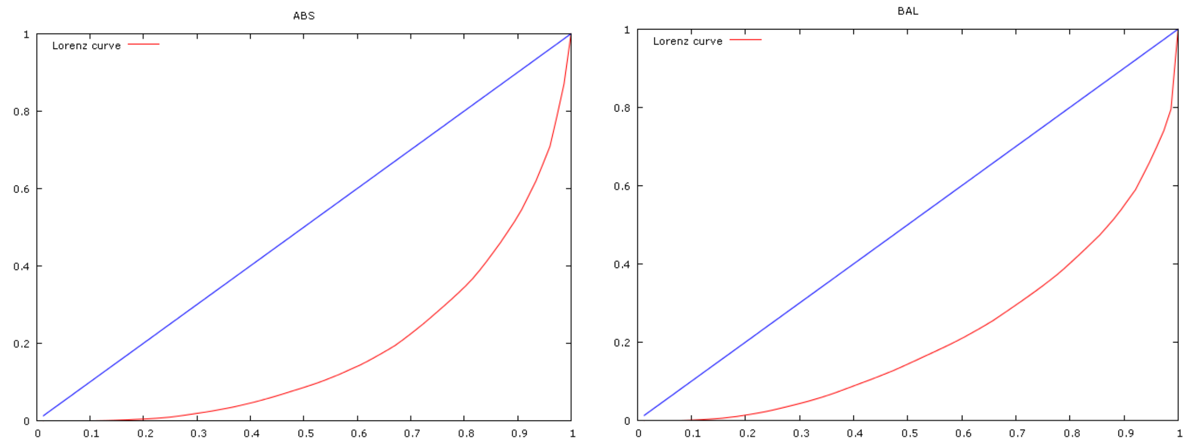
C.2.8. Lorenz curves for basic metals and metal products (in absolute terms on the left and in relative terms on the right)



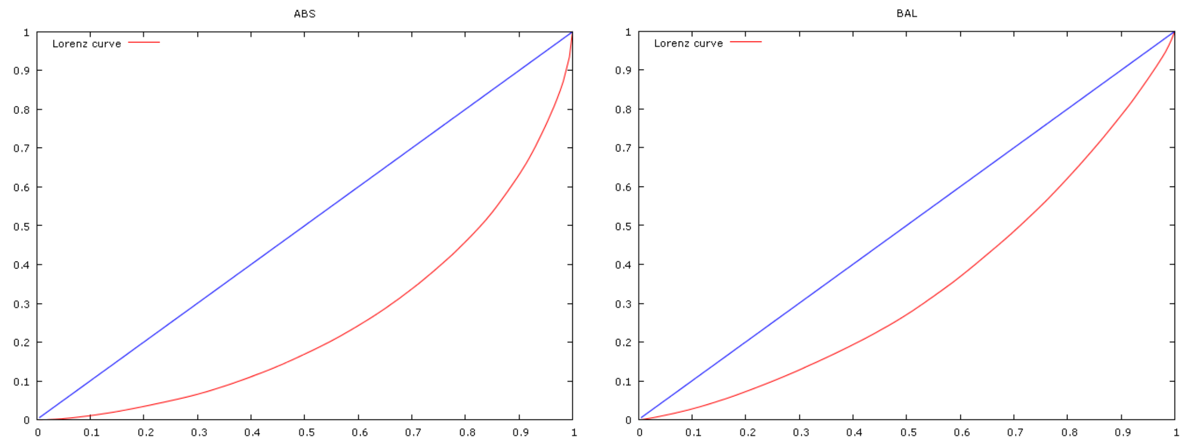
C.2.9. Lorenz curves for computer, electric, electronic and optical products (in absolute terms on the left and in relative terms on the right)



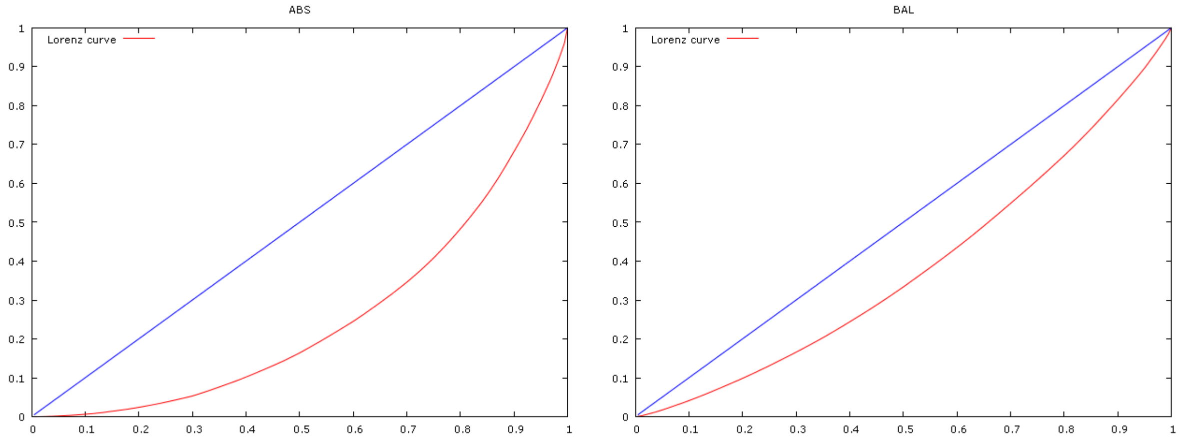
C.2.10. Lorenz curves for motor vehicles and transport equipment (in absolute terms on the left and in relative terms on the right)



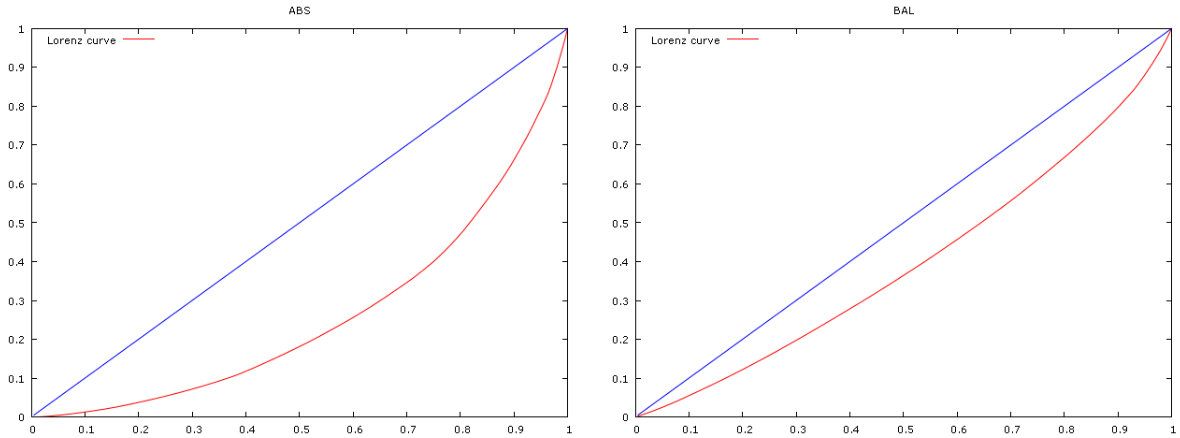
C.2.11. Lorenz curves for electricity, gas, steam and air conditioning supply (in absolute terms on the left and in relative terms on the right)



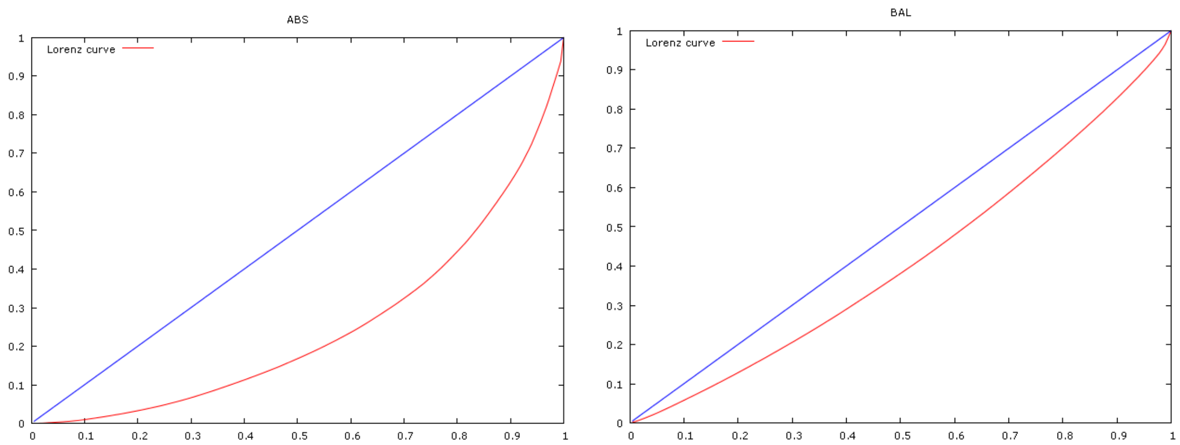
C.2.12. Lorenz curves for water supply, waste management and remediation activities (in absolute terms on the left and in relative terms on the right)



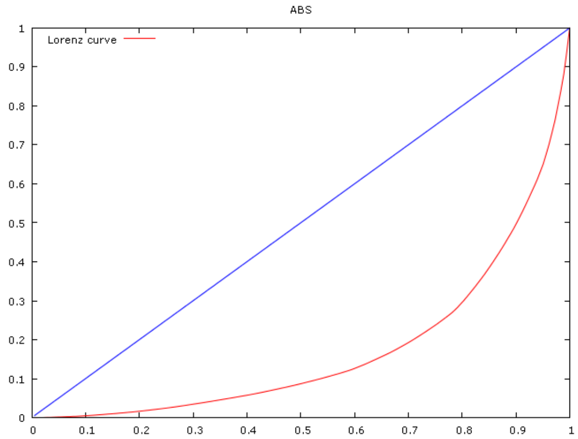
C.2.13. Lorenz curves for construction (in absolute terms on the left and in relative terms on the right)

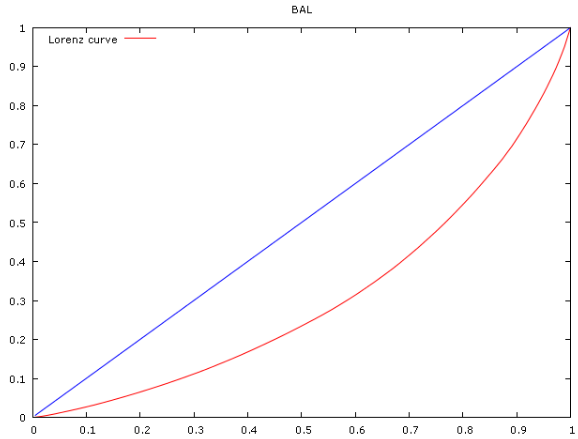


C.2.14. Lorenz curves for transportation and storage (in absolute terms on the left and in relative terms on the right)

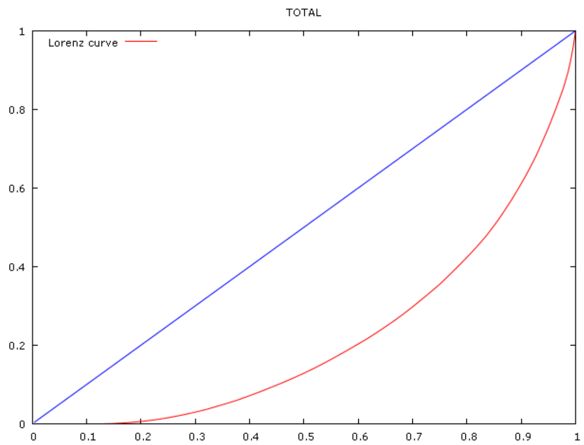


C.2.15. Lorenz curves for information and communication products and technologies (in absolute terms on the left and in relative terms on the right)





C.2.16. Lorenz curves for all industrial sectors (in absolute terms)



Annex D. List of the presentations evaluated in chapter 4

Name of the region, state	Presenters	Venue
Algarve, Portugal	Pinto, H.	Faro (Algarve, Portugal), 4th-5th July 2013
Alsace, France	Sagnier, C., and Anquetil, S.	Strasbourg (Alsace, France); December 4th 2012
Aragón (Aragon), Spain	García, M.A., and Brunet, O.	Palma de Mallorca (Illes Balears, Spain); February 7th-8th 2013
Attiki (Attica), Greece	Kapelouzou, S., and Diathesopoulos, M.	Strasbourg (Alsace, France); December 4th 2012
Bratislavský (Bratislava), Slovakia	Vrátny, Š., Furik, P., and Hakel, M.	Strasbourg (Alsace, France); December 4th 2012
Centre (Center), France	Derrac, M., Garcia, J.L., and Pina, F.	Pisa (Tusacany, Italy), 27th-28th September 2012
Emilia-Romagna, Italy	Bertini, S.	Strasbourg (Alsace, France); December 4th 2012
Illes Balears (Balearic Islands), Spain		Palma de Mallorca (Illes Balears, Spain); February 7th-8th 2013
Islas Canarias (Canary Islands), Spain	Portugués, C., and Ruiz, J.	Ponta Delgada (Azores, Portugal); June 5th-6th 2012
Jihomoravský kraj (South Moravia), Czech Republic	Chládek, P.	Brno (South Moravia, Czech Republic); March 13th-14th 2013
Kujawsko-Pomorskie (Kujawy-Pomerania), Poland	Wachulec B., and Dolecka, M.	Faro (Algarve, Portugal), 4th-5th July 2013
La Réunion (Réunion), France	Cadet, F.	Ponta Delgada (Azores, Portugal); June 5th-6th 2012
Languedoc-Roussillon, France	Dufour, V., and Arsigny, V.	Vaasa (West Finland, Finland), May 14th-15th 2013
Lietuva (Lithuania)	Babelytė-Labanauskė, K., Kucevičius, D., Petrauskienė, J., and Reimeris, R.	Budapest (Central Hungary, Hungary), 24th-25th June 2013
Lubelskie (Lublin), Poland	Pocztowski, B., and Rycaj, E.	Vaasa (West Finland, Finland), May 14th-15th 2013
Malta	Castillo, N.	Budapest (Central Hungary, Hungary), 24th-25th June 2013
Marche, Italy	Sopranzi, P., Torelli, A., and Valenza, A.	Palma de Mallorca (Illes Balears, Spain); February 7th-8th 2013
Nord-Pas de Calais, France	Pruvot, J.M., Godest, J.C., Giry, Y., and Pham, V.	Sevilla (Andalusia, Spain), 3rd May 2012
Northern Ireland, United Kingdom	McGarrity, C., and Lilley, M.	Sevilla (Andalusia, Spain), 3rd May 2012
País Vasco (Basque Country), Spain	Freije, I.	Sevilla (Andalusia, Spain), 3rd May 2012
Piemonte (Piedmont), Italy	Gay, E.	Vaasa (West Finland, Finland), May 14th-15th 2013
Pomorskie (Pomerania), Poland	Matczak, R., and Oberbek, J.	Palma de Mallorca (Illes Balears, Spain); February 7th-8th 2013
Puglia (Apulia), Italy	Agrimi, A., and Zonno, A.M.	Sevilla (Andalusia, Spain), 3rd May 2012
Rhône-Alpes, France	Gahigi, A., Picard, C., and Fraysse, J.	Faro (Algarve, Portugal), 4th-5th July 2013
Sachsen (Saxony), Germany	Schöne, M., and Donauer, J.	Brno (South Moravia, Czech Republic); March 13th-14th 2013
Sicilia (Sicily), Italy	Polizzano, G.	Faro (Algarve, Portugal), 4th-5th July 2013

Name of the region, state	Presenters	Venue
Świętokrzyskie, Poland	Wozniak, A.	Brno (South Moravia, Czech Republic); March 13th-14th 2013
Toscana (Tuscany), Italy	Fabbri, E.	Pisa (Tusacany, Italy), 27th-28th September 2012
Vest (West), Romania	Cibu-Buzac, R., and Mariciuc, A.	Sevilla (Andalusia, Spain), 3rd May 2012
Wales, United Kingdom	Rosser, D., and Davies, A.	Brno (South Moravia, Czech Republic); March 13th-14th 2013

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